ТЕОРИЯ И ПРАКТИКА СОВРЕМЕННОЙ НАУКИ: ВЗГЛЯД МОЛОДЕЖИ

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SECTION 1. ECONOMICS AND SOCIAL DEVELOPMENT TRENDS

УДК 336.11

BASICS OF PERSONAL FINANCE MANAGEMENT: THE PATH TO FINANCIAL INDEPENDENCE

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Abstract. The paper considers the basics of personal finance management. As a result of the study, the methods of financial management, the tendency to achieve financial independence and the reduction of risks in their use are demonstrated.

Keywords: personal finance, tools, budget, planning, savings.

ОСНОВЫ УПРАВЛЕНИЯ ЛИЧНЫМИ ФИНАНСАМИ: ПУТЬ К ФИНАНСОВОЙ НЕЗАВИСИМОСТИ

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Аннотация. В работе рассматриваются основы управления личными финансами. В результате исследования демонстрируются методы управления финансами, тенденция достижения финансовой независимости и уменьшение рисков при их использовании.

Ключевые слова: личные финансы, инструменты, бюджет, планирование, накопления.

The modern world is characterized by rapid changes in the economy, technological advancements, and social structures-all of which significantly impact personal financial management. Amidst instability and the high volatility of financial markets, individuals face the need to adapt to new challenges and actively leverage opportunities offered by contemporary technologies.

First and foremost, inflationary processes stand out as one of the most pressing challenges, eroding the purchasing power of money and compelling individuals to enhance their financial literacy to respond adequately to shifting price levels. As research emphasizes, improving the investment climate, stimulating investment activity, providing reliable information, and advancing citizens' financial literacy can help transform household savings into investments [1, p. 226]. This implies that effective personal financial management requires not only careful budget monitoring

but also active participation in investment activities-an effort inherently tied to the gradual development of financial culture and increased financial literacy among the population.

At the same time, evolving global and local market factors generate a certain degree of instability, particularly in the labor market, where employment conditions have become increasingly unpredictable. Additionally, rising consumer lending amplifies the risk of personal debt obligations. In this context, it becomes crucial to adjust one's financial strategy promptly-an outcome achievable through modern tools and technologies. Thus, contemporary challenges in personal finance management underscore the necessity of cultivating strategic thinking among individuals, developing their ability to adapt to rapidly changing financial environments, and harnessing all available innovative solutions to enhance resilience and achieve long-term financial independence [2].

Tracking income and expenses is a fundamental component of personal budget management. It enables individuals to objectively assess their financial situation, make informed decisions, and attain financial stability. Regularly recording all inflows and outflows provides a clear picture of cash flow, identifies inefficient expenditures, and facilitates timely budget adjustments. In this regard, the following method for managing income and expenses is proposed to help identify unnecessary spending [3].

Table – Personal Income and Expense Management

Управление личными (семейными) финансами					
Income			*Expenses*		
Type of Income		Type of Income	Type of Income		Type of Income
…	…	…	…	…	…
Total Income		…	*Total Expenses*		…
Total Income		*Total Expenses*	*Balance*		
…		…	Income – Expenses		
Expenses that can be reduced					Amount
…					…
				Total Savings	…
Balance (Income – Expenses)		*Savings (Expenses that can be reduced)*	*Total Amount (Sum allocated for savings or investments)*		
…		…	Balance +(-) Savings		

Systematic tracking of income and expenses helps individuals understand their financial inflows and outflows, enhances financial literacy, and promotes rational use of resources. Electronic spreadsheets, modern mobile applications, and specialized software optimize personal finance management and help cultivate consistent financial habits.

Maintaining accurate records of income and expenses is essential for creating a realistic budget, setting financial goals, and monitoring progress toward achieving

them. In a dynamic economic environment and amid low levels of financial literacy, this practice is particularly crucial for developing personal financial planning skills among the population. Modern technologies make financial tracking more accessible by offering automated insights and fostering greater self-discipline. Indeed, consistent income and expense tracking forms the foundation of sound financial strategies and long-term financial independence.

Contemporary financial tools-built on advanced technologies and innovative approaches-significantly simplify personal financial management. They enhance the efficiency, accuracy, and convenience of financial transactions, making them an indispensable part of individuals' daily lives. Savings accounts, for instance, provide a secure mechanism for storing funds while also enabling them to grow through interest accrual-a feature especially valuable in times of inflation [2].

The variety of financial products-including deposits and specialized programs-enables individuals to tailor their financial strategies to their specific goals and personal circumstances. This fosters more flexible and personalized approaches to personal financial management.

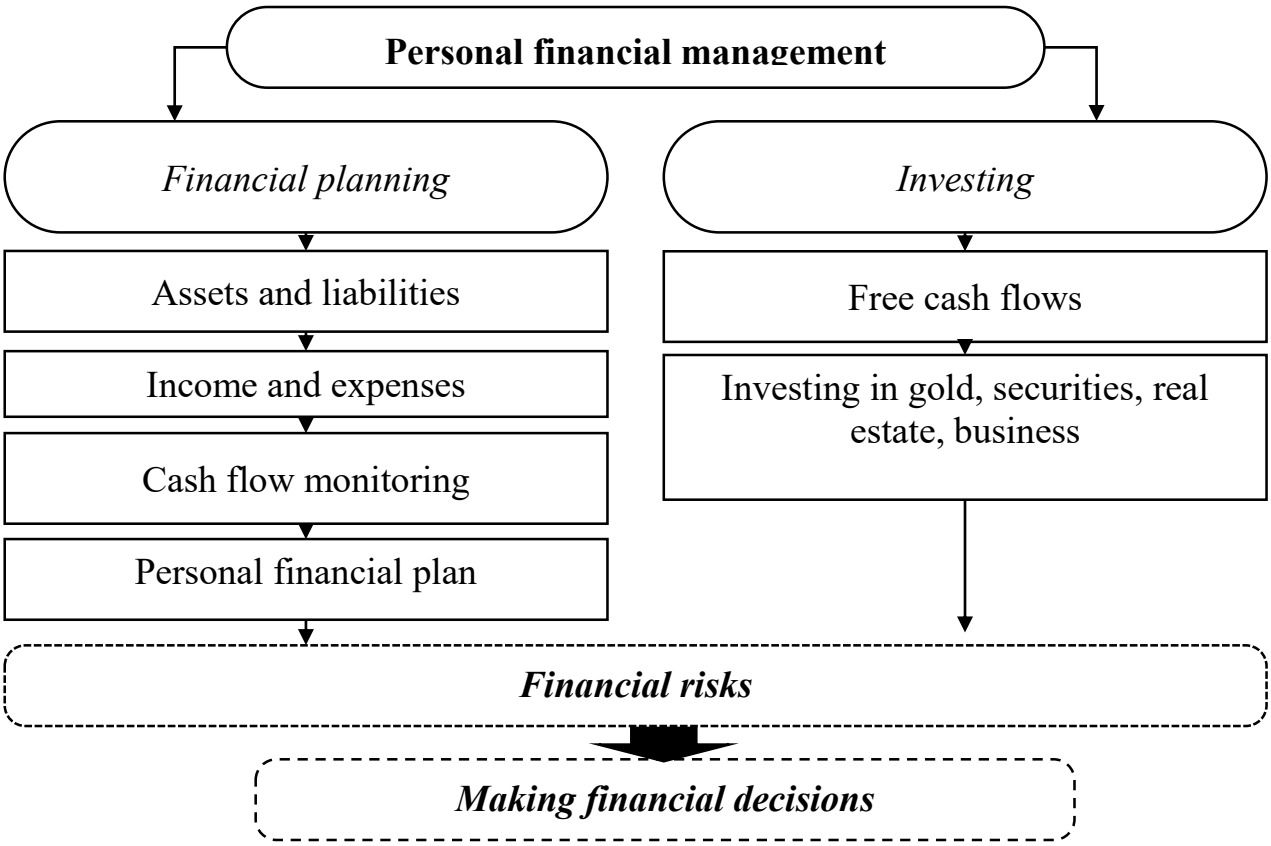


Figure. Principles and methods of personal financial management

Mobile apps and online planners integrated with income and expense tracking systems automate the process of monitoring financial transactions. They not only record transactions but also provide detailed expense analysis and support the setting and achievement of both short-term and long-term financial goals. These tools send reminders about upcoming payments and help ensure timely fulfillment of financial obligations.

Using modern financial tools enhances financial literacy and fosters sustainable

habits of budgeting and investing. They enable rational budget management, increase the transparency of financial operations, and improve the analyzability of financial indicators.

Future development prospects include the integration of artificial intelligence and blockchain technology, opening new horizons for automation and greater efficiency in financial planning. These innovations will allow the creation of more sophisticated and adaptive personal finance management systems, thereby supporting the attainment of financial independence and securing long-term stability.

Creating savings and emergency funds is a key element of financial security and sustainable development. They support the achievement of long-term goals and help reduce stress in challenging situations. Systematically setting aside a portion of income builds a strong financial foundation, minimizes debt burden, and increases independence. Emergency funds cover unexpected expenses, such as medical emergencies or equipment breakdowns. It is generally recommended to save an amount equivalent to three to six months of regular expenses.

To ensure effective saving, it is important to follow a systematic approach: develop a budget with fixed allocations, use automatic transfers, and maintain financial discipline. Early financial literacy helps individuals manage money wisely and plan expenses more effectively. Modern technologies support proper and conceptually sound personal financial management.

Investments also deserve consideration, as they represent one of the key strategies for achieving financial independence. Selecting appropriate instruments accelerates capital accumulation and enhances returns. Investors can build an efficient portfolio by diversifying assets and reducing overall risk. Current markets offer stocks, bonds, real estate, and digital assets. Stocks generate income through price appreciation and dividends; bonds provide stable returns and lower portfolio volatility; real estate acts as a hedge against inflation and produces rental income; digital assets, however, require in-depth study and careful risk assessment [4].

Effective investing involves risk management, diversification, and ongoing portfolio monitoring. Personal goals, financial capacity, and risk tolerance must all be taken into account. Aggressive investors aim for high returns and accept higher risk, while conservative investors prioritize stability and capital preservation. Developing a sound investment strategy requires clarity about objectives and time horizons.

Improving public financial literacy promotes more informed decision-making. Government initiatives actively support financial education, helping individuals assess risks and choose appropriate instruments. Proper planning of resources and goals is crucial for success. Experts agree that investment effectiveness largely depends on the investor’s knowledge and skills.

Financial planning and goal setting are essential components of personal financial management and achieving financial independence. This process includes assessing income and expenses, identifying priorities, and distinguishing between short- and long-term goals. Short-term goals require regular monitoring and saving discipline, whereas long-term goals demand systematic investing and accumulation [5, p. 84].

Strategy development involves analyzing resources, income, expenses, and

opportunities, as well as applying budgeting and financial analysis techniques. Regularly reviewing and updating the plan is essential to adapt to changing circumstances.

Financial literacy serves as the foundation for effective financial management. It helps individuals avoid fraud, use financial instruments correctly, and reduce stress associated with money matters. Setting clear goals fosters healthy financial habits-such as consistently saving and avoiding impulsive purchases-which contribute to long-term stability. Successful planning requires not only the creation of a strategy but also its ongoing adjustment to evolving personal and economic conditions [6, p. 94]. This process cultivates a sense of financial responsibility and promotes a sustainable financial culture.

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SPECIAL TAX REGIMES AS A TOOL TO STIMULATE AND LIMIT BUSINESS DEVELOPMENT

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Abstract. The tax policy of the Russian Federation has undergone significant changes in the field of legal and economic regulation of economic processes over the past 5 years. The introduction of experimental special tax regimes is no exception, as well as the improvement of existing regimes aimed at increasing the business activity of business entities, stimulating entrepreneurship and stabilizing tax revenues to budgets of all levels. Hence, this article is devoted to the analysis and definition of the economic role of special tax regimes within the framework of their stimulating and restrictive functions.

Keywords: tax regime, patent system, OKVED, professional income tax, tax policy, restrictions, economic incentives.

СПЕЦИАЛЬНЫЕ НАЛОГОВЫЕ РЕЖИМЫ КАК ИНСТРУМЕНТ СТИМУЛИРОВАНИЯ И ОГРАНИЧЕНИЯ РАЗВИТИЯ БИЗНЕСА

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Аннотация. Налоговая политика Российской Федерации за последние 5 лет претерпевала значительные изменения в области правового и экономического регулирования экономических процессов. Исключением не стало введение экспериментальных специальных налоговых режимов, а также совершенствование уже существующих режимов, целью которых является повышение деловой активности хозяйствующих субъектов, стимулирование предпринимательства и стабилизация налоговых доходов в бюджеты всех уровней. Этим обусловлен выбор темы данной статьи: анализ и определение экономической роли специальных налоговых режимов в рамках их стимулирующей и ограничительной функций.

Ключевые слова: налоговый режим, патентная система, ОКВЭД, налог на профессиональный доход, налоговая политика, ограничения, экономические стимуляторы.

In the tax policy of the Russian Federation, as one of the macro-regulators of the dynamics of economic development, there are several important economic and legal areas that determine the intensity of economic activity of business entities, stimulating or limiting them in one way or another. One of these areas is the policy in the field of special tax regimes.

First of all, it is necessary to determine the difference between the general tax regime and the special one in order to further characterize the latter. The general tax regime is understood as "the totality of all taxes established by tax legislation, the obligation to pay which arises, changes and ceases if there are grounds provided for by law" [1, p. 107]. At the same time, the general legislative tax regime is expressed in the totality of taxes and fees that operate on the territory of the Russian Federation, a federal subject, or a municipal entity in accordance with regulatory legal acts of the appropriate level, and are required to be paid by all entities subject to the tax. It is important to note that there is no distinction between the categories of general and special regimes at the legislative level in principle, and their differences are reflected in the specifics of legal regulation and the economic objectives of the impact. Therefore, as well as the concept of a general regime, the special tax regime in this study is proposed to be understood in the context of the theoretical doctrine of N.S. Ivashchenko as "part of the general tax regime, expressed by a certain combination of legal means that create conditions for the functioning of tax relations in order to satisfy the interests of individual subjects of law" [2, p. 66]. From a legal point of view, the special tax regime has 2 important features: firstly, it is a narrower area of tax relations, and secondly, it is regulated by special rules that prevail over general legal norms [1, p. 108]. The legal features of the special regime directly imply, and are also interrelated with them, the economic characteristics and specifics of the impact on economic processes, which will be discussed below.

The industry-specific scope of the special regime includes the following types of economic activities: agriculture; mining and processing; fuel and energy complex; trade, transportation and storage; construction; hotel activities and catering; information and communication activities; financial activities; scientific and innovative activities; public administration and security; education and educational services; healthcare and other types [3, p. 51]. The distribution of the weight shares of the use of special tax regimes by the main types of economic activity is presented in table [4].

Table – Structure of tax receipts by type of special tax regimes by type of economic activity for 2024, in %

OKVED Section	STS	ASTS	UAT	PTS	PIT
A	1,20	0,28	96,42	0,54	0,24
B	0,12	0,09	0,00	0,00	0,00
C	7,07	6,20	2,59	2,24	1,11
D	0,28	0,10	0,00	0,01	0,01

E	0,45	0,19	0,00	0,13	0,03
F	10,02	10,78	0,04	3,25	2,06
G	29,44	20,76	0,22	55,18	4,40
H	5,13	4,99	0,01	8,73	4,60
I	5,14	2,20	0,01	8,53	0,54
J	4,25	13,83	0,00	1,46	1,70
K	1,07	0,58	0,00	0,09	0,10
L	14,33	6,10	0,31	11,69	0,64
M	9,45	20,85	0,06	1,73	2,94
N	5,78	4,69	0,01	1,16	0,87
O	0,06	0,04	0,01	0,00	0,00
P	0,82	2,00	0,00	0,71	0,80
Q	1,65	0,58	-0,01	0,45	0,13
R	2,15	3,15	0,00	0,71	0,84
S	1,58	2,60	0,00	3,38	1,52
TU	0,00	0,00	0,00	0,00	0,00
Not distributed by OKVED codes					
-	0,02	0,01	0,32	0,00	0,00
For individuals who are not sole proprietors and do not have an OKVED code					
-	0,00	0,00	0,00	0,00	77,42
In total, from the STR	**88,69**	**0,16**	**1,65**	**3,07**	**6,42**

Let's analyze the data in the table on the structure of users of the STR for 2024.

The share of the STS in the structure of the National Tax System accounts for 88,69 % of taxes levied on business entities. At the same time, the following types of economic activities are active users of the regime in the structure of the STS: trade and repair of motor vehicles – 29,44 %; construction – 10,02 %; real estate transactions – 14,33 %; professional, scientific and technical activities – 9,45 %. It is also worth noting the absolute dynamics in the use of the USN as the main tax regime in the amount of +1,48 % compared to 2023 [3, p. 54].

A special feature of the simplified tax system is that business entities using it as the main regime are able to choose the object of taxation (for example: “income” or “income minus expenses”), thereby reducing the tax burden on businesses; get rid of part of the taxes paid (for example: personal income tax and personal property tax for individual entrepreneurs); or take advantage of extended “tax holidays” up to 2 years. However, in contrast to the stimulating properties of the USN, there are also a number of restrictions: the limit on the number of employees (when changing the tax regime – no more than 100 people, while maintaining the STS – no more than 130 people); the inability to open branches of the company (clause 1, clause 3, Article 346,12 of the Tax Code of the Russian Federation); restriction on permitted types of activities: prohibition the organization of gambling, the provision of banking, notarial, legal services, etc.; limitation of the LLC's participation in other organizations to 25 %; the remaining limit of funds in accounts of 150 million rubles, and other restrictions [5, p. 168].

A modified form of the tax system is the Automated Simplified Taxation System introduced by Federal Law No. 18-FZ dated 02/25/2022 in Article 18 of the Tax Code of the Russian Federation, which is currently at the experimental stage [6]. Its main features are the elimination of reporting and the automatic calculation of the tax burden of the organization, as well as the provision of social guarantees for employees from the budget. The main limitations of the system are: the number of employees is not more than 5 people; annual income is not more than 60 million rubles; the residual value of the organization's fixed assets is not more than 150 million rubles.; a ban on the use of other tax regimes, including the combination of STS and GTR [7].

In the structure of the STR, the ASTS is only 0,16 %, as it has been introduced in several regions of the Russian Federation in a test mode and is currently being finalized. The main types of economic activity using the ASTS are: construction – 10,78 %; trade and repair – 20,76 %; information and communication activities – 13,83 %; professional, scientific and technical activities – 20,85 %.

Considering the Unified Agricultural Tax, it is worth noting the specifics of its distribution across economic entities: organizations and entrepreneurs engaged in the production, sale and primary processing of agricultural products. The abolition of the single imputed income tax led to the formation of a taxation system in the form of a single agricultural tax (UAT), which, along with the simplified taxation system (STS), took the position of an alternative tax regime. According to current legislation, business entities applying this system are required to calculate and pay a single tax based on the tax base, which is the difference between income and expenses, subject to taxation at a fixed rate of 6 %. It is important to note that taxpayers are exempt from paying most federal, regional and local taxes, excluding land and transport taxes [5, p. 165]. However, organizations and entrepreneurs, in accordance with the Tax Code of the Russian Federation, are required to pay VAT on the UAT, while for a number of subjects there is a choice whether to pay VAT or not, but at the request of the tax authorities, they are taxed in the amount of the amount calculated for the reporting period for VAT.

In the structure of the STR, the UAT is 1,65 %, and 96,42 % of the payers are organizations and sole proprietors engaged in agriculture, forestry, hunting, fishing, and fish farming. Such a minority of the UAT in the structure of the STR is explained by its specification and the number of organizations in the field of agriculture that switched to this tax after the abolition of the imputed income tax. This factor is more due to the structural component of the Russian economy than to natural factors or the influence of the general economic environment.

The next, equally important, tax regime is the Patent Taxation System, which is often referred to as the SME trade tax. The PTS is a special tax regime that provides for individual entrepreneurs to obtain a patent granting them the right to operate exclusively within a limited list of areas primarily focused on providing household services to the public. The list of permitted types of activities is established by the regional legislation of the subjects of the Russian Federation, based on the provisions of paragraph 2 of Article 346,43 of the Tax Code of the Russian Federation. The

prohibition on the use of this regime applies to certain categories of activities specified in paragraph 6 of this article. The application of the PTS allows business entities to be automatically exempted from the obligation to pay personal income tax (personal income tax) in respect of income received from their activities, as well as property tax on individuals, with the exception of real estate taxed at cadastral value. This tax regime is compatible with other tax systems, such as the Simplified Taxation System (STS). Disadvantages of the patent system include: limitation of its application to one type of activity; a narrow range of possible business lines, mainly consumer services; established limits on the amount of annual revenue (up to 60 million rubles) and the number of employees (up to 15 people inclusive). Among the advantages are the simplicity of income accounting; exemption from a number of tax obligations; the moderate cost of patents, depending on the potential income level of the entrepreneur; as well as a relatively low tax burden, set at 6 % of the estimated gross income [5, p. 166].

In the structure of the STR, the PTS is 3,07 %, where the main activities using the tax regime are: trade and repair – 55,18 %; real estate transactions – 11,69 %.

The final item in the review of the STR is the PIT – the tax on professional income, which accounts for 6,42 % of the structure of special regimes. The specifics of the regime determine its main user – individuals who are not registered as sole proprietors and do not have the OKVED code – 77,42 %.

PIT or self-employment is a very controversial regime from an economic point of view. On the one hand, the PIT has served as a powerful incentive to boost the economic activity of the population by reducing the tax burden. On the other hand, it has become an effective way to whiten the incomes of the shadow economy. Among other things, the PIT is controversial for one reason – taxpayers, due to the maximum simplification of tax payments and minimal control by tax authorities, simply do not reflect the actual “picture” of their income, which is currently the main determinant of discussions about the abolition of this tax regime in 2026. According to current data, the number of officially registered self-employed citizens reaches 9,3 million people, of which a significant majority (about 8,8 million) are individuals engaged in entrepreneurial activity independently, while the remaining (about 0,5 million) operate as individual entrepreneurs. The observed growth rate is demonstrated by the daily registration of about eight thousand new taxpayers. Over the entire period of operation of the professional income tax, the total amount of income earned by self-employed citizens exceeded 2,9 trillion rubles. The total number of generated checks amounted to more than 1,59 billion copies, while the average size of one transaction is in the range of 1,8 thousand rubles [8, p. 165].

Based on the analysis of current special tax regimes, it is possible to draw several conclusions about their stimulating and restrictive nature.

The stimulating function of the STR is expressed through: reducing the tax burden on business entities; the possibility of choosing a taxable object; the possibility of applying several tax regimes, except for the exceptions mentioned; simplified accounting systems and tax payment procedures. The limiting function is expressed

through the limitation of the number of employees; the exclusion of the possibility of conducting certain categories of activities for each type of STR; the requirements for the maximum income of the organization and the maximum cash balance of the business; differentiation of the types of STR by types of economic activity and a complete ban on the use of STR for a whole list of types of activities. It follows that in addition to the legal and fiscal role, special tax regimes perform an important economic task: stimulating or limiting the business activity of economic entities, which directly affects the total volume of public product, economic conditions and, in the long term, can be used as a tax lever for managing economic cycles [9, p. 679].

Within the framework of the economic role of the STR, it is worth considering important aspects.

First, stimulating economic activity and entrepreneurship helps to warm up the economy, thereby increasing tax revenues of budgets at all levels. However, excessive abuse, such as PIT, or automatic stimulating tax policy in the context of an overheating economy can have the opposite effect – the creation of an excess product creates a shortage of demand, an increase in inventories and cash balances of businesses in the current period, which presuppose inflationary expectations of economic entities, increase total storage costs and, as a result, lead to further reducing business activity, hiding income, and rapidly dumping money into the economy. Ultimately, this creates deficit budgets, as there is an unsecured supply, in other words, the business spends more than it earns.

Secondly, the existence of restrictions is necessary both at the legal and economic levels to ensure a balance of tax policy and the ability to discreetly influence the ongoing processes in the economy in real time [10, p. 278].

Thus, the introduction and subsequent analysis of special tax regimes demonstrate a tendency towards progressive reform of the tax system, stimulating entrepreneurial activity and creating favorable conditions for sustainable economic development. The effectiveness of further improvement of these mechanisms is due to the need for regular monitoring of current economic realities and an adequate response to the needs of the business community, as well as to the current economic situation.

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FEATURES OF CREDIT RISK MANAGEMENT IN THE CONTEXT OF DIGITAL TRANSFORMATION OF MICROFINANCE

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Abstract. This article examines digital transformation in microfinance organizations' credit risk management. Analyzing market trends and technological innovations, it identifies key risk management aspects in the digital economy. The study reveals new economic security challenges and proposes methodology improvements for MFOs. Special focus is given to algorithmic bias, cyber risks, and explainable AI implementation to enhance risk assessment accuracy and security.

Keywords: microfinance, credit risk, digital transformation, artificial intelligence, financial inclusion, economic security, machine learning, big data.

ОСОБЕННОСТИ УПРАВЛЕНИЯ КРЕДИТНЫМИ РИСКАМИ В УСЛОВИЯХ ЦИФРОВОЙ ТРАНСФОРМАЦИИ МИКРОФИНАНСИРОВАНИЯ

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Аннотация. В статье исследуются трансформационные процессы в системе управления кредитными рисками микрофинансовых организаций (МФО) под влиянием цифровизации финансовых услуг. На основе анализа современных тенденций рынка микрозаймов, нормативных изменений и технологических инноваций выявлены ключевые особенности риск-менеджмента в условиях развития цифровой экономики и искусственного интеллекта. Определены новые вызовы экономической безопасности и предложены направления совершенствования методологии управления кредитными рисками МФО. Особое внимание уделяется проблемам алгоритмической предвзятости, киберрискам и объяснимой необходимости внедрения искусственного интеллекта.

Ключевые слова: микрофинансирование, кредитный риск, цифровая трансформация, искусственный интеллект, финансовая доступность, экономическая безопасность, машинное обучение, большие данные.

The financial sector is experiencing accelerated digitalization that profoundly influences microfinance institutions, leading to fundamental modifications in their

credit risk management frameworks. This shift is driven by several technological factors, including the proliferation of open banking APIs, the advent of sophisticated cloud computing platforms, and the increasing affordability of advanced data analytics. Consequently, the very nature of credit risk assessment is being redefined, moving away from periodic, snapshot-based evaluations towards a paradigm of continuous, data-driven monitoring. This evolution necessitates a complete overhaul of legacy systems and compels a strategic rethinking of risk governance models to harness the potential of these new technological capabilities. As noted in a 757studio study: “The Russian AI market in the financial sector is demonstrating steady growth, reaching a volume of 900 billion rubles by 2025, up from 130 billion rubles in 2020. Financial services and banking lead in the implementation of AI technologies, with 72 % of companies adopting them” [1].

This transformation generates dual consequences, it creates opportunities for enhancing financial inclusion and assessment precision while simultaneously introducing novel systemic challenges in economic security. On one hand, these advancements open access to capital for previously underserved segments, such as entrepreneurs with thin credit files, by enabling the use of alternative data for scoring. On the other hand, the increasing reliance on complex algorithmic systems and the centralization of sensitive customer data create attractive targets for malicious actors and raise profound questions about equity and fairness. These challenges encompass cyber threats, data privacy vulnerabilities, and algorithmic discrimination. In this evolving landscape, effective credit risk management becomes paramount for ensuring microfinance institutions' sustainability and broader economic security, as evidenced by the research of Y. S. Evlakhova and A. A. Tregubova: “The crisis in the microfinance market could trigger an influx of high-risk clients into the banking sector” [2, p. 714].

The microfinance sector currently represents one of the most dynamically developing segments in individual lending and financing for micro, small, and medium enterprises worldwide. As R. V. Margatskyi, G. S. Margatskaya, M. A. Markelova, et I.V. Selezneva emphasize: “The application of modern digital technologies in scoring, remote client identification, online credit disbursement, and high-speed microcredit approval make this financing type particularly attractive for MSMEs. In countries like the USA, Poland, Hungary, and Spain, the microcredit-to-GDP ratio ranges from 70 % to 100 %, with microcredits to the SME sector comprising up to 70 % of credit portfolios” [3, p. 250].

The inherent vulnerability of the microfinance sector to credit risk is fundamentally linked to its core demographic. By primarily serving low-income populations and micro-enterprises, segments characterized by limited financial buffers and higher sensitivity to economic fluctuations, and a lack of traditional collateral or verifiable credit history, the industry operates with an intrinsically elevated probability of borrower default on both principal and interest obligations. This leads to increased inequality in access to information and an increase in defaults.

The microfinance sector exhibits an inherent vulnerability to credit risk, a characteristic fundamentally linked to its core demographic. By serving low-income populations and micro-enterprises, client segments typically characterized by limited

financial buffers, high sensitivity to economic shocks, and a lack of traditional collateral or verifiable credit history – the industry intrinsically faces an elevated probability of default.

Evdokimova O.N. state: “traditional approaches to risk management do not allow for a timely and adequate response to the challenges associated with the intensification of digitalization, changes in borrower behavior, and regulatory restrictions” [4, p. 180].

An analysis of Bank of Russia data for the first half of 2025 reveals a number of significant trends that directly impact risk management methodology in microfinance organizations [5]. By mid-year, the microfinance sector demonstrated a recovery in positive dynamics from the initial temporary adjustment period. The total volume of microloans issued during the quarter reached 533 billion rubles, representing a seven percent increase compared to the previous reporting period. The total loan portfolio of organizations increased simultaneously, reaching 739 billion rubles by June 30, 2025, at a similar growth rate. Business activity increased across all key market segments. In the business segment, quarterly growth in issuances amounted to 23 %, while the consumer segment saw a 6 % increase.

Structural changes in the market are characterized by a steady expansion of the share of remote lending, reaching 91 % in the retail segment and 62 % in the corporate segment. At the same time, a downward trend in loan approval rates has been recorded year-on-year, reflecting microfinance organizations' transition to a more balanced and conservative risk management policy.

Research into borrower payment discipline reveals a systemic problem, as every fourth delinquency is due to the inability to fulfill obligations on the first payment date. This situation indicates a persistently high level of household indebtedness and excessive risk appetite among microfinance organizations, which circumvent established macroprudential restrictions through mechanisms for inflated client solvency assessments.

Microfinance organizations continue to actively utilize distressed debt sales as part of their portfolio quality management tools. The total volume of debt obligations sold in the second quarter of 2025 reached 33 billion rubles, representing a 27 % increase compared to the 2024 quarterly average. At the same time, the share of receivables assigned to the total volume of loans increased to 6.2 % during the reporting period, maintaining the upward trend.

Strategic development directions for microfinance organizations include systematic expansion of credit products featuring funding limits, facilitating prolonged relationships with reliable borrowers. By the conclusion of the first half of 2025, revolving loan instruments constituted 28 % of consumer lending structures, with primary growth driven by additional tranches within previously established credit lines.

The analytical findings indicate that credit risk management systems in microfinance are experiencing comprehensive structural reorganization propelled by digital transformation and intensified regulatory requirements. As noted in the study by L. I. Prokopova and O. N. Evdokimova: “digitalization in this case means the transition and use of such models for risk analysis that exclude the human factor as

much as possible and are based on information technology" [6, p. 589]. This underscores the necessity for developing fundamentally innovative approaches to credit risk assessment, monitoring, and mitigation.

Key areas for development include the implementation of more conservative credit policies, the improvement of automated scoring systems based on official income data, and portfolio optimization through product segmentation and the use of receivables assignment mechanisms. The further evolution of MFI risk management will be determined by the ability of organizations to adapt. To adapt to new technological opportunities and regulatory challenges while maintaining financial accessibility for conscientious borrowers.

This integrated approach is particularly methodologically and practically significant in the borrower-seller segment operating on marketplaces. To assess these borrowers, microfinance organizations, along with a general array of alternative data, are actively integrating specialized metrics into their scoring models.

The algorithmic assessment extends beyond conventional financial data, constructing a multi-dimensional profile of the borrower's economic standing. This profile is built upon a tripartite analytical framework: first, an examination of granular, platform-specific commercial activity that reveals real-time sales velocity and market position.

Second, a temporal analysis of revenue streams, evaluating both historical performance and projected viability to gauge business resilience, and third, a critical audit of the applicant's current debt servicing obligations, which directly informs their capacity to manage additional financial liability. This synthesized data architecture allows for a more nuanced and predictive evaluation of creditworthiness than traditional models permit.

This comprehensive methodology creates a reliable system for overcoming information gaps and enables a more accurate assessment of the solvency of small and medium-sized businesses with a short credit history or no credit file at all. This allows us to successfully address the critical challenge of expanding financial inclusion while maintaining high loan portfolio quality standards and automating all stages of the client application review and approval process.

Under the traditional credit risk management model, microfinance organizations primarily rely on retrospective credit history analysis, assessment of the borrower's current financial situation, calculation of debt burden parameters, and the use of standardized statistical regression models. However, the digital transformation of microfinance implies a shift to online platforms, mobile applications, and automated systems. Therefore, traditional approaches are being supplemented with comprehensive big data analysis, including behavioral patterns, digital footprints, and multidimensional client profiling.

The fundamental difference between modern models (Table 1) lies in the shift from static assessments to dynamic forecasting, from a limited set of financial indicators to the integration of alternative data, and from standardized approaches to personalized risk assessment.

Table 1 – Comparison of traditional and digital approaches to credit risk management in microfinance organizations

Management Aspect	Traditional Approach	Digital Approach	Impact on Economic Security
Borrower Assessment	Analysis of a limited set of financial documents and credit history	Automated scoring based on big data and alternative sources (transactions, behavioral metrics, geodata)	Improved assessment accuracy for borrowers with no credit history, but increased risks of algorithmic bias and discrimination
Portfolio Monitoring	Selective checks, retrospective analysis of reporting	Continuous real-time monitoring using predictive models and machine learning	Timely identification of problematic portfolio segments, but dependence on data quality and algorithm correctness
Operational Costs	High operational costs for manual application processing and verification	Cost reduction through automation, but increased investment in IT infrastructure and cybersecurity	Cost optimization expands service accessibility, but requires significant initial investment
Risk Management	Focus on credit and operational risks, limited analysis of cyber threats	Comprehensive approach, including cyber risks, algorithm failures, regulatory changes	Increased resilience to traditional risks, coupled with growing vulnerability to targeted cyberattacks and tech failures

This table highlights that digital transformation, while introducing new vulnerabilities, generally enhances economic security through resource optimization, as evidenced by the 13 % increase in online applications in the first half of 2025, according to the Central Bank of the Russian Federation [5].

The digital systems used by microfinance organizations (MFIs) are capable of analyzing parameters (Table 2) such as digital service usage, transaction patterns, geolocation data, and behavioral characteristics in near real time, enabling the identification of hidden dependencies and the formation of more accurate creditworthiness forecasts. Furthermore, machine learning enables continuous improvement of scoring models based on new data, adapting them to changing market conditions and borrower behavioral trends.

Table 2 – Categorization of Alternative Data Types for Creditworthiness Evaluation

Data Type	Data Sources	Assessment Metrics
Transactional	Bank statements, payment systems	Income regularity, expense structure, savings availability
Behavioral	Mobile applications, web analytics	Financial services usage activity, transaction frequency
Social	Social networks, reviews, reputation platforms	Social capital, business reputation, professional connections
External	Government registries, credit bureau data, judicial databases	Criminal records, litigation history, bankruptcy records
Geospatial	Location data (GPS, cellular networks), mapping services	Location stability, proximity to work/home, area risk factors
IoT (Internet of Things)	Connected devices, sensors, smart devices	Behavioral patterns, asset utilization, business operational data

The digital transformation journey for microfinance institutions presents multiple challenges, predominantly necessitating substantial investments in technical infrastructure modernization, compounded by scarcity of qualified specialists possessing requisite technological expertise.

Comparative examination of diverse alternative data types, illustrated in Figure 1, demonstrates evident correlation between their efficacy for small and medium enterprise creditworthiness assessment and the resource expenditures required for their collection and validation.

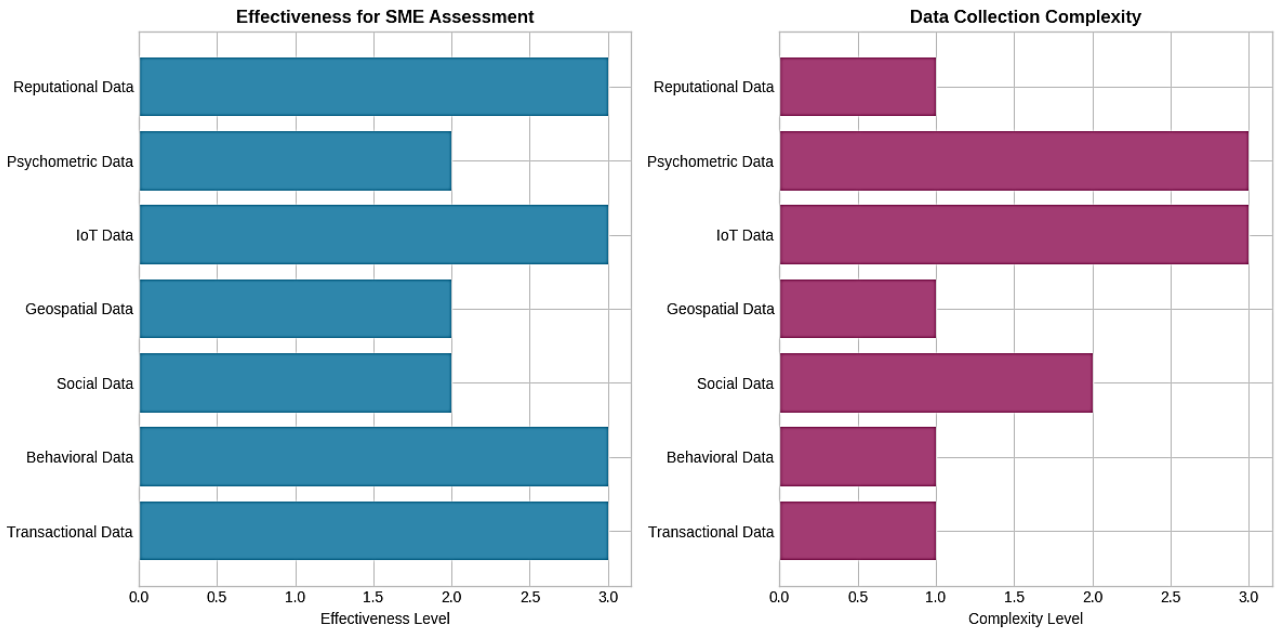


Figure 1. Efficiency and complexity of implementing alternative data types for credit scoring of small and medium businesses

From a pragmatic risk management standpoint, transactional and behavioral data streams offer a distinct methodological advantage over static historical records. Their empirical efficacy lies in generating granular, real-time signals of client conduct and financial activity, which provide a more dynamic and forward-looking assessment of creditworthiness. Furthermore, the structural nature of this data – often digitized and standardized at the source – facilitates its seamless incorporation into established analytical frameworks, enabling a more agile and responsive scoring mechanism without necessitating a complete overhaul of legacy systems. This synergy of enhanced predictive power and operational feasibility makes such data indispensable in contemporary financial modeling.

Meanwhile, psychometric and reputational data, despite their high predictive value, require significant implementation efforts due to challenges with validation, format approval, and regulatory compliance. This dynamic establishes an inherent dichotomy within the strategic calculus of microfinance institutions, the pursuit of predictive model sophistication is perpetually constrained by the imperative of operational pragmatism. Consequently, the architecture of their risk management frameworks necessitates a delicate arbitration. Executives are compelled to weigh the diagnostic value of novel, alternative metrics against their implementability, a tripartite challenge of navigating severe resource constraints, integrating new methodologies into legacy processes, and adhering to an increasingly complex web of regulatory compliance mandates. The ultimate systemic design thus emerges as a function of optimizing this critical trade-off between analytical depth and institutional feasibility.

Machine learning and artificial intelligence technologies (Table 3) are fundamentally changing the approach to credit risk assessment, offering modern algorithmic systems, including decision tree ensembles and neural network architectures, which demonstrate significant improvements in forecasting accuracy compared to classical statistical approaches.

The emerging array of alternative data, which possesses the properties of multidimensionality, weak structure and significant entropy, naturally actualizes the transition to a fundamentally new class of analytical tools, where machine learning and artificial intelligence technologies acquire the status of a structural foundation for the entire financial services sector in 2025, implementing a genuine revolution in the paradigm of credit risk assessment by replacing traditional, often linear, statistical methods with complex non-parametric algorithms, such as ensembles of decision trees (random forest, gradient boosting) and deep learning architectures, which demonstrate significantly higher forecasting accuracy due to their ability to identify hidden non-linear dependencies and patterns in big data.

Table 3 – Comparative Analysis of Machine Learning Algorithms for Credit Scoring

Algorithm	Advantages	Limitations
Logistic Regression	High interpretability of results, decision-making transparency, regulatory compliance	Limited ability to detect complex nonlinear relationships, requires feature engineering
Tree Ensembles (Random Forest, Gradient Boosting)	High predictive accuracy, noise resistance, effective detection of nonlinear patterns	Weak interpretability ("black box"), challenges in model auditing and explaining rejection reasons
Deep Neural Networks	Maximum flexibility and accuracy, automatic feature extraction, works with unstructured data	Extreme interpretation complexity, high computational resource and data volume requirements

They analyze structured and unstructured data, outperforming traditional statistical models, while directly contributing to economic security in the digital economy by preventing the accumulation of toxic assets. Results demonstrate that the use of such an approach can reduce losses by up to 25 %. For example, AI algorithms automate credit scoring using the logistic regression formula to predict risk: $PD = 1 / (1 + \exp(-(\beta_0 + \beta_1X_1 + \beta_2X_2 + ... + \beta_nX_n)))$, where PD is the probability of default, β are coefficients, and X are variables such as income, payment history, and digital footprint, which allows microfinance institutions to reduce the level of non-performing loans by 20 %.

Microfinance organizations benefit significantly from implementing models for assessing the probability of default and forecasting loss amounts in the event of insured events, based on the integrated processing of arrays of structured and unstructured data. These predictive systems integrate heterogeneous sources of information, applying advanced statistical methods and machine learning algorithms to generate credit risk assessments.

The practice of leading fintech companies confirms the effectiveness of using intelligent algorithms to predict microloan defaults using alternative data to assess client solvency.

Under conditions of tightening regulatory requirements and growing cyber threats, successful digital transformation becomes a matter of survival for microfinance organizations. This thesis can be illustrated by the experience of MigCredit company, which demonstrates targeted modernization of a critical business system. The company's original infrastructure was based on the outdated Deductor analytical platform, which by 2019 faced scalability problems. The credit pipeline capacity, designed for 10 thousand applications per day, was exceeded by 20 percent, and the average processing time for one application reached 36 seconds, creating operational risks and deteriorating customer experience [7].

The solution chosen was the Loginom low-code platform, with migration implemented in stages without stopping the existing credit pipeline. The transformation resulted in improved system performance, emergence of vertical

scaling capabilities, and reduction of future operational expenses due to the possibility of independently making changes to the decision-making system without involving external contractors.

Another notable example is the use of artificial intelligence technologies for security by Zaimer microfinance company. A joint solution with developer Smart Engines, based on algorithms for automatic passport recognition and verification, enabled the processing of over two million document images in 2024 and prevented ten thousand attempts of fraudulent loan applications using others' documents [8]. At the same time, all personal data processing is carried out within the organization's closed loop, which complies with strict regulatory requirements for information protection.

A fundamental distinction of modern artificial intelligence systems is the implementation of continuous adaptation and self-learning mechanisms. Production systems deployed in progressive microfinance organizations automatically adjust the parameters of predictive models as new data accumulates on borrower payment discipline, changing macroeconomic indicators, and industry trends, ensuring continuous improvement in the accuracy of risk models in a dynamic economic environment. Digital transformation, along with its benefits, gives rise to fundamentally new categories of risks and challenges. Algorithmic bias is a methodologically complex challenge. It arises from training models on incomplete or inherently biased data, which leads to the reproduction and amplification of socioeconomic stereotypes and hidden discrimination against borrowers based on non-credit-related but sensitive characteristics, such as gender, age, geographic location, and social status. This creates systemic risks, undermining trust in the financial system and posing direct reputational and regulatory risks for MFIs.

In light of the problems of algorithmic bias, leading MFIs are beginning to implement explainable artificial intelligence methodologies, which provide retrospective analysis and meaningful interpretation of the decision-making logic of complex models, enabling the identification of key credit rating factors and verification of the correctness of algorithms. This increases transparency and ensures compliance with evolving regulatory requirements.

Cyber risks are another pressing challenge. According to BI.ZONE, in the first half of 2024, the share of cyber incidents in the financial and insurance sectors reached 15 % of the total, 5 percentage points higher than the same period in 2023 [9]. Cybersecurity remains one of the most critical risks for financial institutions in 2025, second in the global threat rankings only to risks directly associated with the development and application of artificial intelligence technologies.

For microfinance organizations, whose business model is increasingly based on the use of digital platforms and cloud services, the spectrum of cyber threats is particularly specific and includes, in particular, highly organized forms such as advanced persistent threats (APTs), which are prolonged, targeted, and often multi-vector cyberattacks aimed at the systematic theft of confidential data, including client personal data and trade secrets.

Other significant cyber risks include the complete incapacitation of key operating systems, ransomware attacks that involve cryptographically blocking critical information and then demanding a ransom for its decryption, and cyber activity

initiated by nation-states aimed at destabilizing critical information infrastructure and key segments of the financial sector, driven not by commercial but purely geopolitical goals and interests.

It is important to emphasize that digitalization does not eliminate traditional credit risks. A significant deterioration in the quality of loan portfolios is observed, primarily due to the transition of loans issued between the fourth quarter of 2024 and the first quarter of 2025 into the delinquent category. The 90-day overdue debt ratio, which has shown positive dynamics for eighteen months, increased to 28.3 % as of June 30, 2025, exceeding the previous quarter's value by 0.8 percentage points [5]. This clearly demonstrates the persistence of fundamental risks associated with the macroeconomic environment, cash flow gaps, and debt burden.

In response to these challenges, new approaches to risk management are being developed. Deep integration with developing financial ecosystems and the active use of platform solutions implemented using the Banking-as-a-Service (BaaS) model are becoming a strategically significant development area for microfinance organizations. This enables significant transformation of existing business processes through the use of ready-made technological solutions tested within major financial institutions.

As demonstrated by the successful case of Halyk Bank Kazakhstan [10], modern BaaS platforms provide microfinance organizations with comprehensive access to critical modules such as automated client onboarding, biometric identification, payment processing, and the issuance of virtual and physical cards, without the need for capital-intensive investments in the independent development and maintenance of these services, creating fundamentally new opportunities for optimizing operational activities.

Looking forward, as Etoday writes: “MFIs will actively collaborate with banking institutions and fintech companies to develop joint products and expand their client base. This cooperation may include joint lending programs as well as utilization of banking platforms for client acquisition and credit portfolio management” [11].

The advantages of the BaaS model for improving credit risk management are comprehensive and include a significant reduction in operating costs for client verification and identification procedures and the provision of legally binding remote identification, significantly accelerated onboarding processes while simultaneously increasing conversion rates, and the ability to seamlessly integrate with the partner bank's digital ecosystem. The confluence of these factors generates a powerful, self-reinforcing cycle of institutional improvement. The methodological integration leads to a more discerning credit allocation process, which in turn directly suppresses the incidence of non-performing loans. This enhanced portfolio quality and operational efficiency subsequently coalesce to fortify the institution's competitive standing, creating a sustainable advantage in an increasingly crowded financial ecosystem.

The regulatory agenda is also rapidly evolving. In the context of increasing risk trends, the Bank of Russia has initiated a set of regulatory measures aimed at strengthening the resilience of the microfinance sector. A significant transformation is the introduction of a creditworthiness assessment methodology based on verified data on the official income of the population. Pursuant to the instructions of the President of the Russian Federation [12], by March 2026, credit institutions will have access to up-to-date information through the Digital Profile service, integrating data from the

Federal Tax Service and the Social Fund of Russia. To successfully digitalize, microfinance organizations must implement a comprehensive approach that includes technological development, human resources, and risk management. Modernization of technological infrastructure should include the introduction of API platforms for integration with credit bureaus and government information systems. At the same time, employee training programs for machine learning and big data analysis are required, as, according to a study by RBC Novosibirsk, “96 % of credit institutions experience difficulties recruiting mid-level employees; IT specialists, who are also essential for MFIs, take much longer to find” [13].

The analytical findings suggest that credit risk management systems in microfinance are undergoing profound structural restructuring driven by digital transformation and tightening regulatory requirements. Principal defining trends include remote channel dominance, active implementation of artificial intelligence and machine learning technologies, emergence of novel risk categories such as cybersecurity threats and algorithmic bias, and development of platform solutions. The subsequent evolution of microfinance organization risk management will be determined by their adaptability to emerging technological opportunities and regulatory challenges. Promising development avenues encompass implementation of explainable artificial intelligence methodologies to ensure algorithmic decision transparency and ethics, strengthening cybersecurity systems to counter escalating digital threats, deepening integration with financial ecosystems through BaaS platforms for cost optimization and customer experience enhancement, and developing competencies in big data analytics and machine learning.

As part of further scientific research, the development of industry standards for the application of AI and the creation of a comprehensive cyber risk assessment methodology appears methodologically justified and the development of improved stress testing mechanisms that adequately take into account the specifics of the digital transformation of financial services.

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OPPORTUNITIES AND PROSPECTS FOR USE OF DATA MINING TECHNOLOGIES IN ECONOMICS AND MANAGEMENT

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Abstract. The article examines data mining as a crucial tool in modern economics and management. It outlines its theoretical foundations, key tasks, and practical applications across various sectors. A central empirical study uses cluster analysis to diagnose structural imbalances in the Belarusian labor market. The findings demonstrate how data mining transforms raw data into strategic foresight, enabling evidence-based decision-making for enhancing national competitiveness.

Keywords: data mining, machine learning, predictive analytics, descriptive analytics, forecasting, classification, optimization.

ВОЗМОЖНОСТИ И ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ ТЕХНОЛОГИИ ИНТЕЛЛЕКТУАЛЬНОГО АНАЛИЗА ДАННЫХ В ЭКОНОМИКЕ И УПРАВЛЕНИИ

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Аннотация. В статье рассматривается интеллектуальный анализ данных как важнейший инструмент современной экономики и менеджмента. Излагаются его теоретические основы, основные задачи и практическое применение в различных секторах. Центральное место занимает эмпирическое исследование на основе кластерного анализа, выявившее структурный дисбаланс на рынке труда Беларуси. Показано, как при помощи интеллектуального анализа данных необработанная информация может быть преобразована в стратегический прогноз, позволяющий принимать обоснованные решения для повышения национальной конкурентоспособности.

Ключевые слова: интеллектуальный анализ данных, машинное обучение, прогностическая аналитика, описательная аналитика, прогнозирование, классификация, оптимизация.

Data mining represents a transformative approach in the modern landscape of data-driven decision-making, offering powerful methodologies for uncovering previously unknown yet valid patterns within vast and complex datasets. In this context, “valid” patterns are not arbitrary coincidences but statistically significant,

logically interpretable, and practically actionable relationships that persist over time. These patterns enable organizations to forecast future trends, optimize operational processes, and gain deeper insights into customer behavior. The growing ubiquity of digital data – generated by transactions, sensors, social media, and enterprise systems – has intensified the demand for sophisticated analytical tools capable of converting raw information into strategic knowledge. Contemporary advancements in computing power, algorithmic efficiency, and data storage have rendered data mining not only feasible but increasingly accessible, even to small and medium-sized enterprises. As a result, data mining has evolved from a niche technical capability into a cornerstone of competitive strategy across diverse sectors, including finance, healthcare, retail, logistics, and public administration.

To uncover business-relevant patterns that may not be obvious at first glance, it is necessary to analyze large volumes of data to understand them. Traditionally, data were analyzed manually to extract meaningful insights – a process that is indeed highly time-consuming and often infeasible given the scale of modern datasets. To address this challenge, automated methods for data analysis and the extraction of interesting patterns, trends, or other useful information have been developed. These include statistical models, mathematical algorithms, and machine learning techniques – defined as algorithms that automatically improve their performance through experience, such as neural networks or decision trees. Consequently, data mining encompasses not only data collection and management but also sophisticated analysis and prediction, forming an integral part of evidence-based decision-making.

Data mining originated from the metaphor of extracting valuable ore from raw earth – analysts sift through massive datasets to uncover actionable insights. The term, coined as early as 1978, became widespread in the mid-1990s alongside the rise of digital data and machine learning. Closely tied to Knowledge Discovery in Databases (KDD) – a broader process encompassing data selection, cleaning, integration, mining, and interpretation – data mining represents the core algorithmic phase where patterns are discovered [1]. A key milestone was the 1989 workshop by Gregory Piatetsky-Shapiro, which framed the challenge of uncovering “hidden knowledge” in databases and helped establish data mining as a distinct discipline.

Data mining is an interdisciplinary field situated at the intersection of databases, statistics, machine learning, and artificial intelligence. Its primary objective is the automated discovery of new, previously unknown, practically useful, and human-interpretable knowledge within large volumes of data. Such knowledge must be non-trivial – i.e., not evident through superficial inspection – and valid, meaning it can be confirmed on independent datasets.

A modern classification of data mining tasks, as proposed in the foundational work by Han, Pei, and Tong [2, p. 10], distinguishes two main categories: predictive tasks and descriptive tasks. Predictive tasks aim to build models capable of forecasting the value of a target variable based on input features. These include classification (for categorical target variables) and regression (for continuous ones). Descriptive tasks, by contrast, focus on uncovering the intrinsic structure of data without an explicit target variable. Examples include clustering, association rule mining, anomaly detection, and dimensionality reduction. This dichotomy reflects a fundamental distinction in

analytical goals: either to predict future behavior (e.g., the probability of customer default) or to understand current data structure (e.g., segmenting customers into homogeneous groups) (Fig. 1).

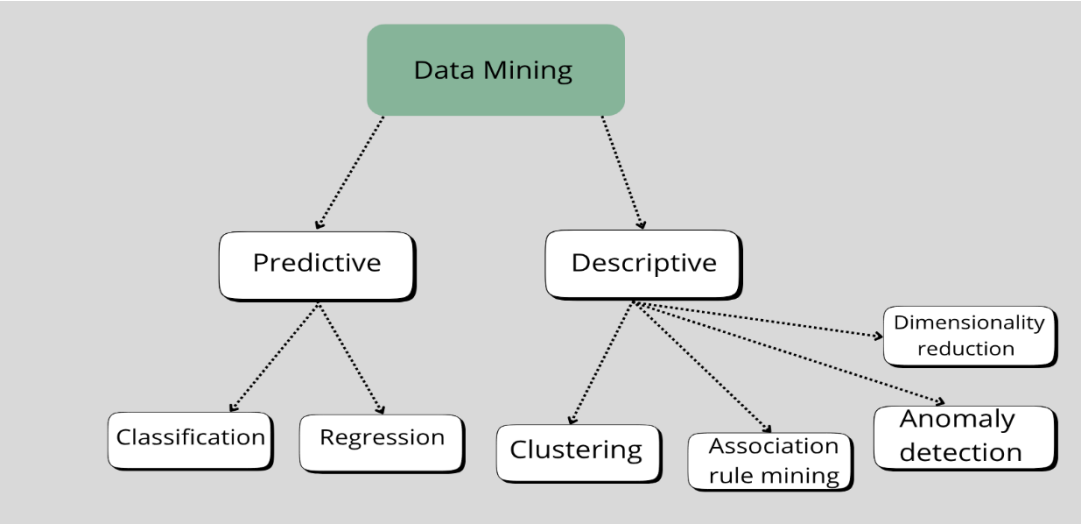


Figure 1. Classification of Data Mining Tasks into Predictive and Descriptive Categories

Russian-language methodological literature, particularly Barsegian et al. [3, p. 89], similarly emphasizes the division between supervised learning (classification, regression) and unsupervised learning (clustering, association rules) (Fig. 2). The authors stress that successful application of data mining methods requires not only algorithmic expertise but also deep domain knowledge, as the interpretation of results and selection of evaluation metrics are heavily dependent on business context.

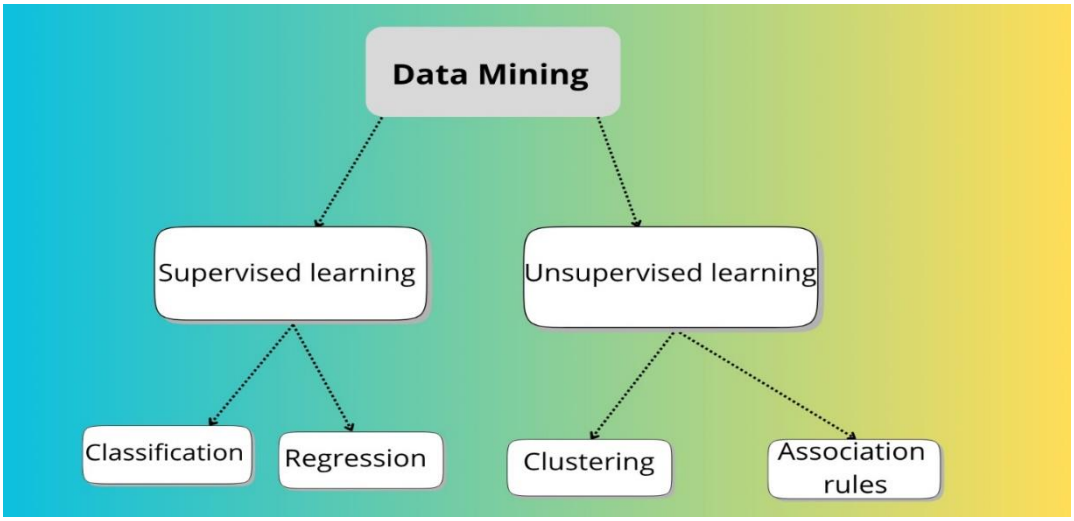


Figure 2. Classification of Data Mining Tasks by Learning Type: Supervised and Unsupervised Learning

This principle is effectively demonstrated by an empirical case study that was undertaken to examine the structure of the Belarusian labor market through the use of cluster analysis.

Application of cluster analysis to identify structural patterns in the Belarusian labor market.

Applying theoretical knowledge and practical competencies in data analysis tools, a clustering procedure was implemented within the STATISTICA software environment. The objective was to segment economic sectors into homogeneous groups based on key labor market indicators.

The dataset used in this analysis comprises official statistics on the employed population by economic activity in Belarus for the year 2023 [4]. The variables selected for analysis included:

- total employment per sector;
- average monthly wage (aggregate, and disaggregated by gender);
- average age of the employed population (Fig. 3).

1	Industry	Employed Population (thousands)	Average Age	Salary (Women), BYN	Salary (Men), BYN	Total Salary, BYN
2	Agriculture	350,3	50	1895,2	2578,1	1266,2
3	Industry	988,5	45	1559,8	1719	2019,4
4	Construction	243,7	42	2012,1	2660,8	1696,9
5	Wholesale and Retail Trade; Vehicle and Motorcycle Repair	592,1	43	2043,9	2372,9	1681,5
6	Transport, Warehousing, Postal and Courier Services	275,7	35	1750,5	2522	1783,1
7	Temporary Accommodation and Food Services	91,6	30	1947,7	2107,1	1266,2
8	Information and Communication	122,8	42	1397,8	1704,4	5122
9	Financial and Insurance Activities	56,2	41	4539,8	7686,7	3050,4
10	Real Estate Transactions	67,2	32	3696,1	5674,5	3034,8
11	Professional, Scientific and Technical Activities	148,1	42	1951,2	2090,1	2338,5
12	Administrative and Support Services	100,9	40	2452,2	3384	2473,3
13	Public Administration	182,3	47	1536,6	1790	2540,5
14	Education	433,8	47	1455,9	1546,9	1317
15	Health and Social Services	328,6	45	1844,1	2249,9	1602,8
16	Creativity, Sports, Entertainment and Recreation	80,9	38	1438,7	2006	1370,5
17	Provision of Other Services	79	44	1285,4	1941,5	1589,2

Figure 3. Employment, Average Wages by Gender, and Average Age of Employed Population Across Economic Sectors in Belarus, 2023

The primary objective of the analysis was to perform an unsupervised clustering of economic sectors to identify latent structures and correlations among age, sectoral affiliation, and wage levels. A secondary objective was to extrapolate socio-economic challenges from the resulting segmentation and propose alternative solutions and potential policy interventions.

Methodology and results.

After performing several steps in STATISTICA, the clustering results were obtained (Fig. 4). The output includes labels such as C_1, C_7, C_16, etc., which correspond to the cluster assignments for each row of the original dataset (e.g., C_1 corresponds to row 2 of the initial table). The analysis yielded a clear segmentation of

the economic sectors into three distinct clusters (Fig. 5). For analytical clarity, these are designated as

- Cluster 1 – green;
- Cluster 2 – blue;
- Cluster 3 – yellow.

Each of these clusters is characterized by a distinct profile, as detailed below.

Cluster 1 shows a combination of relatively low employment levels, the youngest average age of workers, and the highest wage levels among all clusters. (It can be concluded that this combination is explained by the specific nature and requirements of the industry, as well as labor market dynamics. There are unique conditions that may be attractive to young professionals but simultaneously limit the number of available jobs as the profile suggests sectors with high barriers to entry, likely involving specialized expertise, advanced technology, or significant automation).

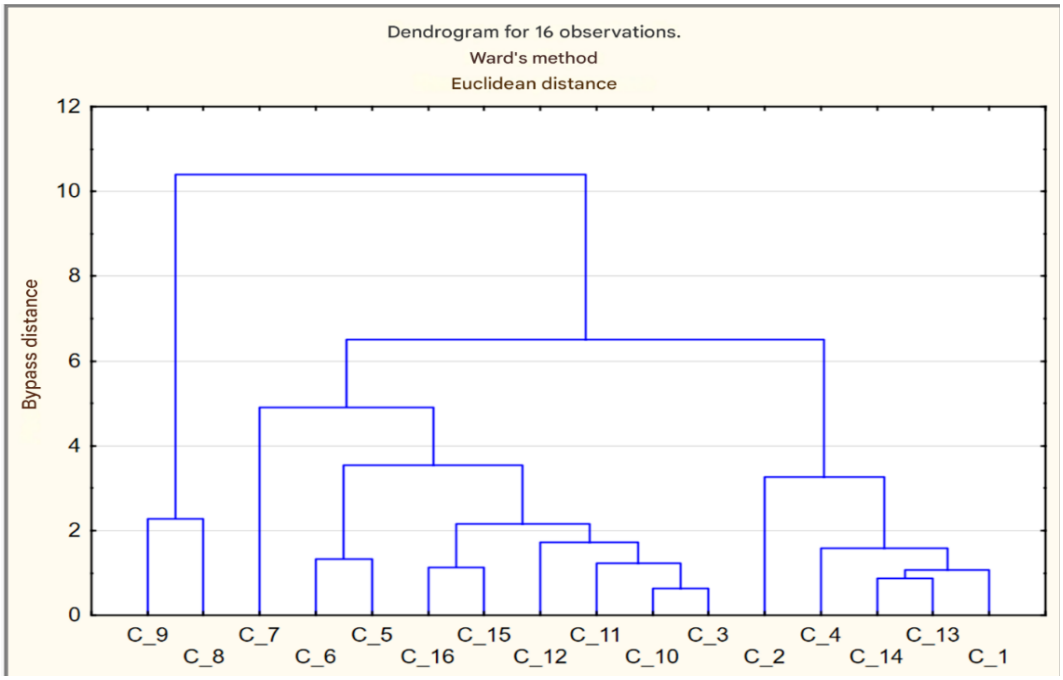


Figure 4. Clustering analysis results

Cluster 2 exhibits moderate to below-average employment levels, a relatively young average age, and mid-range wage values. (Even though employment is modest, the relatively young age suggests that many young specialists or students work in these sectors – particularly in accommodation and food services, transportation, postal, and courier activities, as these are common part-time jobs for students seeking additional income, they offer flexible or entry-level employment rather than high-wage careers).

Cluster 3 demonstrates the highest employment levels, an average age significantly higher than in the other clusters, and below-average wages. (This cluster likely encompasses traditional foundational sectors such as agriculture and manufacturing that employ the largest share of the workforce. The demographic profile suggests a critical challenge: the average age is quite high because few young

specialists choose to enter these fields. An aging workforce coupled with a lack of inflow of young talent, potentially driven by perceived low wage incentives and diminished social prestige of these professions. As a result, Belarus may soon face serious problems such as a shortage of workers).

	Industry	Employed Population (thousands)	Average Age	Salary (Women), BYN	Salary (Men), BYN	Total Salary, BYN
2	Agriculture	350,3	50	1895,2	2578,1	1266,2
3	Industry	988,5	45	1559,8	1719	2019,4
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13	Public Administration	182,3	47	1536,6	1790	2540,5
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15	Health and Social Services	328,6	45	1844,1	2249,9	1602,8
16	Creativity, Sports, Entertainment and Recreation	80,9	38	1438,7	2006	1370,5
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Figure 5. Dataset with Cluster Assignments: Employment, Age, Wages, and Cluster Labels by Economic Sector in Belarus, 2023

Discussion and Socio-Economic Implications.

The clustering analysis successfully identified a critical structural vulnerability within the Belarusian economy. The demographic and wage distribution across clusters indicates a potential demographic-skill mismatch. Cluster 3, which forms the employment base of the economy, is at high risk of a severe labor shortage due to an aging workforce and an insufficient replacement rate by younger specialists. The disproportion can lead to slowing down innovation and sectoral development. This problem requires urgent attention, as physical capacity and productivity tend to decline with age, which could negatively affect overall output. Moreover, insufficient labor supply in agriculture may result in difficulties ensuring the population’s access to food products.

This trend is already corroborated by external evidence; for instance, the 2024 admissions campaign of the Belarusian State Agricultural Academy (BSAA) reported a significant shortage of applicants, necessitating an extension of the application deadline until July 29, 2024.

The concentration of an older workforce in high-employment, low-innovation sectors poses a significant risk to long-term productivity, sectoral development, and even food security, given the critical role of the agricultural sector.

To address the identified imbalance, a multi-faceted approach can be proposed.

1) Enhancing Sectoral Attractiveness. Create attractive conditions for young professionals, such as higher wages and improved working conditions in Cluster 3 sectors.

2) Educational and Promotional Initiatives. Develop state-supported programs to promote educational pathways and careers in strategic sectors facing demographic decline.

3) Technological Modernization. Accelerating the adoption of automation and digital technologies to reduce reliance on manual labor and increase productivity. (Young people are often drawn to working with cutting-edge technologies; implementing automation, robotics, and digitalization in these sectors would make them more appealing to a technologically literate generation).

4) Targeted Government Support. Introducing subsidy programs, grants, and housing incentives for young specialists willing to work in these critical sectors, particularly in rural areas.

By implementing these strategies, Belarus can work towards a more balanced and sustainable labor market structure, mitigating identified risks and ensuring intergenerational continuity in vital industries.

Thus, this application of cluster analysis to study the structure of the Belarusian labor market demonstrates the capacity of data mining to generate actionable insights and inform strategic policy recommendations. Translating these data-driven findings into reliable and effective solutions, however, necessitates a robust methodological foundation. The successful application of data mining, from a simple clustering procedure to complex predictive modeling, relies fundamentally on a strong command of mathematical principles, particularly linear algebra, calculus, and probability theory. These disciplines provide the theoretical scaffolding for designing algorithms that can efficiently process high-dimensional data, manage uncertainty, and generalize from examples. Without this foundation, models risk overfitting, misinterpretation, or failure to capture true underlying relationships.

In the realms of economics and management, data mining serves four principal analytical functions, each addressing a critical aspect of organizational decision-making. Forecasting involves predicting future values of key variables – such as sales volume, cash flow, inventory turnover, or crop yields – based on historical trends and contextual factors. This capability is indispensable in market forecasting, where businesses must anticipate shifts in demand, supply chain disruptions, and the impact of external variables like seasonality or economic policy. Effective forecasting reduces reliance on intuition and mitigates the risks associated with uncertain environments. The process typically entails selecting an appropriate predictive model – ranging from classical time-series methods to advanced deep learning architectures – and rigorously evaluating its accuracy, robustness, and generalizability. Beyond economics, forecasting plays a vital role in healthcare (e. g., disease outbreak prediction), agriculture (yield estimation), and political science (electoral behavior modeling).

Identification focuses on revealing non-obvious associations or behavioral patterns within data. A classic example is the discovery that newlyweds tend to purchase more furniture – a correlation that, while seemingly trivial, can inform targeted marketing strategies or inventory planning. In industrial settings, identification helps detect operational risks, equipment anomalies, or emerging market opportunities by uncovering subtle signals that human analysts might overlook. Classification, meanwhile, involves assigning data instances to predefined categories based on their

attributes. In banking, for instance, loan applicants are routinely classified as "creditworthy" or "non-creditworthy" using models trained on historical repayment data, income levels, employment status, and demographic variables. This automated categorization streamlines decision-making, enhances consistency, and reduces human bias – though it also raises important ethical considerations regarding fairness and transparency.

Optimization, the fourth key function, seeks to maximize the efficiency of limited resources – time, capital, space, or labor – through data-informed strategies. In retail, for example, dynamic pricing models leverage customer segmentation, competitor pricing, and real-time demand signals to adjust prices for maximum profitability. Similarly, marketing budgets can be allocated more effectively by identifying high-value customer segments and channels with the greatest return on investment. Optimization often integrates multiple data mining techniques, such as clustering for customer segmentation, regression for response modeling, and reinforcement learning for adaptive decision rules. Together, these functions enable organizations to move from reactive to proactive management, aligning operations with anticipated future states rather than past performance alone.

The advantages of data mining are substantial and well-documented. In retail, personalized recommendations derived from purchase history have been shown to increase sales by 10 – 15 %, demonstrating the tangible financial impact of data-driven strategies. Moreover, the methodology is remarkably versatile: it can be applied to structured transactional data, unstructured text (e. g., customer reviews), temporal sequences (e. g., sensor logs), and even geospatial information. This flexibility allows organizations to address a wide array of challenges – from predicting equipment failure in manufacturing to analyzing sentiment in social media for brand management. Perhaps most importantly, data mining excels at uncovering latent insights that defy conventional wisdom, enabling innovation and strategic differentiation. However, these benefits are not without limitations. The technical complexity of data mining requires specialized skills in programming, statistics, and domain knowledge, posing a barrier to entry for smaller firms. Furthermore, results are never guaranteed: even the most sophisticated models can fail due to poor data quality, concept drift (changes in underlying patterns over time), or flawed assumptions. The financial costs of implementation – software licenses, cloud infrastructure, data storage, and expert personnel – can also be significant, particularly for large-scale deployments. Ethical concerns represent another critical dimension, exemplified by the Cambridge Analytica scandal of the 2010s, in which personal data from millions of Facebook users was harvested and analyzed to influence political campaigns [5]. This incident not only led to a $100 million settlement by Facebook for misleading investors but also ignited global debates about data privacy, consent, and algorithmic accountability.

A diverse ecosystem of software tools supports the practical implementation of data mining. On the commercial side, platforms like SAS Enterprise Miner and IBM SPSS Modeler offer enterprise-grade capabilities for predictive modeling, widely used in finance, insurance, and government [6]. Open-source alternatives such as KNIME and Weka provide flexible, community-driven environments ideal for research and education, with strong support for integration with Python and R. As Witten, Frank,

and Hall [7, p. 376] note, “there is no universal algorithm” – a method’s effectiveness depends on the specific structure of the dataset. Modern platforms such as Weka therefore offer a broad spectrum of algorithms, enabling researchers to experiment and select optimal solutions. In particular, Weka implements all of the “Top 10” data mining algorithms, including C4.5, k-means, SVM, Apriori, and others. Microsoft’s SQL Server Analysis Services (SSAS) embeds analytical functionality within the broader Microsoft ecosystem, enabling seamless reporting and dashboarding. In Belarus and Russia, tools like Statistica – available in a localized Russian-language version – are commonly used in both academic and business settings, while even Microsoft Excel serves as an entry point for basic analytical tasks among small businesses. The accessibility of these tools has democratized data mining, allowing organizations of all sizes to begin their journey toward data-driven decision-making.

Moreover, the data mining process is highly structured. According to the CRISP-DM (Cross-Industry Standard Process for Data Mining) methodology, a project progresses through six iterative phases: business understanding, data understanding, data preparation, modeling, evaluation, and deployment. As Barsegian et al. emphasize, up to 70 % of project time may be spent on data preparation and cleaning, underscoring the critical importance of data quality for successful outcomes. The authors also highlight the role of OLAP and multidimensional analysis in supporting data mining tasks. They argue that the integration of OLAP technologies with data mining enhances the interpretability and efficiency of analytical processes, especially when dealing with complex economic datasets.

Real-world applications illustrate the profound impact of data mining in management practice. The Russian hypermarket chain Lenta, for example, leveraged loyalty card data to identify distinct customer segments: one group consistently purchased essential goods, while another – predominantly male – favored snacks and beverages [8]. These insights informed strategic decisions about product placement, promotional offers, and store layout, resulting in measurable profit growth. Similarly, in 2015, Yandex made the landmark decision to replace the entire editorial team of Auto.ru with algorithmic content aggregation systems. Originally a manually curated automotive portal, Auto.ru transitioned to a fully automated model that scrapes, classifies, and ranks vehicle listings, reviews, and market data without human intervention. This shift reflects a broader trend toward AI-driven information management, where data mining not only supports but increasingly replaces traditional human roles in content creation and curation.

In the context of Belarus, data mining holds exceptional promise for addressing key challenges in the digital economy. The national “Digital Development of Belarus 2021 – 2025” program [9], particularly its “Smart Cities” initiative, creates fertile ground for the adoption of advanced analytics. Data mining can optimize business processes through demand forecasting and supply chain analytics, enhance customer experience via behavioral segmentation, detect financial fraud in real time, and support risk management in banking and insurance. In urban governance, it enables smarter infrastructure planning – optimizing public transportation routes based on mobility patterns, forecasting energy consumption to improve grid efficiency, and monitoring environmental indicators for sustainable development. In education, learning analytics

powered by data mining can track student progress, identify at-risk learners, and personalize curricula to improve outcomes. These applications align closely with national priorities and position data mining as a strategic enabler of economic modernization.

The anticipated benefits of widespread data mining adoption are multifaceted. Enhanced marketing effectiveness allows firms to tailor messages to specific audience segments, increasing conversion rates and customer lifetime value. Improved customer service emerges from the ability to anticipate needs, resolve issues proactively, and personalize interactions. Supply chain resilience is strengthened through accurate demand forecasting, reducing stockouts and overstock situations. Risk management becomes more anticipatory, with models that flag potential defaults, compliance violations, or cybersecurity threats before they escalate. Ultimately, operational efficiency improves across the board, leading to cost reductions, faster decision cycles, and greater agility in responding to market changes.

Nevertheless, the deployment of data mining must be approached with caution, as it entails significant risks. Data quality remains a foundational concern: inaccurate, incomplete, or biased data inevitably leads to flawed insights. Rigorous data preprocessing – cleaning, normalization, and validation – is essential to ensure reliability. Data security is equally critical, especially when handling personally identifiable information. Organizations must implement robust encryption, access controls, and audit mechanisms, while complying with evolving regulatory frameworks such as GDPR-inspired standards [10]. Ethical risks – including algorithmic bias, discrimination, and manipulative practices – demand adherence to principles of fairness, transparency, and human oversight. Finally, the inherent complexity of modern datasets – characterized by high dimensionality, heterogeneity, and noise – requires sophisticated analytical techniques and careful model validation to avoid spurious correlations or overfitting.

The evidence presented throughout this article affirms that data mining has matured into an indispensable instrument of modern economics and management. As demonstrated through both its theoretical underpinnings and its practical application – its capacity to transform raw data into foresight, efficiency, and innovation makes it a strategic asset in an increasingly competitive and data-rich world. In Belarus, where digital transformation is a state priority, the integration of data mining technologies offers a pathway to improved productivity, enhancing national competitiveness and navigating complex socio-economic challenges. Far from being a purely technical exercise, data mining represents a paradigm shift – from intuition-based to evidence-based decision-making – positioning it as a cornerstone of 21st-century organizational excellence. Guided by rigorous methodology, its continued evolution will undoubtedly shape the future of business, economies, and society at large.

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SHARING ECONOMY: GENESIS AND DEVELOPMENT WITHIN THE FRAMEWORK OF THE INFORMATION SOCIETY MODEL

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Abstract. The article explores the genesis and development of the sharing economy as a new socio-economic model within the information society framework. It examines the reasons for its emergence, competitive advantages over the traditional economy, and development trends. The main reasons for the development are systematized: technological breakthrough, evolution of consumer attitudes and actualization of environmental issues. In conclusion, the potential of the formation of this model as one of the dominant economic trends of the current century is assessed.

Keywords: sharing economy, socio-economic model, collaborative consumption, information society, sustainable development, digital platforms, resource sharing, rational consumption.

ШЕРИНГ-ЭКОНОМИКА: ГЕНЕЗИС И РАЗВИТИЕ В РАМКАХ МОДЕЛИ ИНФОРМАЦИОННОГО ОБЩЕСТВА

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Аннотация. Статья посвящена исследованию генезиса и развития шеринг-экономики как новой социально-экономической модели в условиях информационного общества. Рассматриваются причины ее возникновения, конкурентные преимущества перед традиционной экономикой и тенденции развития. Систематизированы основные причины развития: технологический прорыв, эволюция потребительских установок и актуализация экологической проблематики. В заключении оценивается потенциал становления данной модели в качестве одного из доминирующих экономических трендов текущего столетия.

Ключевые слова: шеринг-экономика, социально-экономическая модель, экономика совместного потребления, информационное общество, устойчивое развитие, цифровые платформы, совместное использование, рациональное потребление.

In the context of the formation of a digital society, there is an institutionalization of the sharing economy as a systemic phenomenon that has a transformational impact

on traditional economic structures. The ability of this model to redefine established patterns of production and distribution of goods actualizes the need for a scientific understanding of its role in changing the socio-economic landscape.

The main research focus of the work is aimed at a systematic analysis of the sharing economy as a structural element of the digital age in order to identify its potential in the formation of innovative models of socio-economic interactions. To achieve this goal, a number of tasks were set:

1. To establish the key prerequisites and conditions that contributed to the institutionalization of the sharing economy as a new model.

2. Comparative assessment of the operational effectiveness of the sharing model in comparison with traditional economic mechanisms.

3. Identification of strategic directions of evolution correlating with the principles of sustainable development.

This research will provide a foundation for a holistic understanding of the transformational potential of the sharing economy and its role in shaping a new architecture of socio-economic relations in the information society model.

The emergence of the sharing economy at the turn of the 20th and 21st centuries was a response to rapid technological development and worsening resource constraints on a global scale. This concept suggests a radical revision of existing approaches to economic growth, shifting the focus from increasing production volumes to intensifying the use of already created assets through their collective use. Such a transformation of the economic paradigm reflects the search for optimal ways to overcome the contradiction between the growing needs of society and the limited resources available [1].

The fundamental difference between the new paradigm is the transition from property rights to access rights as the main economic value. This model is based on the concept that various resources, from vehicles and housing to professional competencies, can bring significantly greater returns when used by a group of consumers instead of individual ownership. This approach allows you to maximize the usefulness of assets by reducing their downtime and optimizing loading.

The term “shared consumption”, first introduced into scientific use by F. Babion in 1964, and was widely recognized only after the publication of the book “What's Mine Is Yours: The Rise of Collaborative Consumption” by economists R. Botsman and R. Rogers in 2010. The authors presented a detailed justification of the thesis about the greater economic feasibility and practicality of temporary use of the product compared with its acquisition into ownership. Speaking at the TED conference, R. Botsman additionally revealed the potential of this economic system, pointing out its ability to radically transform existing ideas about consumption [2, p. 304-305].

From a theoretical point of view, the sharing economy is not a break with the past, but a natural development of consumer cooperation ideas adapted to the digital environment. As shown in the Russian Journal of Management, this is a natural stage in the evolution of cooperative principles in new technological conditions. If traditional cooperation was based on the voluntary association of individuals into communities with fixed membership for the joint ownership and management of resources, then the sharing economy significantly transforms this model.

The key organizational difference is evident in the transition from a membership structure to a platform architecture. Digital platforms act as open infrastructure intermediaries that ensure the interaction of a wide, anonymous and dynamic range of users. This architecture radically increases the scalability and flexibility of cooperative interactions, taking them far beyond local communities and geographical constraints.

Evolutionary changes have also affected the economic foundations of interactions. In the classical cooperative model, income and costs were distributed among cooperative members according to established rules and procedures. In contrast, in the sharing model, the platform functions as an independent commercial operator, profiting from the organization and facilitation of transactions between users. This creates a fundamentally different economic model, where value is created not through co-ownership mechanisms, but through optimizing the use of excess capacity and unclaimed resources.

The mechanisms of trust formation have also undergone significant changes. In a traditional cooperative, trust was built on the basis of personal connections, shared values, and long-term relationships within a closed community. In the sharing model, it is based on algorithmic reputation systems that include mutual evaluations, detailed reviews, a history of previous transactions, and formal verification procedures. Thus, the social capital of cooperation is gradually being replaced by digital capital, which creates the opportunity to establish business ties between unfamiliar participants on a global scale, overcoming the barriers of geographical remoteness and social heterogeneity.

It is important to note that despite the technological transformation, the sharing economy retains the fundamental cooperative principle of benefiting from the collective use of resources. However, while in traditional cooperation this benefit was primarily socially oriented, in the modern model it is expressed in saving time, money and increasing convenience for the individual user.

Such an evolutionary view gives grounds to interpret the sharing economy not as a break with the past, but as an actual, technologically mediated version of the cooperative idea of collective satisfaction of needs. Nevertheless, this transformation is associated with profound changes that create a dilemma: on the one hand, they open up new vectors for economic growth, and on the other, they create a set of problems in the field of legal regulation and guarantees for participants.

These challenges include, in particular, the issues of determining the legal status of platform participants, especially in the field of labor relations, where the line between an employee and a self-employed person is often blurred. This creates legal risks both for the platforms themselves and for the performers, who may be deprived of the social guarantees provided for by labor legislation. On the other hand, transformation creates significant opportunities, which are reflected in the democratization of market access for microenterprises and individuals with excess assets. Digital platforms significantly reduce transaction costs and barriers to market entry, allowing you to effectively monetize idle resources – from an empty apartment room to a free hour of time. Thus, the fundamental shift caused by the sharing economy requires lawmakers and society to find a balance between stimulating innovation and ensuring fair and safe conditions for all participants in this new economic model [3].

The development of the sharing economy was initiated by a complex of technological and socio-cultural factors. Digital platforms have played a key role, eliminating traditional barriers, making the processes of resource search, counterparty interaction, and payment transactions simple and efficient. At the same time, a trend has gained momentum that is reorienting consumers from the idea of ownership to the value of instant access to goods, reflecting the growing demand for practical and environmentally friendly alternatives to traditional consumption.

The spread of the sharing economy has resulted from the mutual influence of several fundamental trends. Demonstrative consumption as a marker of social status is gradually being replaced by a rational approach, where the value shifts from owning a thing to the possibilities of its practical application. This psychological shift has become possible due to the formation of a culture of digital trust, when online communications and reputational mechanisms of platforms create a safe environment for interaction between unfamiliar participants. An essential catalyst is economic expediency – in conditions of instability and geopolitical changes, renting many assets becomes a financially more justified strategy than acquiring them into ownership. The urban context also plays an important role: high population density in megacities creates optimal conditions for the development of sharing, while exacerbating the problem of efficient use of limited spatial and material resources. Finally, for a significant part of the population, shared consumption opens up access to goods and services that remained inaccessible under the traditional ownership model [4, p. 48-50].

The semantic core of this economic model is the principle of rationalizing the use of resources through their constant circulation, which significantly prolongs the life cycle of assets. A good illustration is a private car that sits idle 95 % of the time on average, demonstrating the low efficiency of private ownership, a problem that the sharing model is designed to solve. The key operational element of the system is the digital environment, where Internet platforms and aggregators act as intermediaries, drastically simplifying the processes of search, access and interaction between participants. These technological solutions effectively overcome geographical barriers, making a variety of goods and services available almost anywhere in the world. The fundamental basis for the functioning of the entire system remains trust between its participants, and the legal difference is the retention of ownership rights for the provider while transferring only temporary rights to use assets to users.

The scope of application of shared consumption models continues to expand steadily, covering many sectors of the economy today. In the transport industry, this is reflected in the development of carsharing, ridesharing, carpooling, as well as bicycle and scooter rentals. The catering industry is actively developing foodsharing, aimed at minimizing food waste. The tourism sector has undergone a significant transformation, where platforms offer rental housing from individuals and house exchanges. Medical services, including online consultations and telemedicine, are becoming widespread. The financial sector is represented by crowdfunding and P2P lending. A wide range of private services, from tutoring and psychological assistance to dog walking and household errands, are also being actively transferred to sharing through specialized platforms. Separate segments are the rental of warehouse and parking spaces, as well

as coworking spaces – the rental of workplaces in shared office spaces, the market of which is showing significant growth. As noted before, consumer cooperation in the format of shared consumption is a flexible structure capable of covering several areas of economic activity and competing with traditional business models in the future [5].

Over a relatively short historical period, the sharing consumption model has demonstrated significant evolutionary potential, revealing a number of strategic advantages over traditional economic systems. The fundamental advantage of the sharing economy is the optimization of the use of the resource base due to their circulation between users, which minimizes asset downtime. This approach creates a double-efficiency effect: it reduces the burden on producers who do not need to increase output, and at the same time reduces the consumption of energy and raw materials, which has a beneficial effect on the environmental situation [6, p. 2-3].

The most important social achievement of the model was its inclusivity. Digital platforms, acting as intermediaries between resource owners and their potential users, provide unprecedented access to goods and services without having to bear the burden of ownership. This principle of consumption management contributes to the formation of a sustainable economic model, where reducing excess consumption is combined with economic benefits for end users and a reorientation of manufacturers to improve the quality and durability of products.

An analysis of the current dynamics makes it possible to predict the strengthening of the position of the sharing economy as one of the dominant models of the 21st century. This is facilitated by the synergy of technological and socio-cultural factors: the improvement of digital infrastructure, the rationalization of consumer behavior and the formation of cohesive user communities based on the principles of mutual trust. Special attention should be paid to the environmental component of the model, where resource conservation, reduction of production capacities and the development of energy-efficient technologies create a comprehensive positive environmental effect [7, p. 27].

The sharing economy has completed the transition from an experimental format to a sustainable socio-economic model, which was facilitated by the formation of a digital platform ecosystem, the revision of consumer priorities in favor of rational resource management and the need to overcome the limitations of the traditional economy. The main difference between sharing is the ability to generate a multiplier effect, while simultaneously achieving economic efficiency, environmental sustainability and social integration through the transformation of access rights into an alternative to ownership and the creation of new markets to optimize the use of assets.

The further evolution of the model is due to its compliance with the key trends of our time – digitalization, rationalization of consumption and sustainable development. Adaptability to industry specifics and the ability to form new formats of economic interaction confirm the significant transformative potential of the sharing economy. Maintaining a balance between technological efficiency, social orientation and environmental responsibility will determine the success of its integration into traditional economic processes and possible convergence with other promising areas of the new economy.

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B2B TRANSFORMATION: THE IMPACT OF DIGITAL PLATFORM AND SERVICES

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Abstract. This article discusses the digital transformation reshaping B2B commerce, driven by the rise of digital platforms, data analytics, and new ecosystem strategies. It analyzes how this global shift manifests differently across countries.

Keywords: B2B, analytics, transformation, business, economics, market.

ТРАНСФОРМАЦИЯ B2B-СЕГМЕНТА: ВЛИЯНИЕ ЦИФРОВЫХ ПЛАТФОРМ И СЕРВИСОВ

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Аннотация. В данной статье рассматривается цифровая трансформация, изменяющая сферу B2B-сегмента, которая обусловлена развитием цифровых платформ, аналитики данных и новых стратегий развития бизнес-экосистем. В статье также анализируются национальные особенности проявления этих глобальных изменений.

Ключевые слова: B2B, аналитика, трансформация, бизнес, экономика, рынок.

For a long time, the digital revolution was almost synonymous with the business-to-consumer (B2C) world, defined by online marketplaces, mobile apps, and direct-to-customer sales. In recent years, however, the business-to-business (B2B) sector has begun a dramatic and profound transformation. The traditional B2B model, which was built on personal relationships, direct sales teams, phone calls, and paper-based workflows, is rapidly becoming outdated. In its place, new flexible, tech-driven, and customer-centric approaches are emerging.

This shift is largely driven by the changing expectations of the buyers themselves. Modern B2B purchasers are also consumers in their personal lives, accustomed to the seamless, on-demand convenience of platforms like Amazon. They now expect that same level of transparency, efficiency, and immediate service from their corporate suppliers. This new demand is forcing B2B companies to fundamentally rethink their entire sales and service strategies. To stay competitive, they are investing

heavily in digital channels, automated processes, and building integrated ecosystems where value is created through collaboration and data sharing, not just transactions.

The most profound change catalyzed by digitalization in the B2B sector is the structural evolution from traditional, linear supply chains to dynamic, multi-sided ecosystems. A traditional supply chain is a process where value moves in a straight line: from raw material supplier to manufacturer, to distributor, to retailer, and finally to the end client. Information and goods flow in one direction, with financial transactions and data feedback moving in the other. This model, while established, is inherently rigid and slow to respond to disruption.

In stark contrast, a digital B2B ecosystem is a networked community of interdependent organizations – manufacturers, suppliers, distributors, logistics providers, financiers, contractors, and end clients – interacting on a shared digital platform. This platform acts as a foundational infrastructure that standardizes interactions, facilitates data exchange, and governs the community. The platform's value grows through network effects; the more users it attracts, the more indispensable it becomes, creating a self-reinforcing cycle that locks in participants and builds a powerful barrier to entry [1].

A B2B digital platform is like the brain of a business network. It is much more than a simple website. It connects everyone and makes the whole system work together smoothly. It works in four key ways:

1. *Connection* helps businesses find each other easily. For example, a small company can quickly find a special supplier from another part of the world.

2. *Data Sharing* collects and shares important information from everyone in one place. This includes real-time data about stock levels, production plans, and where deliveries are.

3. *Automation* uses technology to do routine jobs automatically. This includes creating orders, sending bills, and managing payments. This reduces mistakes and saves time.

4. *Rules and Standards* creates common rules and formats that all members follow. This makes sure that all the different companies and their software can work together without problems and trust each other.

In short, the platform doesn't just sell products. It connects all the partners, shares information, and automates work, so the entire business network can operate as one smart and efficient team [2].

In B2B ecosystem, every company transforms from being an isolated player to becoming an active partner in a connected network. Based on how B2B platform works with data its given, its important to mention how it operates with the members of business processes and how they benefit of such interactions. Manufacturers get real-time data about customer needs, helping them plan production better and improve products based on direct feedback. Suppliers in distributors in their turn can reach new markets and customers beyond their usual geographic limits through the platform’s extensive work. Contractors and Service Providers receive a steady stream of qualified projects, reducing their marketing costs and letting them focus on their specialized work. End Clients get a seamless experience where they work with one coordinated network instead of managing multiple separate vendors. When all participants become

active partners in a digital network, the platform's role as a central coordinator becomes critical. A prime example of this coordination in action is the B2B wholesale marketplace like the B2B Amazon, which demonstrates the practical benefits for both buyers and sellers.

Platforms like Alibaba act as central hubs for business trade. They work by connecting buyers and sellers from around the world in one efficient digital space [3].

For buyers the platform provides instant price comparisons from many suppliers, along with reviews and ratings. This creates transparency and helps them find the best deal. It also simplifies logistics and payments, managing everything from shipping to secure transactions, which reduces risk.

For sellers, especially for small and medium-sized ones, the platform acts as a global storefront. It gives them immediate access to international customers without the need for a large and expensive sales team.

Beyond wholesale marketplaces, B2B ecosystems also include specialized platforms for managing complex projects and on-demand services. To see this, we can look at two other types of platforms: collaborative project platforms, which integrate teams around a shared digital model for complex projects like construction, and on-demand service platforms, which act as intelligent matchmakers connecting businesses with specialized contractors.

Collaborative Project Platforms (The Digital Workspace)
Platforms like Autodesk BIM 360 are used in industries like construction and engineering. They create a single, shared digital model of a project – a "digital twin" – that all teams (architects, engineers, contractors) work on simultaneously. This allows for real-time updates and automatically detects conflicts between systems (like plumbing and electrical lines) during the design phase, preventing costly errors and delays on the construction site. All communication is centralized, creating a clear record for everyone.

Service and Contractor Platforms (The On-Demand Enterprise)
like ServiceNow act as intelligent matchmakers for service needs. They connect a company requiring a service (like equipment repair or an IT installation) with the perfect qualified contractor based on skills, location, and availability. The platform then manages the entire process automatically, from the initial request and quoting to scheduling, providing digital work orders, and final invoicing. It also tracks performance data, helping businesses choose the best contractors for future work.

In conclusion, the rise of B2B ecosystems [4] represents a fundamental re-architecting of how business is conducted. They are moving the competitive battleground from the quality of a single product or the cost of a single transaction to the strength and efficiency of an entire network. Companies that continue to operate as isolated entities in a linear chain will find themselves at a severe disadvantage, struggling with inefficiencies and an inability to meet modern customer expectations.

The businesses that will lead their industries in the coming decade are those that either master the art of building and governing their own ecosystem or strategically integrate themselves into existing ones as indispensable partners. By fostering transparency, automating collaboration, and unlocking the collective intelligence of the

network, B2B ecosystems are not just a new way of selling; they are the new operating model for the digital age.

In the landscape of the modern digital economy, data has become one of the most valuable assets a company can possess. Often called “the new oil”, its true value is not in its raw state but in its delicacy – transformed into the fuel that powers smarter decisions, predictive insights, and automated operations. For B2B firms, this evolution is not a future possibility but a present-day imperative. The central challenge, and the greatest opportunity, lies in mastering the cycle of collecting, analyzing, and acting on this data effectively.

The journey begins with understanding the vast and varied types of data at a B2B company's disposal. This wealth of information can be categorized into three key streams: deep customer behavior insights like purchase history, browsing patterns, and feedback; critical operational metrics such as inventory levels, delivery times, and production efficiency; and crucial external market trends including demand forecasts, competitor pricing, and seasonal fluctuations. Together, these streams form a comprehensive picture of both the internal machinery and the external market environment.

Harnessing this data unlocks transformative applications that are redefining core B2B processes. Through predictive analytics, algorithms can forecast future demand, allowing companies to proactively adjust inventory and production. Furthermore, dynamic pricing enables prices to adjust fluidly based on real-time demand, order volume, and client history, allowing a company to reward a loyal customer with better rates while applying a premium for urgent, last-minute orders [5].

The benefits of this data-driven approach are profound and directly impact the bottom line. It leads to significant cost reduction through less waste, fewer stockouts, and optimized logistics. It creates unparalleled speed, enabling faster decision-making and a more agile response to market changes. To achieve this, a powerful toolkit is essential. Business Intelligence (BI) Platforms visualize complex data and generate clear, actionable reports. Machine Learning Models dive deeper, identifying subtle patterns and anomalies that would escape the human eye. Finally, ERP Integration acts as the central nervous system, syncing data across all departments – from sales and finance to operations – to create a single, holistic source of truth for the entire organization. Of course, this path is not without its challenges. The principle of “garbage in, garbage out” holds true, making data quality a foundational concern, as inaccurate or incomplete data leads to poor decisions. Security is paramount, as the sensitive nature of client and operational data demands robust protection. Finally, the Skills Gap must be addressed, requiring investment in training so that teams can confidently interpret data and leverage these advanced tools effectively.

That’s why in today’s data driven world, investing in analytics is key. Analytics in B2B processes is an engine that keeps such structured warehouse of connections running.

The promise of digital transformation in the B2B landscape is undeniable: streamlined operations, data-driven insights, and enhanced customer experiences. However, the journey from legacy systems to a digitally-native enterprise is fraught with significant hurdles. Success is not guaranteed by technology alone; it requires a

strategic and human-centric approach to overcome a complex mix of technical, cultural, and strategic barriers.

One of the most formidable obstacles lies not in hardware or software, but mainly in people. Everything in such complicated interactions ruled by people and their management skills. So, employee resistance is quite common challenge, as sales and operations teams may be hesitant to adopt new tools and skills needed due to fears of job displacement or the perceived complexity of new systems. Such type of resistance can stall even the most well-funded initiatives and ideas.

Simultaneously, the very act of digitization introduces profound cybersecurity risks. As processes and data migrate to digital platforms, the attack surface expands, exposing sensitive client information and operational data to potential breaches, making sturdy security protocols non-negotiable.

From a technical standpoint, integration complexity often becomes a major bottleneck. Many B2B companies operate on a foundation of legacy systems. Getting new software to work with old, entrenched systems is a major hurdle. Since these legacy systems often lack the necessary connectors and documentation, integration becomes a slow and expensive process.

Overcoming these barriers requires intentional and calculated strategy. To address internal resistance, a strong change management program is essential. This involves clearly communicating the "why" behind the transformation, providing comprehensive training, and actively involving employees in the process. Besides that, companies must proactively invest in cybersecurity as a non-negotiable pillar of their transformation strategy. Critical actions include deploying end-to-end encryption, enforcing strict access controls, and conducting routine security audits to build a resilient and trusted foundation. For integration, the most effective strategy is a modular one. Rather than attempting risky, large-scale replacements, businesses should implement new platforms in phases, allowing for seamless integration with existing systems. This method reduces operational disruption, enables continuous adjustment, and generates early wins.

In conclusion, digital transformation is a complex but necessary journey. It is not a final destination but an ongoing process of adaptation. Companies that approach these challenges with strategic foresight, invest in their people, and remain responsive to client needs will be the ones best equipped to not just survive, but to truly thrive in the evolving B2B landscape.

Around the world, businesses are undergoing a massive shift. The ideas of digital B2B platforms, data-driven decision-making, and high-tech business strategies are no longer just theories in a textbook. They are being put into practice every day, changing how companies buy, sell, and work together. But this digital revolution does not look the same everywhere. The speed and style of this change depend heavily on a country's unique situation. Factors like the types of industries that dominate its economy, the level of its technology infrastructure, and the size of its market all play a crucial role.

To understand this global picture, we can look at three different regions: Belarus, the countries of the European Union, and the United States. Each one tells a different part of the story. Together, they show us the entire journey of digital B2B evolution. On one end, we have emerging ecosystems that are just beginning to adopt new tools.

On the other, we have fully developed, mature markets where digital platforms are now the standard way of doing business. By comparing these regions, we can see the future of business – and it is a future being built at different speeds, in different ways, all across the globe.

Belarus

As a country with a renowned IT outsourcing sector and a strong engineering talent pool, Belarus possesses a unique market. Its domestic B2B market is still in the early stages of digitalization, characterized by a gradual shift from traditional relationships to digital processes.

Many Belarusian companies are starting to use online software to improve their internal operations. Instead of installing programs on their own computers, they are subscribing to cloud-based services that manage their finances, sales, and stock levels. Right now, the main goal for these businesses isn't to create huge, interconnected networks with other companies. Their first and most important step is to make their own internal work smoother and faster. They want to bring all their information together into one place to get a clearer picture of how they are performing. This is also true for the country's large manufacturers, like the MAZ and BELAZ vehicle plants. They are investing in technology that uses data from sensors on their machinery. This data helps them predict when a machine needs maintenance before it breaks down, which prevents costly delays. In short, they are using data as a valuable resource – like "new oil" – but they are primarily using it within their own four walls to improve their own processes, rather than sharing it widely in an open business network.

In Belarus, the move to digital business is mostly about looking inward. Companies are focused on using technology to make their own operations smoother and more cost-effective. The biggest hurdles they face come from the past. The old economic system was very centralized, and business was often done through personal connections. Changing these deep-rooted habits is a slow process. Because of this, their approach is careful and step-by-step. Instead of rebuilding everything from scratch, they add new digital tools piece by piece to their current systems. The main goals are simple and clear: to lower costs and maintain high quality. While online B2B platforms do exist, they are still in the early stages. For now, these sites function mainly as online catalogs and ordering systems. They haven't yet evolved into the kind of deeply connected, collaborative networks that you see in more digitally mature countries.

European union

The European B2B landscape is highly diverse but is unified by a drive towards standardization, sustainability, and cross-border collaboration, heavily influenced by regulations like GDPR (General Data Protection Regulation) [6].

The European Union itself is a macro-platform, with regulations and digital single market policies designed to break down barriers. B2B marketplaces like Mirakl (a French platform that allows companies to launch their own marketplaces) are used by major distributors to offer a wider range of products and streamline cross-border procurement for their B2B clients, handling complexities like VAT and compliance.

The European approach is collaborative yet regulated. Ecosystem growth is balanced with a strong emphasis on data privacy (GDPR), cybersecurity, and

environmental, social, and governance (ESG) standards. The transformation is strategic and long-term, often involving partnerships between industry consortia, governments, and private companies. Platforms are valued not just for efficiency but for enabling compliance, sustainability, and resilient, transparent supply chains.

United States of America

The American B2B landscape is defined by its scale, venture capital funding, and a relentless drive for market disruption and dominance through platform models.

The best-known examples of this are huge platforms like Amazon Business. It used its massive consumer shopping system to become a giant in the business supply world. It wins by offering a huge number of products, completely clear prices, and super-fast, often next-day, shipping.

Another giant, Salesforce, started as a simple customer management tool. It has grown into a huge digital universe. Through its AppExchange, thousands of other software companies create programs that connect to it. This means that once a business starts using Salesforce, it becomes deeply connected to this ecosystem, making it very difficult to leave. [7]

American companies are also leaders in finding ways to make money directly from data. A great example is John Deere. It's no longer just a tractor company. Through its "Operate Center", it uses sensors on its equipment to gather huge amounts of field data. It then sells farmers high-tech advice based on that data. This clever use of information has created a brand new, highly profitable business for them.

Ultimately, the American B2B landscape demonstrates that the future of business lies not merely in adopting new tools, but in embracing entirely new models, where the platform itself becomes the marketplace, and data becomes the most valuable product.

In conclusion, while the core components of B2B digital transformation platforms, data, and strategic implementation are universal, their manifestation is deeply local. Belarus is on a path of building a foundational digital layer, Europe is architecting a connected yet principled digital single market, and America is charging ahead with a model designed to create and dominate new digital economies. For any global company, understanding these nuances is not just academic; it is essential for crafting a localized strategy that resonates with the specific drivers, regulations, and competitive landscapes of each region.

To put it simply, the world of business is changing in a big way. The old style of doing business – relying mostly on phone calls, paper forms, and familiar contacts – is quickly fading. A new, digital way is taking its place.

This change is happening because the people who buy for companies now want the same easy experience they get when shopping online for themselves. They want speed, clear information, and simple processes. To meet these new demands, companies are building digital networks where everyone can connect and work together smoothly. They are using data to predict needs, avoid problems, and make smarter decisions. This makes the whole business process faster, cheaper, and more efficient. Of course, changing how a company works can be difficult. Employees need to learn new tools, and old computer systems need to be updated. But by taking clear steps and training their teams, businesses can overcome these challenges.

In the end, the companies that will succeed are those that embrace this new connected way of working. The future of business is no longer about just selling a product. It's about being a reliable and efficient partner in a smart, digital network.

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DEVELOPMENT OF EXISTING AND CONSTRUCTION OF NEW TRANSPORT AND LOGISTICS ROUTES BETWEEN RUSSIA AND CHINA

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Abstract. This article analyzes the current situation and prospects of China-Russia transport and logistics channels, evaluates the capacity of railway and multimodal transport, the flow and timeliness of goods, pays attention to new projects such as bridges and high-speed rail, points out bottlenecks such as infrastructure and administration, and proposes countermeasures to improve efficiency through modernization and digitalization.

Keywords: Russia, China, transport corridors, logistics, Trans-Siberian Railway, Belt and Road, infrastructure, bottlenecks, intermodal transport.

РАЗВИТИЕ СУЩЕСТВУЮЩИХ И СТРОИТЕЛЬСТВО НОВЫХ ТРАНСПОРТНО-ЛОГИСТИЧЕСКИХ МАРШРУТОВ МЕЖДУ РОССИЕЙ И КИТАЕМ

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Аннотация. В статье анализируется текущее состояние и перспективы китайско-российских транспортно-логистических каналов, оценивается пропускная способность железнодорожных и мультимодальных перевозок, поток и своевременность доставки грузов, уделяется внимание новым проектам, таким как мосты и высокоскоростные железные дороги. Выявлены узкие места, в частности, в инфраструктуре и администрировании, предлагаются контрмеры для повышения эффективности за счет модернизации и цифровизации.

Ключевые слова: Россия, Китай, транспортные коридоры, логистика, Транссибирская магистраль, «Пояс и путь», инфраструктура, узкие места, интермодальные перевозки.

Introduction

In the context of the reshaping of the global economic paradigm, Russia-China strategic cooperation has deepened, and trade growth has put forward higher requirements for transportation channels [1, p. 125-142]. Existing corridors are close to saturation, and new projects are constrained by funding and coordination. This report

analyzes the current status and bottlenecks of major channels linking Chiana and Russia and proposes a path to improve efficiency through infrastructure modernization and digitalization.

Analysis of existing transport and logistics routes between Russia and China

Russia and China have a long land border, and their transport links mainly rely on railways, roads and multimodal transport routes combined with sea transport. Among them, railway transportation occupies a core position by virtue of its advantages of large volume, relatively stable cost, and lower dependence on climate.

Transport corridors between Russia and China can be broadly divided into two groups: direct routes and indirect routes. Direct routes are transport corridors that directly connect China and Russia. Indirect routes are corridors that go through territories of third countries (like the popular China-Kazakhstan-Russia corridor). The present paper is entirely dedicated to direct transport routes.

Major railway corridors

The Trans-Siberian Railway (TSR), which runs through all of Russia, is the main land artery connecting the two countries. Goods enter and exit China through the Trans-Siberian Railway and its branch lines through several key border crossings.

The most important railway crossings are the junction point between Zabaikalsk in Russia and Manzhouli in China, and the docking point between Grodykovo and the Suifen River. In recent years, container traffic through these ports has grown significantly. According to the data, in 2018 alone, Russia's railway export container traffic to China reached 1.131 million TEUs (20-foot TEUs) [1, p. 166]. Despite the rapid growth, it is worth noting that only 10-20 % of Russian-Chinese container trade is currently completed directly through the land border, and most of the goods still need to be transited through seaports for multimodal transit [1, p. 162].

Rail cargo exports from Russia to China mainly include mineral products, food and agricultural products, steel, wood and paper products and other commodities, while imports from China are mainly high value-added manufactured goods, such as machinery and equipment, metal products, building materials, chemical products and consumer goods, etc. [1, p. 162-165].

The transit time of the express container train is approximately 14 days through the “East-West” international transport corridor across Russia, Mongolia and Kazakhstan [2, p. 10]. The pure land transportation time from Moscow to Xi'an or Qingdao, China is also roughly about two weeks, demonstrating the competitiveness of rail transportation in terms of timeliness [3, p. 7].

Multimodal transport routes

In order to alleviate the pressure on purely land ports and optimize logistics routes, multimodal transport corridors combined with sea transport are playing an increasingly important role, especially through ports in the Russian Far East.

The “Binhai 1” and “Binhai 2” international transport corridors (ITCs) are important demonstrations of China-Russia multimodal transport cooperation. Binhai 1 departs from Harbin in northeast China, passes through the Mudan River, Suifen River, and Hunchun to the ports of Vladivostok and Nakhodka in the Russian Far East, and can be extended to southern China and the Asia-Pacific region by sea. Binhai No. 2 takes Jilin as the core and transits through Zarubino Port.

These two corridors have significantly shortened the distance and time of transportation in Northeast China. According to the latest forecast, by 2030, the annual freight volume (excluding petroleum products) of the two corridors will reach about 45 million ton [4, p. 1], reflecting infrastructure upgrades, railway capacity enhancement and Sino-Russian cross-border logistics policy coordination [2, p. 89-104].

The timeliness of multimodal transport is between pure sea and pure land transportation. For example, the route from Moscow to Vladivostok via the Trans-Siberian Railway, and then by sea to a Chinese port, takes about 3.5 weeks [3, p. 7]. Although it takes longer than pure rail, it still has advantages over pure sea routes around the Suez Canal and is generally less expensive than air freight.

Construction and planning of new transport routes

In order to meet the growing trade demand and fundamentally solve the capacity bottleneck on existing routes, Russia and China are actively cooperating in the construction of a series of new large-scale infrastructure projects. These projects cover railways, roads, bridges and ports, aiming to build a more three-dimensional and efficient modern logistics network.

As the first cross-border railway bridge across the Amur River (Heilongjiang), the Tongjiang-Nizhoninskoye railway bridge is a milestone in the infrastructure connectivity of the two countries. The bridge connects the city of Tongjiang in China with the Jewish Autonomous Region of Russia [5].

The Moscow-Kazan high-speed railway project aims to build the starting section of the “Moscow-Beijing” Eurasian high-speed transport corridor - the Moscow-Kazan high-speed railway [2].

The opening of the modern two-way road bridge across the Amur River in June 2022 will increase the capacity of foreign trade corridors in the Far East, and the annual freight volume (excluding petroleum products) is expected to exceed 45 million tons by 2030 [4].

In line with the development of the Primorsky International Transport Corridor, Russia is increasing investment and modernization of the Far East port cluster, focusing on Vladivostok, Nakhodka, Vostok Port and Zarubino Port [5].

Key bottlenecks and challenges in development

Despite the promising development prospects of the Russian-Chinese transport corridor, the full release of its potential is still subject to a series of deep-rooted bottlenecks and challenges. These issues involve both hardware infrastructure and software-level operations and management.

Russian railways use 1520 мм broad gauge, while Chinese railways use 1435 мм standard gauge. Due to the incompatibility of the two countries' gauges, cross-border trains must undergo axle rotation or container transfer operations at border crossings (e.g. Zabaikalsk-Manzhouli). Relevant studies have pointed out that it usually takes several hours to change wheels or transfer operations [6].

Insufficient border port handling capacity is one of the most prominent bottlenecks at present. Taking the busiest Zabaikalsk-Manzhouli port as an example, its infrastructure capacity is far from meeting the freight demand during peak periods, and there is often a large number of trains backlogged waiting for transit [7, p. 99-104].

In addition to border crossings, key railway hubs and logistics centers in the interior of Russia generally lack modern multimodal logistics centers that can provide one-stop services such as warehousing, distribution, and customs clearance, which greatly restricts the further expansion of container transportation [8, p. 10-19].

Although the Chinese and Russian governments are committed to simplifying customs clearance procedures, in practice, customs inspection, inspection and quarantine procedures are still cumbersome, and coordination between different departments is sometimes not smooth enough [9]. This problem can be solved on the basis of further digital transformation of cross-border logistics (including digitalization of customs procedures) [10]. At present, cross-border transportation between Russia and China has not yet achieved full and unified digital management. According to Russian statistics, as of 2024, only about 30 % – 40 % of cross-border cargo transportation documents use electronic documents in Russia, and paper documents are still the mainstream [11].

Russia's Siberia and Far East have long and cold winters, and climatic conditions such as extreme low temperatures, blizzards, and frozen soil pose serious challenges to the maintenance and operation of railways, highways, and other infrastructure. In addition, a special study pointed out that in the permafrost area, the low temperature environment caused a significant increase in the rigidity of the subgrade material, the deformation of the track structure and the aggravation of equipment fatigue damage [12].

Strategies and prospects for overcoming challenges

To address these challenges, Russia and China and countries along the route need to adopt a systematic and multi-dimensional comprehensive strategy to jointly enhance the competitiveness and sustainability of the Eurasian transport corridor through continuous investment, technological innovation and deepening cooperation.

First, Russia and China should invest in infrastructure. At present, Russia is promoting a series of projects in the grand infrastructure of Northeast China, including large-scale electrification and double-track construction of the Baikal-Amur Railways and the Trans-Siberian Railway, while promoting the expansion of border crossings, the application of automatic changeover equipment, and the construction of modern multimodal logistics hubs at major transportation nodes to improve cargo handling capacity and transportation efficiency [13].

Secondly, we will deepen policy coordination, and under the leadership of Eurasian Economic Commission, we will gradually implement unified electronic waybills (such as CIM/SMGS unified waybill standards), simplify and unify customs, inspection and quarantine procedures, and promote “single window” and “green channel” in the framework of the Belt and Road Initiative and the Eurasian Economic Union and other facilitation measures to achieve mutual recognition of supervision and mutual assistance in law enforcement [14, 15].

Thirdly, the “construction” of “digital transport corridors” is considered an important direction for the future development of the Russian transport and logistics system. By using advanced technologies such as the Internet of Things, big data, and blockchain, it is planned to establish a transparent and real-time cross-border logistics information platform, which aims to realize the visual tracking of goods from the

consignor to the consignee, optimize route planning, and promote the digitization of all transportation documents and processes, so as to fundamentally improve transportation efficiency and safety [16].

Fourth, while continuing to strengthen the backbone role of railway transportation, more attention should be paid to the development of multimodal transport. By optimizing the sea-rail and road-rail intermodal transport lines, especially making full use of the connection potential of the Northern Sea Route and the Siberian railway network, as well as developing cross-border road transportation, a diversified and complementary comprehensive transportation system with strong risk resistance will be formed [17, 18]. The Northern Sea Route that connects Chinese Pacific ports with Russian ports of Murmansk and Arkhangelsk in the Arctic can potentially become an important alternative to the Suez Channel for transportation of Chinese goods to Europe (especially taking into account China's interest towards ensuring its presence in the Arctic zone). The Northern Sea Route is substantially shorter that the traditional sea route via the Suez Channel and deliveries take less time. It could also increase the resilience of the Chinese international logistics as, unlike the traditional routes via the Suez Channel, it does not go through regions with military threats (regular Houthi attacks in the Red Sea etc). There are some examples of successful use of the Northern Sea Routes by Chinese ships. However, hard climatic conditions, higher risks and lack of logistics infrastructure can slow down the development of this transport corridor.

The example of the Northern Sea Route demonstrates that transport corridors between Russia and China should not be analysed separately from the new growing global connectivity networks that China is now building to ensure the resilience of its international trade.

Conclusion

The Russia-China transportation and logistics corridors are in a critical period of development, with opportunities for bilateral trade growth and the docking of the Belt and Road Initiative and the Eurasian Economic Union, and start of new bridges and other projects to improve connectivity between two countries and in Eurasia in general. However, gauge differences, port congestion, and digital lag still restrict efficiency. In the future, it is necessary to accelerate infrastructure modernization, break down barriers, and promote digitalization in order to unleash the potential of the corridor and promote the connectivity and common development of the two countries and Eurasia.

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DEVELOPING THE CUSTOMER CAPITAL OF A HIGHER EDUCATION INSTITUTION THROUGH THE IMPROVEMENT OF DIGITAL SERVICES

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Abstract. The article presents a comprehensive analysis of the customer capital development problem in modern universities within the context of digital transformation. The research substantiates the crucial role of digital services quality and accessibility in forming loyalty among key stakeholder groups, including applicants, students, alumni, and corporate partners. The study examines the structural components of university customer capital and identifies the most effective digital interaction channels. Particular attention is paid to the analysis of implementation challenges and development strategies for digital ecosystems in educational organizations. The paper proposes a conceptual model for assessing the effectiveness of digital services in building customer capital, supported by empirical data and case studies from leading Russian universities.

Keywords: customer capital, higher education institution, digital services, client-oriented approach, stakeholder loyalty, university competitiveness, digital ecosystem, educational marketing.

РАЗВИТИЕ КЛИЕНТСКОГО КАПИТАЛА ВЫСШЕГО УЧЕБНОГО ЗАВЕДЕНИЯ ЧЕРЕЗ СОВЕРШЕНСТВОВАНИЕ ЦИФРОВЫХ СЕРВИСОВ

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Аннотация. В данной статье рассматривается проблема развития клиентского капитала современного университета в условиях цифровой трансформации. Автор обосновывает позицию, согласно которой качество и доступность цифровых сервисов становятся ключевым фактором формирования лояльности таких стейкхолдерских групп, как абитуриенты, студенты, выпускники и корпоративные партнеры. В исследовании анализируются основные составляющие клиентского капитала вуза и определяются наиболее значимые цифровые каналы взаимодействия с ними. Делается вывод о необходимости комплексного подхода к развитию цифровой экосистемы образовательной организации как стратегического направления повышения ее конкурентоспособности и финансовой устойчивости.

Ключевые слова: клиентский капитал, высшее учебное заведение, цифровые сервисы, клиентоориентированный подход, лояльность стейкхолдеров, конкурентоспособность университета.

The contemporary landscape of higher education is characterized by intensifying competition and rapid digitalization, compelling universities to seek innovative approaches to maintain their market positions. Customer capital emerges as a fundamental strategic resource in this context, representing the aggregate value of relationships with key stakeholders built on mutual trust and long-term engagement [1, p. 41]. The transformation from traditional educational paradigms to client-oriented models requires fundamental changes in institutional management approaches, where digital services become not merely technological tools but essential components of strategic development [2, p. 116]. The urgency of this research direction is amplified by the growing demands of digital-native generations and the increasing importance of universities' brand capital in the global educational space.

The theoretical significance of this study lies in the systematization of approaches to understanding customer capital in the context of digital transformation of higher education. The practical relevance is determined by the need to develop specific methodological tools for assessing the effectiveness of digital services in building sustainable relationships with university stakeholders. This research aims to bridge the existing gap between theoretical concepts of customer capital and practical implementation of digital transformation strategies in higher education institutions.

The concept of customer capital in higher education requires detailed theoretical examination through the prism of modern economic and managerial theories. Customer capital represents an intangible asset that accumulates through systematic efforts to build long-term relationships with key stakeholder groups. According to contemporary research, the structure of university customer capital comprises several interconnected elements: relational capital with applicants and students, reputational capital with academic community, partnership capital with employers, and alumni engagement capital [4, p. 35].

The distinctive feature of customer capital in education lies in its dual nature - simultaneously serving both commercial and social purposes. This duality creates unique challenges in its management and measurement. Traditional approaches to capital valuation often prove inadequate for capturing the full value of customer relationships in educational contexts. The research demonstrates the feasibility of developing comprehensive methodologies for assessing customer capital value, incorporating both quantitative and qualitative indicators [3, p. 67].

The digital transformation of higher education has fundamentally altered the mechanisms of customer capital formation. Digital platforms enable continuous engagement with stakeholders throughout their entire lifecycle – from prospective applicant to alumnus. This continuity creates new opportunities for value co-creation and long-term relationship building. The integration of digital technologies into all

aspects of university operations has become a critical success factor in today's competitive educational landscape.

The evolution of digital services in higher education has transformed them from supporting tools to strategic assets. Modern digital ecosystems encompass multiple interaction channels, each contributing uniquely to customer capital development. For prospective students, virtual campus tours and AI-powered admission consultants create immersive experiences that significantly influence enrollment decisions. These technologies demonstrate the institution's innovative capabilities while providing personalized attention to potential applicants.

Learning management systems have evolved into comprehensive educational platforms that facilitate not only knowledge transfer but also community building. Advanced analytics capabilities allow for monitoring student engagement and early identification of at-risk individuals, enabling proactive support interventions. This comprehensive approach to student experience management directly contributes to increased satisfaction and loyalty, forming the foundation of sustainable customer capital.

Alumni relations platforms represent another crucial element in the digital ecosystem. Modern systems facilitate professional networking, continuing education opportunities, and mentorship programs. The integration of blockchain technology for credential verification and smart contracts for alumni contributions creates transparent and trustworthy engagement mechanisms. These technological solutions transform occasional interactions into sustained relationships, significantly enhancing the university's customer capital.

Corporate partnership portals have become sophisticated B2B platforms that streamline collaboration between universities and industry partners. These systems manage joint research projects, internship programs, and talent pipeline development. The automation of partnership processes and real-time collaboration tools enhance the efficiency and scalability of industry-academia interactions, creating measurable value for all participants.

The development of integrated digital ecosystems faces several significant challenges that require careful strategic planning. Technical integration represents a major hurdle, as many universities operate legacy systems that are difficult to modernize. The implementation of middleware solutions and API-based architectures can facilitate gradual digital transformation while maintaining operational continuity. Data security and privacy concerns necessitate robust cybersecurity measures and compliance with evolving regulations.

Organizational resistance to change often impedes digital transformation initiatives. Successful implementation requires comprehensive change management strategies, including staff training programs and clear communication of benefits. The cultural shift toward client-centricity must be supported by appropriate incentive structures and performance metrics aligned with customer capital development objectives.

Financial constraints present another significant challenge, particularly for public institutions. Creative funding models, including public-private partnerships and phased implementation approaches, can help overcome budget limitations. The return on investment calculation must consider both tangible benefits, such as increased enrollment, and intangible gains, including improved reputation and stakeholder satisfaction.

The measurement of digital services effectiveness requires developing comprehensive assessment frameworks. Key performance indicators should encompass user engagement metrics, satisfaction scores, conversion rates, and long-term relationship value. Advanced analytics and artificial intelligence capabilities can provide deeper insights into user behavior and service impact, enabling continuous improvement of digital offerings.

Analysis of leading Russian universities reveals several successful approaches to digital service implementation. Many institutions have developed mobile-first strategies recognizing the primacy of smartphone usage among modern students. These platforms integrate academic, administrative, and social functionalities, creating seamless user experiences that enhance engagement and satisfaction.

Personalization emerges as a critical success factor in digital service design. Institutions implementing AI-driven recommendation systems for educational content and career guidance demonstrate significantly higher user engagement rates. These systems adapt to individual learning patterns and professional interests, creating unique value propositions for each stakeholder.

The integration of gamification elements into digital platforms proves effective in enhancing user engagement. Leaderboards, achievement systems, and progress tracking mechanisms motivate continuous participation and skill development. These approaches are particularly successful in alumni engagement platforms, where they encourage ongoing professional development and community participation.

Blockchain implementation for credential verification and micro-credentialing represents an emerging trend with significant potential for customer capital enhancement. Transparent and secure credential management builds trust with employers and other educational institutions, strengthening the university's reputation and the value of its qualifications.

The research demonstrates that strategic development of digital services is essential for building and maintaining customer capital in modern higher education institutions. The integrated approach to digital ecosystem development, encompassing all stakeholder groups and their specific needs, creates sustainable competitive advantages in the increasingly crowded educational market. The successful implementation requires addressing technical, organizational, and financial challenges through comprehensive strategic planning and change management [5, p. 245].

Future research should focus on developing more sophisticated methodologies for measuring the impact of digital services on customer capital valuation. Longitudinal studies tracking the relationship between digital engagement metrics and long-term stakeholder value would provide valuable insights for strategic decision-making. The

exploration of emerging technologies, particularly artificial intelligence and blockchain, in enhancing customer capital represents another promising research direction.

The increasing importance of data-driven approaches to customer relationship management in higher education necessitates further investigation into ethical considerations and privacy protection frameworks. As digital services continue to evolve, universities must balance technological innovation with responsible data management practices to maintain stakeholder trust and sustainable customer capital development.

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HUMANITARIAN AID: RUSSIA'S ROLE IN GLOBAL CRISES

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Abstract. This article aims to provide a comprehensive analysis of the Russian Federation's role in providing humanitarian assistance. Special attention is given to modern areas of Russian humanitarian assistance, including countries within the Commonwealth of Independent States, Africa, the Middle East, and Latin America. Various forms and mechanisms of support are analyzed, highlighting the multidirectional nature and strategic significance of Russian humanitarian efforts. Government cooperation with Russian businesses is identified as a potential vector for the advancement of Russian humanitarian endeavors.

Keywords: humanitarian aid, Russian Federation, international cooperation, foreign policy, effectiveness, international arena, role of Russia**.**

ГУМАНИТАРНАЯ ПОМОЩЬ: РОЛЬ РОССИИ В ГЛОБАЛЬНЫХ КРИЗИСАХ

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Аннотация. Настоящая статья посвящена комплексному анализу роли Российской Федерации в оказании гуманитарной помощи. Особое внимание уделено современным направлениям оказания Россией гуманитарной помощи, включая страны Содружества Независимых Государств (СНГ), Африканского континента, Ближнего Востока и Латинской Америки. Анализируются формы и механизмы поддержки, демонстрирующие многовекторность и стратегическую значимость российской гуманитарной деятельности. Статья определяет сотрудничество органов власти с российскими компаниями как потенциальный вектор развития российской гуманитарной деятельности.

Ключевые слова: гуманитарная помощь, Российская Федерация, международное сотрудничество, внешняя политика, эффективность, международная арена, роль России.

The world is currently witnessing a surge in both the number and severity of humanitarian crises, stemming from natural disasters, human-caused events, armed conflicts, disease outbreaks, and economic downturns. In response, delivering humanitarian aid to relieve suffering and protect lives is paramount. Russia, as a permanent member of the UN Security Council with a long-standing history and substantial resources, is positioned to contribute significantly to global humanitarian efforts. However, amid the present-day “information war”, Western media outlets are reportedly engaged in a campaign designed to undermine Russia's humanitarian work, diminishing its perceived positive contributions on the world stage.

Currently, in the context of the ongoing information war, there is a problem of Western media's focus on a campaign aimed at discrediting Russia's efforts to provide humanitarian assistance to other countries, which devalues Russia's positive role in this area on the global stage. Through various communication channels, Western countries are forming a skeptical attitude among target audiences towards Russia's humanitarian aid to other nations. Given this context, the significance of the research on this topic is undeniable.

According to official information published on the website of the Russian Ministry of Emergency Situations, Russia is currently recognized as one of the leading countries in the world in terms of humanitarian assistance [1]. This recognition is confirmed by the large number of successful humanitarian operations conducted abroad.

In fact, foreign media have a fundamentally different perspective on the issue. Western media outlets have expressed skepticism regarding the goals of Russia's humanitarian aid to other countries. For example, the InoSMI news aggregator, which provides translations of articles from international media in Russian, reported that journalist Jacobo Jacoboni wrote in an article published in the Italian newspaper La Stampa, that up to 80 % of funds provided by Moscow during the COVID-19 pandemic have been deemed ineffective, which diminishes the actual value of Russia's supplies [2]. Additionally, there are concerns that Russia's assistance to Italy was not motivated by good intentions, and that there may be some hidden intentions. In The Washington Post's American edition, Robin Dixon described Russia's aid in the fight against the coronavirus as an opportunity to conduct propaganda during a pandemic [3]. As a result, Western media has been focusing on a campaign to discredit Russia's humanitarian efforts as part of an information war.

In response to unsubstantiated reports from foreign media outlets, it is important to note that Russia's support for vulnerable countries has a long and well-established tradition. Anatoly Wasserman, a prominent Russian statesman, has stated that the provision of humanitarian assistance by Russia is not the responsibility of the government in particular, but rather a shared responsibility of the entire Russian people [4].

Authors of the article on the humanitarian policy of the Soviet Union highlight the rich experience of the former USSR in the field of humanitarian policy. The Soviet Union was a major donor of humanitarian aid, supporting friendly nations as part of its ideological efforts and efforts to promote the development of countries in the developing world [5].

As a result of the dissolution of the USSR, the 1990s were a challenging period for Russia, marked by economic and political crises and social problems, which led to a decline in the standard of living for the population, a reduction in the birth rate, and an increase in crime. These factors, of course, significantly limited Russia’s capacity to provide humanitarian assistance.

However, the beginning of the 21st century saw an improvement in Russia's economic situation and political stability, allowing it to once again become an active participant in providing humanitarian aid to needy countries. The main focus of Russia's humanitarian policy has been on assisting countries within the Commonwealth of Independent States (CIS) and other countries with which it has historical and economic ties/Today, according to the Ministry of Emergency Situations of Russia, within the framework of international cooperation in the Russian Federation, there are more than 50 international agreements on cooperation and assistance with foreign countries.

Russia is actively investing in the establishment and operation of specialized humanitarian centers aimed at training foreign specialists in the field of emergency response and disaster management using Russian educational methods. These centers are designed to provide training in order to protect territories and populations in relevant regions, as well as to swiftly respond to emergencies. Among them:

1. Russian-Serbian Humanitarian Center (Serbia);
2. Russian-Armenian Humanitarian Response Center (Armenia);
3. Regional Russian-Cuban Fire and Rescue Specialist Training Center (Cuba);
4. The International Center named after the Russian-Nicaraguan Friendship (Nicaragua).

Employees of the Russian Emergency Ministry are among the first to be dispatched to foreign countries for the most challenging search and rescue missions. The Ministry continues to actively implement the methodologies of the International Search and Rescue Advisory Group (INSARAG) and the UN System for Emergency Assessment and Coordination (UNDAC), ensuring that Russian rescuers comply with international standards and increasing the effectiveness of their humanitarian response.

Since 1993, the Russian Ministry of Emergency Situations has conducted approximately 700 emergency response operations. The types of these operations are shown in Figure 1.

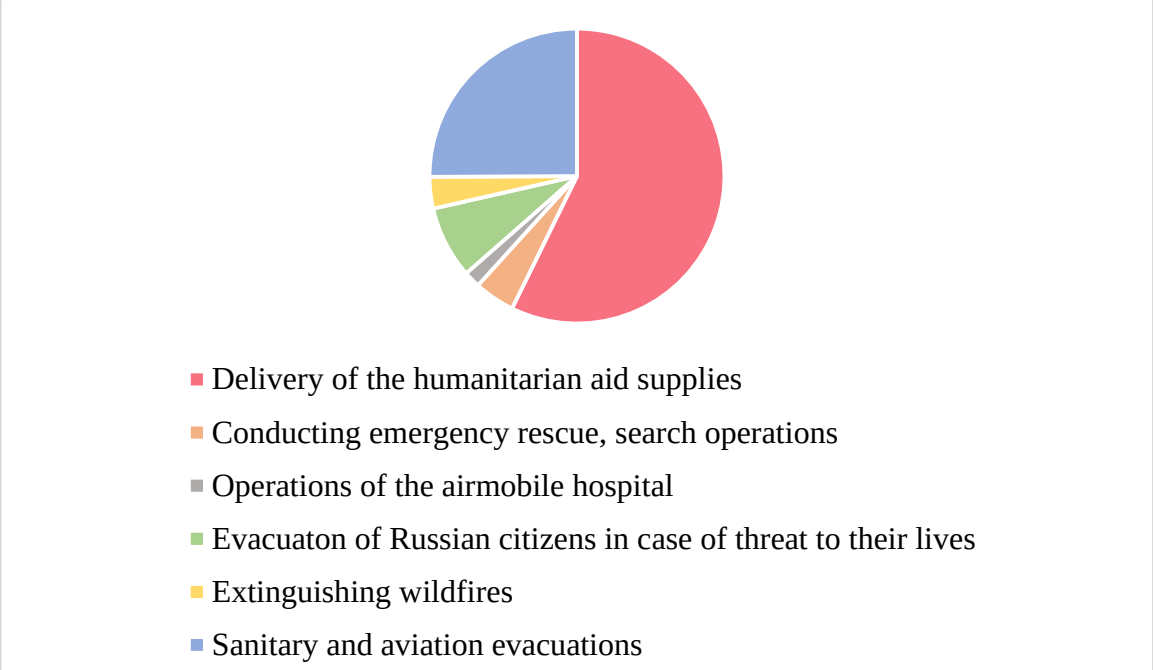


Figure. Types of emergency operations

There are several key areas of humanitarian assistance that demonstrate the highest level of activity and are of significant importance in the context of Russia's foreign policy and global humanitarian challenges.

Countries of the Commonwealth of Independent States (CIS)

The Russian Federation considers the provision of humanitarian assistance to the countries of the Commonwealth of Independent States (CIS) not as a one-time act of mercy, but as a multilevel and strategically adjusted policy integrating concern for neighbors with the realization of its own national interests.

So, one of the recent examples is the support of Armenia. After the devastating floods in the Lori region at the end of May 2024, the Russian Humanitarian Mission promptly delivered 7 tons of humanitarian aid to the most affected towns of Akhtala and Karkop. This aid included essential food and personal hygiene supplies, as well as a generator for a medical facility, which had been experiencing power outages due to the floods [6]. In 2023, the Russian Humanitarian Mission, in collaboration with the Renaissance of Hearts Charitable Foundation and as part of the Rossotrudnichestvo's “Russia with You” project, organized the shipment of assistance to Armenia. The aid consisted of warm clothing, footwear, bedding, and medical supplies. Additionally, in response to the challenging humanitarian situation resulting from the mass displacement of the population in Nagorno-Karabakh in 2023, the Ministry of Emergency Situations of the Russian Federation delivered 40 tons of humanitarian aid on behalf of the President and Government of Russia. Russian funds have also collected about 6 tons of aid for internally displaced persons, including not only food, but also electrical equipment, cots and clothes [7].

However, humanitarian assistance is not limited to food and medicines, but also includes logistical assistance. For example, in January 2024, a ceremony was held in Bishkek for the transfer of 28 vehicles purchased under the Agreement between the

Ministry of Internal Affairs of Russia and the Ministry of Internal Affairs of Kyrgyzstan on Assistance in Combating Illicit Drug Trafficking, which is part of a gratuitous support package of 627 million rubles for 2024-2025. In February 2024, Russia provided Abkhazia with 10 fully equipped ambulances, a mobile fluorography unit, and 20 school buses, significantly strengthening its social infrastructure. Financial support is also an important element: in 2023, the Russian Government allocated 30 million rubles to Belarus for technical assistance to the State Control Committee to implement a data analysis and visualization system.

It is important to understand that these examples represent only a part of the wide-ranging and diverse humanitarian efforts Russia undertakes within the CIS. These activities go far beyond simple emergency response and represent a complex balance between humanitarian imperatives and geopolitical calculations, shaping Russia's unique profile as a donor of humanitarian aid in the post-Soviet space.

Africa

Humanitarian aid to African countries is becoming an increasingly important area of Russian foreign policy. The Russian Federation is actively providing humanitarian assistance to the countries of the African continent, mainly in response to acute epidemiological challenges and food security issues. These initiatives demonstrate Russia's comprehensive approach to supporting the region.

A priority is enhancing the healthcare system in the Republic of Congo. For example, in 2025, Russia equipped the country with an advanced mobile laboratory for detecting and tracking infectious diseases. This lab, capable of research under strict biosafety conditions, will prove vital in remote, inaccessible epidemic and epizootic hotspots lacking permanent lab facilities, as well as in emergency scenarios. This support is essential to the efforts of the government of the Republic of Congo and other countries in Central Africa to combat the spread of monkeypox and other infectious diseases [8]. Moreover, the Russian House in Bangui has provided the Central African Republic with more than 77,000 doses of the BIKTARVY drug combination for the treatment of HIV infection. This amount of medication is sufficient to cover a three-month treatment course for HIV-positive residents of the country [9].

A significant part of Russian assistance is aimed at addressing hunger and ensuring food security. Therefore, this year, the Russian side transferred 1,630 metric tons of grain as food assistance to Ethiopia for refugees in the Gambella region. This donation has been crucial for the United Nations World Food Programme (WFP), which faces diminishing resources and will provide food for 163,240 refugees [10]. Furthermore, in 2024, Russia supplied gratuitous shipments of grain crops to several other African nations. In particular, Burkina Faso, Zimbabwe, Mali, Somalia, and Eritrea each received 25,000 metric tons, while the Central African Republic received 50,000 metric tons of wheat. These large-scale food distribution operations are often conducted within the framework of cooperative arrangements between the Ministry of Agriculture of the Russian Federation, United Grain Company, and with the support of the Ministry of Foreign Affairs and Ministry of Transport of Russia.

In 2023, a wide range of humanitarian aid was sent to numerous African countries, including Burkina Faso, Burundi, Guinea, the Democratic Republic of the

Congo, Zimbabwe, Kenya, Libya, Madagascar, Malawi, Mali, the Republic of the Congo, Somalia, Sudan, Uganda, the Central African Republic, Eritrea and Ethiopia. This assistance encompassed a variety of forms, including financial resources, medical supplies (including diagnostic equipment and pharmaceuticals), food items (such as grains and wheat), and logistical support, including mobile power generators and lighting systems.

Therefore, Russia is actively involved in humanitarian programs in Africa, providing various forms of assistance, including high-tech medical equipment (mobile laboratories), vital medicines (anti-HIV drugs), and large quantities of food (grains). Aid to Africa is strategically directed toward tackling two pressing issues: the precarious epidemiological landscape (fighting diseases like monkeypox and HIV) and widespread food shortages (supporting refugees and nations facing grain deficits).

Middle East

The Middle East region, especially in recent decades, has been a hotbed of serious humanitarian crises, and Russia plays a prominent role there. The Middle East is a region directly related to Russia's security interests. Ongoing armed conflicts (for example, in Syria and Yemen) generate large-scale humanitarian disasters, mass population displacement, and the growth of extremist groups. Russia, actively participating in conflict resolution, also provides humanitarian assistance to alleviate the suffering of civilians, support the recovery process, and stabilize the situation

In 2024, significant assistance was provided to residents of the Gaza Strip. Specifically, the Republic of Ingushetia has already dispatched 32 consignments of humanitarian supplies. Additionally, the team of Peoples Together – Through the Years (PTT) project has provided medicines, personal hygiene items, and food to the inhabitants of Palestine. The national cultural autonomies of the Volgograd region, under the guidance of the public organization House of Friendship, have joined in the collection of assistance. The delivery of these shipments was facilitated by the Russian Ministry of Emergencies, and students from Volgograd universities have provided active volunteer assistance [11].

In addition, Lebanon received significant humanitarian aid in 2024. Three deliveries were made by the Russian Ministry of Emergencies: on November 21st (24 tons of medical supplies and food [12]), November 5th (over 19 tons of basic necessities and medical supplies [13]), and October 3rd (33 tons of food, essential goods, medical supplies, and mobile power generators).

Thus, Russia plays a significant role in providing humanitarian assistance to the countries of the Middle East. Support is provided in various forms, from food and medicine to logistical support, which indicates a comprehensive approach to assistance and a desire to strengthen friendly ties with these regions. It is important to note that humanitarian aid is being collected throughout Russia, which underscores the nationwide support for these efforts.

Latin America

Latin America, although not as high a priority as the CIS or the Middle East, is also coming to the attention of Russian humanitarian aid, reflecting the desire to diversify foreign policy. For Russia, Latin America is a region where there are

opportunities to strengthen partnerships and counter the dominance of other powers. Humanitarian aid can become a tool for establishing dialogue and demonstrating benevolent intentions, which is important in the context of the formation of a multipolar world.

In 2024, Mexico received assistance in the field of basic needs. The Rossotrudnichestvo representative office in Mexico, in collaboration with the "Women Working for the Benefit of Our Planet" association, installed rainwater harvesting systems for domestic use in residential buildings in San Pedro Hueytentan, Puebla, significantly improving access to water for the local community [14].

Russia has provided significant assistance to Cuba aimed at improving emergency preparedness and ensuring essential security. This humanitarian package includes 8 firefighting and rescue motorcycles, 1,500 individual water filters, and 500 emergency medical kits for victims.

Venezuela has also received significant health assistance. As part of Russian-Venezuelan cooperation, the Ministry of Health in Venezuela received five ambulances manufactured in Russia. The supply of these vehicles was financed by the Russian-Venezuelan joint venture, Eurofinance Mosnarbank, with the support of its major shareholder, Rostec State Corporation [15].

In addition, in 2023, the Russian Embassy in Argentina provided humanitarian assistance to the Maria Cecilia Foundation, a local organization that specializes in supporting children with cancer, through the efforts of Russian diplomats. The Embassy's staff collected 16 boxes weighing a total of 265 kilograms, containing groceries, toys, and consumer goods, for distribution to the Foundation's beneficiaries.

Thus, the conducted research confirms the significant and multi-faceted role of the Russian Federation in providing humanitarian assistance on the international stage, encompassing key regions such as the CIS countries, Africa, the Middle East, and Latin America. The variety of forms of support, from food and medicine to technical assistance, demonstrates an integrated approach to problem solving. However, despite the favorable overall picture, the key issue for further development is to increase the effectiveness of these activities. In our opinion, the achievement of maximum effectiveness in the provision of humanitarian assistance is largely due to the expansion of cooperation with the private sector.

Currently, the practice of such interaction in Russia is characterized by limited distribution, as evidenced by the participation of only a few large companies, such as PJSC RUSAL, PJSC Gazprom and PJSC Lukoil, in humanitarian operations. It seems advisable to significantly expand the opportunities for government cooperation with Russian companies by integrating their logistics, insurance, agro-industrial and pharmaceutical resources into humanitarian projects. For example, large agro-industrial holdings such as Rusagro and Miratorg, due to their large-scale production facilities and well-developed logistics infrastructure, can play a key role in ensuring food security by promptly delivering vital goods. Similarly, pharmaceutical companies, in particular R-Pharm and Pharmstandard, are indispensable partners capable of supplying a wide range of medicines and medical equipment. It is also possible to involve logistics companies, for example, Business Lines, SDEK,

Zheldorexpedition and PEC, which provide services for cargo delivery, warehouse logistics, etc. Such a strategic partnership, aimed at sharing resources and experience, is a potential vector for the development and improvement of the effectiveness of Russian humanitarian activities, allowing for a more rapid and large-scale response to global challenges.

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INSTITUTIONAL TRANSFORMATION OF OIL-DEPENDENT REGIONS: STRATEGIES FOR OVERCOMING THE “DUTCH DISEASE” IN THE CONTEXT OF GLOBAL CHALLENGES

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Abstract. The article provides a comprehensive analysis of the problem of the "Dutch disease" in resource-based regions, using the examples of the Khanty-Mansi Autonomous Okrug – Yugra and the Republic of Tatarstan. The author examines the institutional traps that hinder economic diversification and proposes mechanisms for designing transitional economic institutions. Based on a systematic approach and comparative analysis, the key elements of the institutional environment of regions in the post-oil period are identified. The necessity of an integrated approach combining state strategic planning, innovation support, and human capital development is substantiated. The experience of Benelux countries in using higher education as a tool of “soft power” and economic development is considered as a potential benchmark for Russian regions. Special attention is paid to the role of digital transformation and the formation of innovation ecosystems in overcoming resource dependence. The article proposes a conceptual model for the transformation of resource regions based on the synthesis of institutional economics and modern theories of regional development.

Keywords: Dutch disease, institutional traps, resource regions, economic diversification, transitional institutions, Tatarstan, Khanty-Mansi Autonomous Okrug, regional development, innovation, human capital, digital transformation, innovation ecosystem.

ИНСТИТУЦИОНАЛЬНАЯ ТРАНСФОРМАЦИЯ НЕФТЕЗАВИСИМЫХ РЕГИОНОВ: СТРАТЕГИИ ПРЕОДОЛЕНИЯ «ГОЛЛАНДСКОЙ БОЛЕЗНИ» В УСЛОВИЯХ ГЛОБАЛЬНЫХ ВЫЗОВОВ

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Аннотация. В статье представлен комплексный анализ проблемы «голландской болезни» в ресурсодобывающих регионах на примере Ханты-Мансийского автономного округа – Югры и Республики Татарстан. Автор исследует институциональные ловушки, препятствующие диверсификации экономики, и предлагает механизмы проектирования переходных экономических институтов. На основе системного подхода и сравнительного

анализа выявляются ключевые элементы институциональной среды регионов в период после падения добычи нефти. Обосновывается необходимость комплексного подхода, сочетающего государственное стратегическое планирование, поддержку инноваций и развитие человеческого капитала. Опыт стран Бенилюкс в использовании высшего образования как инструмента «мягкой силы» и экономического развития рассматривается в качестве потенциального ориентира для российских регионов. Особое внимание уделяется роли цифровой трансформации и формированию инновационных экосистем в преодолении ресурсной зависимости. Предлагается концептуальная модель трансформации ресурсных регионов на основе синтеза институциональной экономики и современных теорий регионального развития.

Ключевые слова: голландская болезнь, институциональные ловушки, ресурсные регионы, диверсификация экономики, переходные институты, Татарстан, Ханты-Мансийский автономный округ, региональное развитие, инновации, человеческий капитал, цифровая трансформация, инновационная экосистема.

The sustainable development of resource-dependent regions represents one of the most complex challenges in modern economics. High concentration on the extraction and export of raw materials makes their economies extremely vulnerable to price fluctuations in global markets and leads to the formation of the phenomenon known as the “Dutch disease” [1]. This economic syndrome, first identified in the Netherlands after the discovery of natural gas fields, is characterized by several typical symptoms: strengthening of the national currency, which negatively affects the competitiveness of non-resource sectors of the economy (primarily manufacturing industry and agriculture), as well as provoking a structural imbalance in the distribution of resources in favor of the extractive industry [2].

The research of L. N. Safiullin and his colleagues is dedicated to a profound analysis of this problem using the example of two key oil regions of Russia – the Republic of Tatarstan and the Khanty-Mansi Autonomous Okrug – Yugra (KHMAO – Yugra). In their works, they not only identify signs of the institutional trap of “Dutch disease” [3], but also develop innovative approaches to designing transitional economic institutions for a smooth exit from this state [4]. The authors convincingly demonstrate that the key problem is not only the economic structure, but also the institutional environment, which is characterized by conservatism and resistance to changes, continuing to reproduce the resource-dependent model even after the peak of production has passed.

The core of the “Dutch disease” as an institutional trap is a self-sustaining system of informal norms, practices, and interests that systematically block attempts at diversification. As A. G. Kosterev and M. Yu. Kim rightly note in the context of analyzing the problems of the Russian higher school, complex subsystems, having lost connection with the systemic whole (in this case, with the large-scale national development project of the Soviet era), begin to gradually degrade, reproducing

outdated forms and management models [5]. A similar phenomenon is observed in the economy of resource regions: the established economic model, even having exhausted its development potential, continues to function by inertia, creating significant barriers to the emergence of new growth points and innovative industries.

The study of L. N. Safiullin and colleagues [4] shows that an effective tool for breaking this vicious circle is the conscious design of transitional institutions. These are specially created norms, rules, and management practices that facilitate the gradual restructuring of the economic system, reducing transaction costs for economic actors seeking to move into non-resource sectors. The effectiveness of such institutions is assessed precisely by their ability to reduce the level and dynamism of transaction costs [4]. This approach is methodologically close to the system analysis proposed by A. V. Akhokhova and colleagues for managing regional projects in healthcare, where the flexibility and adaptability of the management system to frequent modifications without total restructuring of the entire project plays a key role [6].

For the successful implementation of such a transformation strategy, an integrated approach is required, combining coordinated efforts in several strategic directions. First, it is an active industrial and innovation policy of the state, aimed at creating effective incentives for the development of high-tech industries and knowledge-intensive services. Here, the experience of the Benelux countries, which, despite their relatively small size, have managed to create powerful innovation ecosystems and become world leaders in many technological fields, is extremely indicative. As A. A. Posazhennikova notes in her research, higher education in these countries acts not only as a tool of “soft power”, shaping the image of an innovative and technologically advanced country, but also as a direct source of economic growth through the mechanism of attracting talented foreign students, who often remain in the country as highly qualified specialists [7]. For Russian regions such as Tatarstan, which is actively developing the IT sector and digital economy, this model can be particularly attractive. Creating favorable conditions for retaining graduates of local universities and attracting talents from other regions and countries should become one of the priority tasks of regional development policy.

Secondly, special attention should be paid to the systematic development of human capital, which is the main resource for modernizing the economy. The permanent reforms of the Russian higher school, noted by A. G. Kosterev and M. Yu. Kim, often lead to the opposite result – a decrease in the quality of student training and devaluation of the diploma [5]. In the context of the urgent need for economic diversification, this creates additional risks and barriers. The region needs not just specialists with diplomas, but people with modern, flexible thinking, capable of working in conditions of uncertainty and rapid technological changes, possessing entrepreneurial skills and leadership qualities. The implementation of the principles of Industry 5.0, which implies synergistic integration of human and machine intelligence, requires the formation of a fundamentally new type of collaborative skills and digital competencies [8]. The development of STEM and STEAM competencies, which is

actively discussed in the context of reforming engineering education [5], should become a priority for the regional education system, starting from school.

Thirdly, it is necessary to actively develop digital infrastructure and promote comprehensive digitalization of all sectors of the economy. The conceptual model of the neuro-digital ecosystem of Industry 5.0 proposed by P. V. Simonin and colleagues [8] considers the integration of human and artificial intelligence as a key factor in increasing organizational productivity and creating new competitive advantages. For a resource region, the introduction of such technologies can become a powerful driver for the modernization of traditional industries and the creation of completely new production and service segments, for example, in the field of "green" energy, bioeconomics, or circular economy. The formation of regional innovation ecosystems, including technology parks, business incubators, and centers for collective use, becomes a necessary condition for successful transformation.

An important aspect of institutional transformation is the development of mechanisms for effective interaction between government, business, and science. As the experience of successful regions shows, it is the triple helix model that ensures the most effective transfer of technologies and knowledge from the scientific sphere to real production. In this context, the research of M. M. Lebedeva and M. V. Kharkevich on the role of "soft power" in integration processes is particularly relevant, as they emphasize the importance of creating attractive conditions for cooperation and knowledge exchange [9].

It is important to understand that the institutional transformation of resource regions is a long and complex process that cannot be limited to purely economic measures. As the experience of the Netherlands shows, even successful and economically developed countries face significant challenges when trying to change the established model. Posazhennikova A.A. notes that in the Netherlands, against the backdrop of growing right-wing populist sentiments and negative attitudes towards migrants, a policy of limiting the internationalization of higher education and reducing the share of foreign students is being implemented, although this contradicts the long-term strategy of attracting talents and developing human capital [7]. This example clearly illustrates that institutional changes are always met with resistance from certain social groups and require strong political will and consistent implementation.

For the Khanty-Mansi Autonomous Okrug and Tatarstan, which have significant scientific, educational, and infrastructural potential, the way out of the "Dutch disease" trap seems quite realistic, but it requires a conscious and systematic policy based on modern scientific approaches. The scenarios for the development of the socio-economic system of regions in the post-oil period, developed by Safiullin L. N. and colleagues [3, 4], should be integrated into a broader national development project, without which, as Kosterev A. G. and Kim M. Yu. rightly point out, any reforms of individual subsystems are doomed to low efficiency and fragmentation [5].

Particular attention in the transformation strategy should be paid to the development of regional innovation systems. The concept of "soft power" in education, explored by J. Nye [10], can be effectively applied at the regional level to create an

attractive image of the territory for investors, scientists, and highly qualified specialists. The formation of a favorable innovation climate, support for startups, and development of venture financing become key elements of the new economic model.

The digital transformation of the regional economy should be considered not as a separate direction, but as a cross-cutting process penetrating all spheres of economic activity. The development of smart city technologies, the introduction of digital platforms for interaction between business and government, the creation of conditions for the development of the digital economy – all these are necessary components of a successful transformation strategy. The experience of implementing the principles of Industry 5.0, described by Simonin P. V. and colleagues [8], can be adapted to the conditions of resource regions, taking into account their specifics and competitive advantages.

An important aspect of institutional transformation is the development of mechanisms for sustainable environmental management and implementation of the principles of green economy. For resource regions, this is particularly relevant, as it allows not only to reduce the negative impact on the environment, but also to create new points of economic growth in the field of environmental technologies and services.

The social dimension of transformation also deserves special attention. The restructuring of the economy inevitably entails changes in the labor market, requiring programs for retraining and advanced training of workers, development of the social infrastructure, and preservation of social stability during the transition period. The systematic approach to managing regional projects proposed by Akhokhova A. V. and colleagues [6] can be effectively applied to solve these problems.

Thus, overcoming the “Dutch disease” in resource-dependent Russian regions involves not only economic diversification, but also deep institutional restructuring affecting all spheres of social and economic life. The design of transitional institutions, the development of human capital based on a modernized higher education system, the active introduction of digital technologies, and the formation of an innovation ecosystem should become the pillars of this transformation. The successful experience of small European countries and the scientific developments of Russian researchers can serve as a reliable basis for developing effective regional development strategies in the post-oil era. The proposed integrated approach allows for a systematic consideration of all aspects of this complex process and develop balanced management decisions aimed at achieving sustainable and balanced regional development.

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PRODUCTION COST MANAGEMENT: COST CLASSIFICATION AS A TOOL FOR IMPROVING BUSINESS EFFICIENCY

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Abstract. This article explores methods for managing production costs through effective classification of production costs. It examines the main types of classifications and their importance for analyzing the financial performance of an enterprise and developing management decisions. Particular attention is paid to the role of proper cost classification in optimizing resource flows, reducing production costs, and increasing overall business profitability.

Keywords: production costs, production expenses, cost classification, cost management, resource optimization, improving business efficiency, management decisions.

УПРАВЛЕНИЕ ПРОИЗВОДСТВЕННЫМИ РАСХОДАМИ: КЛАССИФИКАЦИЯ ИЗДЕРЖЕК КАК ИНСТРУМЕНТ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ БИЗНЕСА

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Аннотация. Статья посвящена исследованию методов управления производственными расходами посредством эффективной классификации издержек производства. Рассматриваются основные виды классификаций, их значимость для анализа финансовых результатов деятельности предприятия и разработки управленческих решений. Особое внимание уделено роли грамотной классификации издержек в оптимизации ресурсных потоков, снижении себестоимости продукции и увеличении общей доходности бизнеса.

Ключевые слова: производственные расходы, издержки производства, классификация издержек, управление затратами, оптимизация ресурсов, повышение эффективности бизнеса, управленческие решения.

One of the fundamental elements of a market economy is the firm (or enterprise). A firm is an economic entity engaged in production activities, possesses economic independence, and pools resources to produce economic goods with the goal of increasing profits (or income). A firm's profitability is directly related to costs, that is, the costs of production, sales, storage, etc.

Based on marketing research, managers of manufacturing firms determine the conditions for producing goods (services) to be supplied to the market. In this process,

they pay considerable attention to upcoming expenses. The costs of production factors used for production and sales activities are called production costs. From an economic perspective, costs represent the cost of all materials and services consumed. Therefore, every firm is interested in analyzing costs and their relationship to the price of a product.

There are two approaches to cost estimation: accounting and economic. Both accountants and economists agree that a firm's costs in any period are equal to the value of resources used to produce the goods and services sold during that period. Every company, when defining its strategy, focuses on maximizing profits. At the same time, any production of goods or services is unthinkable without costs. A company incurs specific expenditures on the acquisition of production factors. In doing so, it will strive to use a production process that achieves a given volume of output with the lowest possible cost of the factors used.

The costs of acquiring the factors of production used are called production costs. Costs are the expenditure of resources in their physical, natural form, while expenses are the valuation of the costs incurred [1, p. 214].

From the perspective of an individual entrepreneur (firm), individual production costs are distinguished, representing the costs of a specific economic entity. Costs incurred in producing a given volume of a product are, from the perspective of the entire national economy, social costs. In addition to the direct costs of producing a particular range of products, these include costs for environmental protection, training of skilled labor, and other expenses. A distinction is made between production costs and distribution costs. Production costs are costs directly related to the production of goods or services. Distribution costs are costs associated with the sale of manufactured products. They are subdivided into additional and pure distribution costs.

The former includes the costs of bringing manufactured products directly to the consumer (storage, packaging, packing, and transportation of products), which increase the final cost of the goods; the latter include costs associated with the change in the form of value during the purchase and sale process, transforming it from commodity to monetary (sales salaries of sales staff, advertising costs, etc.), which do not create new value and are deducted from the cost of the goods.

The economic understanding of costs is based on the problem of resource scarcity and the possibility of their alternative uses. The use of resources in a given production process precludes the possibility of their use for another purpose. The selection of certain resources for the production of a product precludes the production of an alternative product. The economic, or imputed, cost of any resource selected for use in a production process is equal to its value under the best of all possible uses.

From the perspective of an individual firm, economic costs are those costs the firm must bear to the resource supplier in order to divert these resources from use in alternative production processes. Such costs can be both external and internal. Monetary costs that a firm incurs to suppliers of labor, fuel, raw materials, auxiliary materials, transportation, and other services are called external or explicit costs. In this case, the resource suppliers are not the owners of the firm [2, p. 50].

At the same time, a firm can also use its own resources. In this case, costs are also inevitable. The costs of owning and independently using resources are unpaid, or

internal (implicit), costs. The firm views them as equivalent to the cash payments that would be received for an independently used resource if it were used optimally.

The minimum wage required to maintain someone in a given business is called normal profit.

From an accounting perspective, production costs should include all real, actual expenses incurred in monetary form. These may include wages of workers; rent for buildings, structures, machinery, and equipment; transportation costs; fees for banks, insurance companies, etc.

From an economic perspective, production costs should include not only actual expenses incurred in monetary form, but also costs not paid by the firm, costs associated with the lost opportunity to optimally utilize its resources. According to this approach, production costs should include all costs – both external and internal – including normal profit.

Implicit costs should not be equated with so-called sunk costs. Sunk costs are costs incurred by the firm once and cannot be recovered under any circumstances. For example, if a business owner incurred certain monetary expenses to have a sign with its name and business activity painted on a wall, then when selling the business, the owner is prepared to incur certain losses associated with the cost of the sign. Sunk costs are not considered opportunity costs; they are not included in the company's current operating costs.

Another criterion for classifying costs is the time intervals during which economic decisions are made. The costs a firm incurs in producing a given volume of output depend not only on the prices of the factors of production used, but also on the specific factors (resources) used and in what quantities.

The quantity of some resources (labor, fuel, raw materials, auxiliary materials, etc.) and their combinations can be changed relatively quickly; the quantity of others (for example, the production capacity of a machine-building plant) can be changed over a fairly long period.

Depending on the time required to change the quantity of resources used in production, a distinction is made between short-run and long-run periods in a firm's operations [3, p. 175].

The short-run period is the time period during which a firm is unable to change its production capacity. It can influence the course and performance of production only by changing the intensity of its capacity utilization. During this period, a firm can quickly change its variable factors – the quantity of labor, raw materials, auxiliary materials, and fuel. The long run is the period of time during which a firm can change the quantity of all resources used, including production capacity. At the same time, this period must be long enough for some firms to exit the industry and others to enter it.

A firm's financial statements record actual (“explicit”) costs, which represent the monetary outlays for the production resources used (raw materials, supplies, labor, etc.). However, economists consider “implicit” costs in addition to explicit costs. Let's illustrate this with the following example.

Suppose a firm invests borrowed capital from a bank in its production; then the costs would also include funds to pay off bank interest. Consequently, assuming that borrowed capital is invested, implicit costs equal to bank interest must be excluded

from the firm's income. However, even the concept of “implicit costs” does not provide a complete picture of the true costs of production. This is explained by the fact that from a multitude of possible resource use options, we make a single choice, the uniqueness of which is forced by resource limitations [4, p. 110].

Now it is clear why, when making a production decision and assessing actual costs, economists consider them as opportunity costs. “Opportunity costs” refer to the costs and losses of income that arise when choosing one production or sales option, which means forgoing other possible options.

Thus, opportunity costs can be viewed as the sum of the revenues that the factors of production could have provided the firm if they had been used more profitably in alternative options. Economic agents, when conducting business transactions, are forced to incur costs. Their magnitude is one of the main factors influencing the market supply of goods: the higher the costs, the more expensive the goods are and, consequently, the more difficult they are to sell.

The modern definition of costs is that they should be viewed as payment for acquired factors and internal expenses for a specific production option under the specific conditions of a given enterprise. They are typically measured and used in monetary terms. The same costs and their components can be viewed from different perspectives. A multidimensional classification includes over thirty types of costs. Each of these reflects the specific nature of their manifestation.

Costs are divided into fixed and variable. A firm's costs associated with the compensation of production factors, the amount of which does not depend on the volume of output, are called fixed. These include depreciation charges, rent, management salaries, and other expenses that incur even when the company is not producing products. Over a given range of output, the total amount of these costs remains virtually constant.

Variable costs are those that change with increases or decreases in output. These include expenses for the purchase of raw materials and labor – costs whose level changes with changes in production volume.

However, if we consider average variable costs (costs per unit of output), we can see that their level remains approximately the same across different production volumes. The same amount of raw materials, electricity, etc. is consumed per unit of output.

Average fixed costs (per unit of output) decrease as production volume increases and increase as it decreases.

The sum of fixed and variable costs constitutes the enterprise's total costs. As production volume and sales volume increase, total costs per unit of output decrease due to a reduction in fixed expenses. The concept of marginal costs is widely used. These are the expenses required to achieve increased output. They are also called incremental costs, as they are aimed at obtaining additional output.

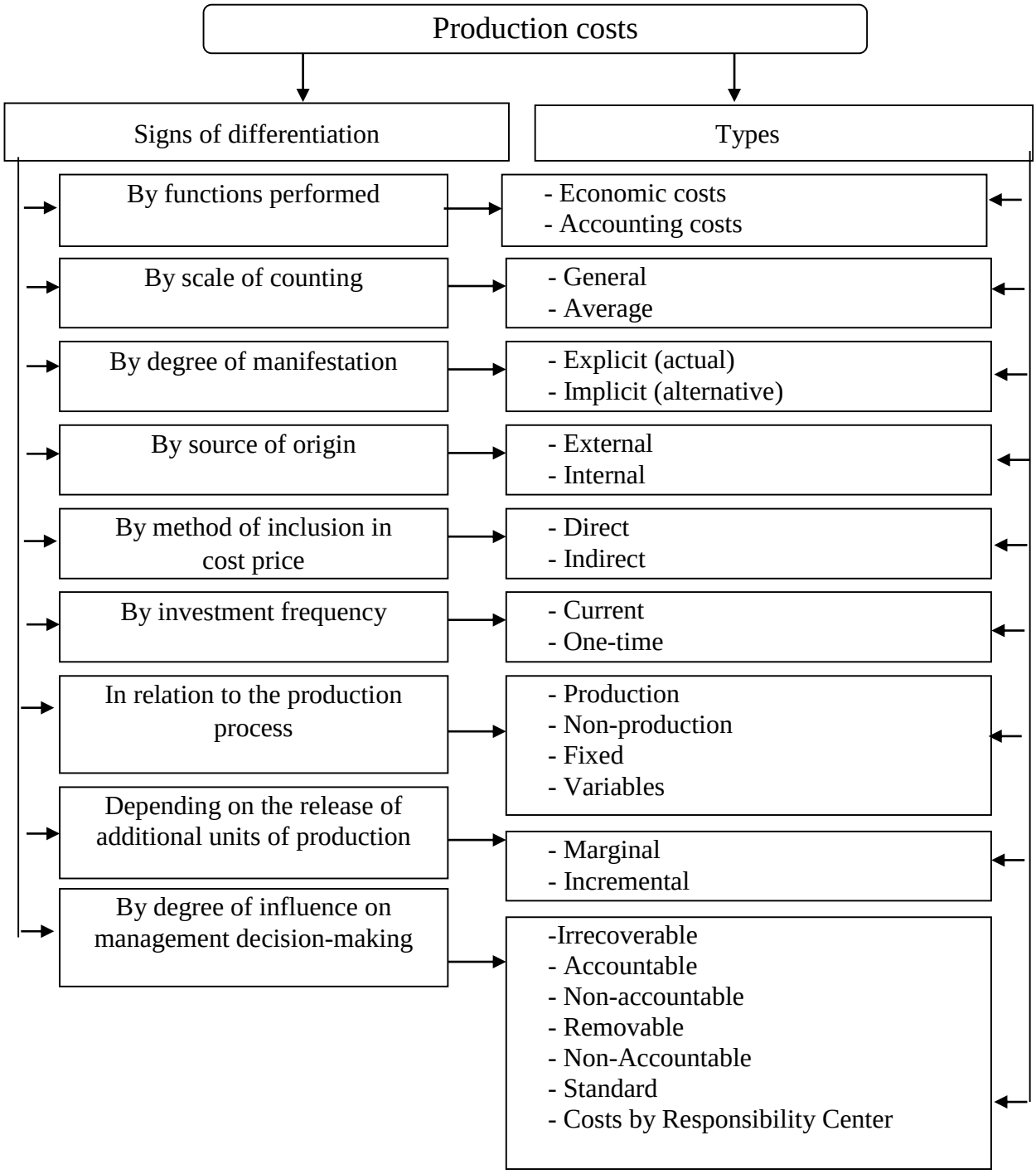


Figure. Detailed structured classification of types of production costs in the economy of an enterprise

Marginal costs refer to the change in total costs resulting from a one-unit change in output volume.

In the production process, choices must often be made between different resources. The quantity of products that must be given up or sacrificed to obtain a given quantity of any given product is called opportunity cost. This does not refer to the actual expenditure of resources, but to the loss of goods that could have been produced from other resources, generating different income. This is a loss of opportunity.

Since opportunity costs imply a choice between different uses of available resources, they play an important role in planning production activities. By choosing a particular investment option, a company not only incurs the costs associated with implementing the chosen option but also loses some potential revenue through the alternative. Therefore, entrepreneurs must constantly compare, evaluate, and choose between appropriate investment options.

Competition has created transaction costs. These are associated with protecting an entrepreneur's position in market transactions and are unrelated to the process of value creation. They create benefits that are valuable to the economic agent (enterprise, firm, or association). These include the costs of searching for relevant business information, negotiating, concluding contracts, and protecting trademarks and trade names. It is also believed that a type of this type of cost is losses from so-called opportunistic behavior by counterparties, when they negotiate for their own benefit.

The total cost of goods circulation for retailers is called circulation costs. Based on their economic content, circulation costs are divided into net and additional. Net circulation costs include the costs of selling goods, such as advertising, salesperson salaries, office and stationery expenses, and accounting [5, p. 883].

Additional circulation costs are based on the continuation of the production process in the circulation area. These include the costs of transporting goods, refining them, assembling them, packaging them, and packing them. These costs also include the costs of loading and unloading operations, the costs of renting and maintaining buildings, structures, and inventory, as well as routine repairs and the installation of refrigeration units. Both net and additional circulation costs are included in the price of goods as a markup on the wholesale price in favor of retailers.

Production costs represent the costs of the production factors used in the firm's production and sales activities.

Before beginning production, any firm should have a clear understanding of its expected profit. To do this, it studies demand and determines the price at which the product will be sold, and compares the expected revenue with the costs to be incurred.

Costs are classified by their structure as:

— explicit and opportunity;
— fixed and variable;
— average;
— marginal;
— transaction.

Explicit costs include all the firm's costs associated with paying for the factors of production used. Classic factors of production are labor, land (natural resources), and capital.

Opportunity costs are the costs (opportunity value) of using resources owned by the firm. These costs are not included in the firm's payments to other organizations or individuals.

A firm's costs associated with compensating for production factors, the amount of which does not depend on the volume of output, are called fixed costs. Variable costs include compensation for employee wages, calculated based on output, payments

for raw materials and supplies, fuel, electricity, etc. Dividing costs into fixed and variable is important for analyzing a company's operations, particularly when deciding whether to close or declare bankruptcy if the company is operating at a loss.

Average costs are those per unit of output. They are calculated by dividing costs by the volume of output. The incremental cost associated with producing an additional unit of output, i. e., the ratio of the incremental variable cost to the resulting incremental output, is called the firm's marginal cost. Transaction costs are those costs that a firm objectively incurs under the division of labor and a market economy.

The cost function is related to the production function of minimizing costs for the production of any given volume of output and depends in part on producing the maximum possible volume of output given a given combination of factors. This function describes the relationship between resource inputs and output, allowing one to determine the maximum possible volume of output for each given amount of resources, or the minimum possible amount of resources to achieve a given volume of output.

Any improvement in production technology that promotes increased labor productivity creates a new production function.

A market economic system encourages the search for ways to maximize profits, develop the best methods of economic behavior, and create favorable conditions for the realization of the knowledge, skills, and experience of all members of society. Only in this case can an economic system achieve the best economic results. This is the essence of optimizing economic performance.

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UGC AS A TOOL FOR ENHANCING THE EFFECTIVENESS OF MARKETING STRATEGIES IN THE DIGITAL ECONOMY

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Abstract. The article examines user-generated content (UGC) as a tool of digital marketing communications. It explores its key characteristics, forms, and mechanisms influencing consumer trust and decision-making processes. The study identifies the advantages and risks associated with the use of UGC in strategic brand management. The conclusion highlights the importance of UGC for fostering customer loyalty and increasing the effectiveness of online communications.

Keywords: user-generated content; UGC; digital marketing; social proof; consumer behavior; marketing communications; brand communities; source credibility; online platforms.

UGC КАК ИНСТРУМЕНТ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ МАРКЕТИНГОВЫХ СТРАТЕГИЙ В ЦИФРОВОЙ ЭКОНОМИКЕ

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Аннотация. В статье анализируется пользовательский контент (User-Generated Content, UGC) как инструмент цифровых маркетинговых коммуникаций, формирующий лояльность и повышение эффективности коммуникаций в онлайн-среде. Рассматриваются его ключевые характеристики, формы и механизмы влияния на доверие потребителей и процесс принятия решений. Выявлены преимущества и риски применения UGC в стратегическом управлении брендом.

Ключевые слова: пользовательский контент, UGC, цифровой маркетинг, социальное доказательство, потребительское поведение, маркетинговые коммуникации, бренд-сообщества, доверие к источнику, онлайн-платформы.

The contemporary structure of media consumption is characterized by declining trust in traditional advertising formats and the growing importance of opinions expressed by real consumers. In an environment of intense market competition,

companies seek to employ new mechanisms for influencing audiences, and one of the most resilient tools is user-generated content (UGC) [1].

In academic literature, UGC is defined as informational material created by end users of a product and disseminated by them in digital environments independently of the brand or advertiser. From the perspective of communication processes, UGC represents a form of horizontal communication in which the message is initiated by the user rather than the producer company [2].

The key characteristics of UGC include:

- Autonomy – the absence of direct managerial control by the brand;
- Authenticity – content reflects the creator's real experience and subjective opinion;
- Social verification – content is grounded in mechanisms of social proof, as described in Robert Cialdini's theory;
- Viral potential – the ability to spread organically due to network effects.

Thus, user-generated content may be viewed as a form of collective consumer participation in a brand's communication activities, exerting significant influence on trust formation and brand image.

To systematize UGC, it is useful to distinguish several categories based on the format of presentation, the degree of author involvement, and the intended purpose:

1. Visual content (photos and videos) is the most common type of UGC. This category includes product photographs "in real settings," video reviews, demonstrations based on personal experience, unboxing materials, as well as short-form videos created for social platforms. Visual materials exhibit high informativeness and demonstrative value, which strengthens their impact on decision-making processes.

2. Text-based reviews on marketplaces, forums, and social networks serve as an important source of information for potential buyers. Unlike promotional descriptions, reviews contain evaluative judgments that are perceived as independent and therefore more credible.

3. Reviews, guides, and expert materials imply a deeper level of user involvement. Consumers produce comparative analyses, practical recommendations, product tests, or educational materials. Such content functions as "para-advertising" messages that, while remaining unbiased, provide audiences with a comprehensive understanding of the product.

4. Content created within branded activities (challenges, hashtags). Brands initiate mass campaigns that encourage users to create content according to predefined guidelines. Although such materials emerge with brand participation, they retain the status of UGC because they are created voluntarily and disseminated by users.

5. Fan content, memes, and creative formats arise spontaneously and reflect the cultural significance of a brand within digital communities. The integration of a product into meme culture indicates a high level of brand awareness and emotional connectedness between the audience and the brand (Fig.) [3].

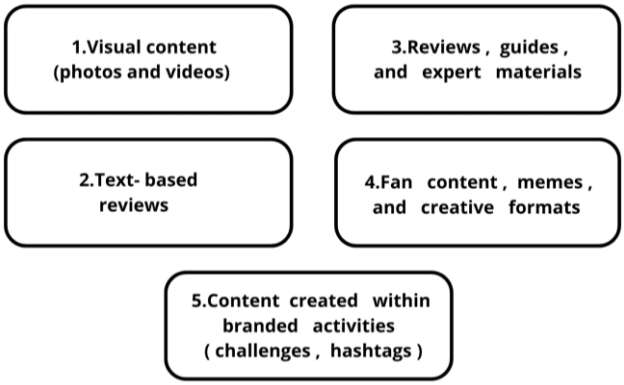


Figure. Categories of UGC content

The primary mechanism for engaging with user-generated content is the audience itself, as users are the ones who produce such material. The brand's objective is to stimulate this activity by employing strategies such as gamification, humor, exclusive incentives, challenges, or competitive initiatives. For instance, a company may invite users to create a meme or an original post in exchange for a reward. Ideally, users not only generate UGC but also disseminate it independently; however, this is not a strict requirement, as organizations may initiate the distribution of such content themselves.

There are also less explicit methods of influence, including posting comments from official brand accounts on users' profiles. Such actions can prompt individuals to create additional content in hopes of attracting attention or eliciting a response from the brand.

Understanding the mechanisms through which UGC exerts influence requires referring to the theory of social proof, the model of source credibility, and the concept of user engagement. User-generated content is perceived as less biased because it is created by independent consumers, which increases trust. According to the principle of source credibility, messages from peers within a social group evoke greater trust than commercial communications. Thus, UGC functions as a tool for enhancing the perceived credibility of a brand.

Authentic photos, videos, and reviews reduce uncertainty associated with remote consumption (for example, in online shopping). They provide visual and contextual information that is unattainable through official advertising materials. As a result, purchase readiness increases and decision-making time is reduced.

UGC also reduces the need for costly content production. Brands obtain a substantial volume of materials at no cost or with minimal incentives. This is particularly important for small and medium-sized enterprises, as it lowers the entry barrier to digital communication activities.

The use of UGC contributes to audience consolidation around a brand and fosters the formation of a sustainable digital community, increasing engagement and supporting the development of brand communities. Publishing user materials strengthens emotional bonds, fosters a sense of belonging, and motivates further interaction [4]. Despite the obvious advantages, the use of user-generated content entails certain risks and limitations.

One of the primary risks associated with UGC is limited quality control. Brands cannot fully regulate the content produced by users, and low-quality images, inaccurate information, or incorrect product usage can distort perception and potentially harm the

brand's reputation. Another concern is the dissemination of negative experiences. Critical reviews and complaints are inevitable in user-generated content. From a reputational management perspective, such messages require prompt and professional responses, as they carry a high level of credibility with the audience [5].

Legal considerations also play a crucial role. Using UGC in marketing materials requires the author's permission, as publication without consent may infringe on copyright. Additionally, privacy regulations must be observed if the content includes images or personal data of individuals.

Finally, there are reputational risks. Certain types of user content may conflict with corporate values or ethical standards. This issue is particularly relevant given the speed at which information spreads across social media platforms.

In conclusion, user-generated content represents a significant tool in contemporary marketing, combining authenticity, social verification, and high informational value. While it provides numerous advantages, including increased trust, higher engagement, reduced content production costs, and the development of brand communities, its implementation requires careful management. Legal compliance, quality monitoring, and effective handling of negative feedback are essential to leverage UGC safely and strategically.

Thus, UGC should be considered not merely as consumer activity, but as an integral component of comprehensive marketing communications, influencing brand perception, consumer behavior, and the strategic development of companies in the digital environment.

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DIGITAL TRANSFORMATION OF HIGHER EDUCATION AS A RESPONSE TO MODERN LABOR MARKET CHALLENGES: A CASE STUDY OF RUSSIAN UNIVERSITIES

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Abstract. This paper examines the profound impact of digital transformation in the higher education system on the contemporary labor market, with a particular focus on the post-pandemic recovery period. The study provides a comprehensive analysis of the role universities play in developing robust digital ecosystems to address evolving labor market demands, including the growing need for remote work competencies, continuous professional development, and enhanced adaptability among graduates. Utilizing a mixed-methods approach that incorporates statistical analysis, case-study, and literature review, the author evaluates the current state of digitalization in Russian universities and its alignment with the needs of the entrepreneurial sector. The research underscores the critical importance of systematically integrating digital tools and methodologies into educational processes to effectively prepare graduates for contemporary economic challenges. The findings suggest that universities that successfully implement digital transformation strategies are better positioned to contribute to regional economic development and national competitiveness.

Keywords: digital transformation, higher education, labor market, entrepreneurship, COVID-19, digital ecosystems, remote work, lifelong learning, economic adaptation, university management.

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ ВЫСШЕГО ОБРАЗОВАНИЯ КАК ОТВЕТ НА ВЫЗОВЫ СОВРЕМЕННОГО РЫНКА ТРУДА: НА ПРИМЕРЕ РОССИЙСКИХ УНИВЕРСИТЕТОВ

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Аннотация. В данной статье исследуется глубокое влияние цифровой трансформации системы высшего образования на современный рынок труда, с особым акцентом на период постпандемического восстановления. В исследовании представлен комплексный анализ роли университетов в развитии устойчивых цифровых экосистем для удовлетворения меняющихся требований рынка труда, включая растущую потребность в компетенциях для удаленной работы, непрерывного профессионального развития и повышенной адаптивности выпускников. Используя смешанный методологический подход,

включающий статистический анализ, кейс-стади и обзор литературы, автор оценивает текущее состояние цифровизации в российских университетах и его соответствие потребностям предпринимательского сектора. В исследовании подчеркивается критическая важность системной интеграции цифровых инструментов и методологий в образовательные процессы для эффективной подготовки выпускников к современным экономическим вызовам. Результаты позволяют предположить, что университеты, успешно реализующие стратегии цифровой трансформации, находятся в лучшей позиции для содействия региональному экономическому развитию и национальной конкурентоспособности.

Ключевые слова: цифровая трансформация, высшее образование, рынок труда, предпринимательство, COVID-19, цифровые экосистемы, удаленная работа, непрерывное обучение, экономическая адаптация, управление университетом.

Modern global challenges, most notably manifested during the COVID-19 pandemic, have significantly accelerated the pace of digitalization across various sectors of the global economy, including higher education and entrepreneurship. These rapid changes have had a complex impact on employment structures, requirements for professional skills, and the very organization of work activities [1, p. 3860]. In parallel, universities have begun to play an increasingly important role in forming and developing digital ecosystems that significantly contribute to training personnel adequately meeting new socio-economic realities [2, p. 5]. The processes of digital transformation in higher education should be viewed not as a forced measure, but as a strategic response to fundamental shifts in the economy and society, requiring a deep rethinking of traditional educational paradigms and management approaches.

The COVID-19 pandemic triggered serious structural changes in employment and entrepreneurial activity. As convincingly demonstrated in his research by D. V. Sannikov, Russian entrepreneurs during this period faced a whole range of difficult-to-solve problems, including the need for significant staff reductions, mass transfer of personnel to remote work forms, and radical adaptation of existing business models to the conditions of the online format [1, p. 3865]. These forced anti-crisis measures, on the one hand, allowed partially preserving the operational activities of many enterprises, and on the other hand, required a fundamental revision of established approaches to human resource management and business process organization. Particular attention deserves the fact that the global change in the vector of business development directly affected the labor market situation, which began to actively adapt to the emerging new demand, which, in turn, actualized the question of the correspondence of university graduates' competencies to the real needs of the economy.

In response to these unprecedented challenges, universities around the world, including Russian ones, were forced to intensify processes of internal digital transformation. According to monitoring data presented in the statistical collection by Sannikov D.V., the overall level of formation of the digital ecosystem of Russian higher education institutions demonstrates significant variability depending on the region and type of university, but in general, there is a steady positive trend in such key

areas as the large-scale implementation of massive open online courses (MOOCs), active use of artificial intelligence technologies in the educational process and administration, as well as the consistent development of technological infrastructure that provides opportunities for full-fledged distance learning [2, p. 12-15]. This process, however, is not linear and faces a number of systemic limitations, which is reflected in the critical understanding of the historical experience of educational reforms in Russia [3, p. 157].

The digital ecosystems of modern universities should be focused not only and not so much on optimizing internal administrative and educational processes, but on creating sustainable channels of interaction with external stakeholders, key among which are employers and industrial partners. As many researchers rightly emphasize, the strategic integration of specialized digital platforms and services allows universities to monitor changes in the labor market promptly and, accordingly, timely adapt curricula and teaching methods to emerging trends [4, p. 72]. This approach is fully consistent with the concept of Industry 5.0, where the emphasis is on close collaboration between human and machine intelligence, which opens up fundamentally new opportunities for training highly qualified personnel capable of working effectively in a high-tech environment.

The introduction of advanced technologies, such as artificial intelligence and collaborative robots (cobots), into industrial production and the educational process creates unique opportunities for modernizing the personnel training system. As noted by Simonin P.V. and his colleagues, the successful integration of human and machine intelligence not only contributes to a significant increase in overall labor productivity and solving routine tasks but also requires the formation of a fundamentally new set of competencies among future specialists, including skills of metacognitive interaction in human-machine systems [4, p. 73-74]. This, in turn, sets the task for universities to adjust the content of educational programs, which should now include modules devoted to working with artificial intelligence, basics of robotics, and management of complex cyber-physical systems. This transformation is part of a broader trend observed in the Benelux countries, where higher education is actively used as a tool of “soft power” and economic development through attracting foreign students and forming an innovative image of the country [5, p. 138].

Despite the noted positive dynamics, Russian universities in the process of digital transformation face a number of serious systemic problems, among which the most significant are chronic underfunding, the persistently low level of digital literacy of a significant part of the teaching staff, as well as organizational resistance to changes rooted in traditional academic culture [3, p. 161]. However, as demonstrated by the successful experience of leading Russian and foreign universities, consistent and targeted policies in the field of digitalization, supported by adequate resources and changes in organizational culture, allow these barriers to be gradually overcome [6, p. 22]. An important aspect is also the development of effective models for managing these complex processes, which is reflected in studies devoted to the application of project approach and prototyping methods in the social sphere, including healthcare and education [6, p. 20].

World experience shows that the concept of “soft power”, in which education plays a pivotal role, is directly related to the ability of national university systems to adapt to global challenges and offer competitive educational products [7, p. 11]. In this context, digital transformation becomes not just a matter of internal optimization, but a strategic tool for strengthening the country's position in the international arena. Russian researchers have repeatedly pointed to the potential of education as a tool of foreign policy and forming an attractive image of the country [8, p. 87], and in modern conditions, digitalization is a key element in realizing this potential. This is especially relevant in light of the trends observed in some European countries, such as the Netherlands, to curtail the policy of internationalization of higher education under the influence of right-wing populist sentiments [5, p. 142], which creates new opportunities for Russian universities.

Analysis of modern trends in global higher education, including processes occurring in small countries such as the Netherlands, demonstrates that successful adaptation to the challenges of the digital era requires universities to be flexible and capable of rapid transformation [9, p. 48]. These qualities become especially in demand in conditions where traditional models of university management and the educational process demonstrate their limitations. The development of digital ecosystems should be carried out taking into account both global trends and national specifics, which is reflected in conceptual developments related to the formation of neuro-digital industrial ecosystems of the new technological order [10, p. 377].

Thus, the digital transformation of higher education is not a technological whim, but an objective necessity and an imperative for training competitive personnel capable of adequately and effectively responding to the numerous challenges of the modern labor market. Universities are called upon to actively develop holistic digital ecosystems, organically integrating them with the current needs of the entrepreneurial environment and the industrial sector. Such a strategic approach allows not only to successfully adapt to post-pandemic socio-economic realities but also to lay a solid foundation for sustainable long-term development that ensures national competitiveness in the conditions of the global knowledge economy. The implementation of this task requires consolidated efforts from both the academic community and the state, as well as business structures interested in the quality training of future specialists.

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ACTUALISATION OF APPLICATION OF "GREEN LOGISTICS" PRINCIPLES IN WASTE MANAGEMENT

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Abstract. The article explores theoretical and practical aspects of implementing "green logistics" principles in waste management systems. Various methodological approaches to defining the concept of environmentally oriented logistics are considered, key directions of its development and main barriers to implementation are analyzed. Special attention is paid to the analysis of advanced technological solutions that contribute to minimizing the environmental footprint of logistics operations, including transport electrification, Power to Gas/Liquid technologies, and digitalization based on Big Data. The study demonstrates that the implementation of "green logistics" principles in waste management not only reduces negative environmental impacts but also creates economic advantages for enterprises and facilitates the formation of a circular economy model. Recommendations are proposed for overcoming barriers and stimulating the development of environmental logistics in modern conditions.

Keywords: "green logistics", environmental logistics, waste management, circular economy, sustainable development, environmental efficiency, resource conservation.

АКТУАЛИЗАЦИЯ ПРИМЕНЕНИЯ ПРИНЦИПОВ «ЗЕЛЕНОЙ ЛОГИСТИКИ» В УПРАВЛЕНИИ ОТХОДАМИ

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Аннотация. В статье исследуются теоретические и практические аспекты внедрения принципов «зеленой логистики» в системы управления отходами. Рассмотрены различные методологические подходы к определению концепции экологически ориентированной логистики, проанализированы ключевые направления ее развития и основные барьеры на пути имплементации. Особое внимание уделено анализу передовых технологических решений, способствующих минимизации экологического следа логистических операций,

включая электрификацию транспорта, технологии Power to Gas/Liquid и цифровизацию на основе Big Data. В исследовании демонстрируется, что внедрение принципов «зеленой логистики» в управление отходами способствует не только снижению негативного воздействия на окружающую среду, но и созданию экономических преимуществ для предприятий, а также формированию модели циркулярной экономики. Предложены рекомендации по преодолению барьеров и стимулированию развития экологистики в современных условиях.

Ключевые слова: «зеленая логистика», экологистика, управление отходами, циркулярная экономика, устойчивое развитие, экологическая эффективность, ресурсосбережение.

1. Introduction

To date, many works by both domestic and foreign authors have been devoted to the issues of optimising supply chain processes with a focus on minimising environmental impact. In the context of waste management, it concerns waste collection, transportation, processing and utilisation using resource-saving and environmentally friendly methods.

In the early nineties of the twentieth century, the concept of environmentally oriented logistics was formed in the international academic environment, which was subsequently integrated as a key element of the paradigm of sustainable socio-economic development [1]. In scientific terminology, this direction is also labelled as “environmental logistics”, being synonymous with the basic term “green logistics”. Despite the fact that the concept under consideration was formed over a quarter of a century ago, in modern times there is no unified interpretation of this concept, so there are many different methodological approaches to the interpretation of the environmental component in logistics processes.

Therefore, the following tasks were set within the framework of the research:

– to analyze and compare approaches to the definition of “green logistics”;

– to define key vectors for the development of environmentally-oriented logistics;

– to identify the main barriers to the implementation of the principles of green logistics and the possibilities of overcoming them.

2. Methods

The methodological basis of the study was a comprehensive analysis of scientific literature on the problems of green logistics and waste management. In the process of work 10 scientific articles, monographs and reports of international organisations for the period from 2001 to 2023 were reviewed. The literature search was carried out in scientific databases Scopus, Web of Science, RINC by keywords: “green logistics”, “ecology”, “waste management”, “circular economy”, search terms were entered in Russian and English.

Content analysis method was used to systematise and compare different approaches to the definition of green logistics. Identification of key areas of green logistics development was carried out using the method of systematisation and classification.

Practical examples and cases were selected based on the criteria of relevance, topicality and accessibility of information. Special attention was paid to the experience of companies that have successfully implemented green logistics principles in their waste management systems.

3. Results

3.1. Analysis of methodological approaches to the interpretation of green logistics

J. P. Rodrigue considers the concept of green logistics as a transport distribution system functioning on the basis of the most optimal and efficient technological solutions [2].

G. N. Dohansson and G. Henriksson define environmental logistics as a specialised area of logistics activities focused on the comprehensive integration of the economic component with environmental and social components of development [3].

Y. Agiabeng-Mensah interprets the concept in question as an integrated system of strategic planning, operational management and project activities based on the application of innovative logistic approaches in combination with environmental tools and methodology, the purpose of which is to minimise anthropogenic impact and optimise the use of natural resources in accordance with the principles of environmental safety [4].

C. Baah characterises environmental logistics as a scientifically based approach covering a system of measures that ensure the movement of material flows in production processes from the stage of acquisition of raw materials to the moment of their transformation into finished products and production waste, including subsequent environmentally safe waste management, as well as encompassing processes of collection, classification, transportation of consumer waste with its further return to the production cycle as secondary raw materials [5].

C. Chen considers environmental logistics as a scientific and practical field of activity aimed at creating an effective mechanism for combining economic efficiency with social and environmental aspects at all stages of planning, design and management of logistics processes in order to minimise environmental and economic damage and increase the consumer value of products through the use of environmentally oriented technologies [6].

E. De Souza characterises this concept as an environmental subsystem that performs the functions of waste collection, sorting, transportation, disposal and recycling, functioning in parallel with other logistics subsystems of the enterprise, such as production, supply, storage and other subsystems [7].

Analysing the existing scientific approaches, we can distinguish two main directions in understanding the essence of environmentally oriented logistics. The first group of researchers interprets this concept as a set of progressive methodological solutions and advanced technological developments that provide a significant reduction in the destructive impact on the natural environment. Representatives of the second group consider environmentally-oriented logistics as a specialised subsystem or a separate direction of logistics activity that contributes to the formation of the most efficient transport infrastructure within the paradigm of sustainable socio-economic development.

Modern system methodology suggests the need to analyse environmentally oriented logistics as an integral component of the overall logistics architecture of an economic entity, designed to ensure the functioning of all constituent subsystems with mandatory consideration of environmental and socio-economic factors.

This methodological position provides an integrated consideration of all basic elements of the concept of sustainable development. In the economic dimension, this means strategic planning and operational management of logistics processes oriented towards achieving optimal economic efficiency.

It should be emphasised that, irrespective of the different interpretations of green logistics, the key characteristic of the discipline is its strong practical orientation and applied nature of research.

3.2. Analysing the implementation of green logistics practices

There are currently a significant number of specialised programmes and international organisations focusing on greening transport operations all over the world. Such initiatives include Green Freight Europe, specialising in freight transport, Lean and Green International, covering freight transport and municipal transport, Logistics Emissions Reduction Scheme, focused on freight operations, SmartWay Transport Partnership, working with freight and rail transport, Clean Cargo Working Group, focusing on maritime container operations, and many other similar structures [8, 9].

The key areas of activity of these organisations include: systematisation and comprehensive analysis of information on the logistics activities of transport companies; development of specialised programmes and methodological approaches for carbon dioxide calculation; formation of unified reporting forms for carbon dioxide emissions accounting; assessment of energy efficiency and environmental characteristics of logistics activities of transport companies; creation and practical implementation of the most promising resource efficiency and environmental characteristics of transport companies; creation and practical implementation of the most promising resource efficiency programmes and methodological approaches for carbon dioxide calculation.

The current methodology of environmentally oriented technologies in foreign countries extends far beyond freight and passenger transport. The industrial sector also demonstrates a gradual transition to innovative resource-saving methodologies. In particular, in the member states of the European Union, market participants have received direct directive instructions on the development of environmental activities.

Governmental structures of individual countries introduce special regulatory requirements for industrial sectors characterised by the most significant negative effects on the natural environment, such as EU Directive 2010/75/EU on industrial emissions [10], Regulation (EU) No 517/2014 on fluorinated greenhouse gases [11] and Directive 2008/98/EC on waste [12].

3.3. Key aspects of green logistics

Key aspects of green logistics in waste management processes include optimising transport by shortening routes, using electric or biofuel vehicles, and reducing CO2 emissions. Internet of Things (IoT) technologies help to monitor container occupancy, optimising the collection schedule.

Of particular importance is the application of green logistics principles in sorting and recycling processes. For example, the introduction of separate waste collection at the initial stage increases the efficiency of recycling, which in turn reduces the volume of recycling.

The so-called circular economy, which involves integrating with recycling facilities to convert waste into raw materials while reducing the need for new resources, is becoming increasingly important.

In the context of this topic, the use of reusable containers should be mentioned separately, as they significantly reduce waste generation.

In terms of the environmental and economic relevance of applying green logistics principles, it is important to note the reduction of the ecological footprint, in particular the reduction of greenhouse gas emissions, soil and water pollution, as well as the saving of resources by reducing fuel, disposal and raw material costs through recycling.

For the increasingly popular concept of responsible business conduct, regulatory compliance is of particular importance. Encouraging companies to comply with environmental standards (e. g. EU Waste Framework Directive, ECG rating, etc.) and improving the company's image help to increase the loyalty of sustainability-oriented customers and investors.

To confirm the relevance and practical orientation of the above, let us give some successful examples of the application of green logistics principles in the field of waste management. As noted in the works of K. Baah, the introduction of green logistics principles allowed a number of companies to reduce waste volumes by 30-45 % and reduce logistics costs by 15-20 % [5].

Thus, it is appropriate to recall the use of "smart containers" in European cities, which signal when full, reducing the number of trips of garbage trucks; the creation of logistics hubs for sorting waste near the sources of generation, minimizing transportation. Particular attention should be paid to the successful practice of partnership with recyclers, since companies such as TerraCycle transform complex waste (plastic, electronics) into new products [13].

3.4. Vectors of technological development of green logistics

When analysing the key vectors of environmentally oriented logistics development, it becomes evident that the industrialised nations of the world community are making targeted efforts to minimise destructive anthropogenic impact on the environment and are focusing research resources on developing innovative approaches in the following strategic areas.

The introduction of electrically powered vehicles and commercial vehicles characterised by zero emissions is a priority. The mass spread of electrified vehicles creates prerequisites for the complete abandonment of power plants operating on the principles of internal combustion of fuel, which provides a significant reduction in atmospheric emissions of greenhouse gases.

However, the practical implementation of this concept faces a number of technological limitations [14], including the impossibility of operating electrified vehicles on long routes, a long time interval of the procedure for restoring the energy potential of batteries, as well as a decrease in the electrochemical activity of battery

cells under low-temperature operating conditions, which leads to a reduction in the autonomous mileage between recharging cycles.

One of the most promising ways to overcome these technical obstacles is the transition to plug-in hybrid electric vehicles (PHEVs). Vehicles in this category are equipped with a combined energy system comprising an electric storage system and a conventional petrol or diesel engine. When the electric battery reaches a critically low level of charge, the internal combustion engine is automatically activated to restore the energy potential of the battery pack, after which the vehicle returns to the electric traction mode [8].

The second strategic direction is represented by Power to Gas and Power to Liquid technological solutions. The Power to Gas concept involves the transformation of electrical energy into gaseous fuel through electrolytic splitting of water molecules into oxygen and hydrogen components. Subsequent application of the methanation process provides methane as the final product. According to 2013 data, the efficiency of converting electrical energy to gaseous fuel using combined cycle power plants did not exceed fifty per cent. However, 2018 research results have demonstrated the possibility of achieving eighty per cent efficiency using reversible solid oxide fuel cells. Power to Liquid technology is a set of technical operations focused on the production of liquid energy carriers. Gaseous products produced using the Power to Gas methodology are liquefied, which ensures the optimisation of logistical processes for their transportation with minimal economic costs.

The third key direction is digitalisation based on Big Data technology. Despite the apparent remoteness of the processes of digital transformation and processing of data arrays from the principles of environmentally oriented logistics, the use of analytical algorithms to organise goods distribution processes creates opportunities for the most efficient structuring of logistics activities of enterprises. This approach provides the definition of optimal transport routes, which contributes to a significant reduction in idle runs of vehicles; consolidation of cargo lots within the goods movement; optimisation of cargo delivery procedures through the exclusion of intermediate warehousing points and transshipment operations, which makes it possible to implement a straight-through scheme of transportation of commodity products; reduction of storage capacity and the corresponding reduction in the amount of waste and product spoilage in the process of warehousing; reduction of storage capacity and the corresponding reduction in the amount of waste and product damage in the process of warehousing and storage of goods.

The advantages and disadvantages of the above directions are systematised in Table.

Table – Advantages and disadvantages of the directions of environmental logistics

Direction	Advantages	Disadvantages
Plug-in hybrid (PHEV)	– Reduced fuel consumption and CO_2 emissions; – Possibility of operation in electric mode; – Automatic switching between energy sources;	– Complexity of design and maintenance; – Higher cost compared to traditional cars; – More weight due to the presence of two power plants;

	– No limitations on the driving range; – Does not require special charging infrastructure.	– Not completely eliminating fossil fuels; – Limited electric range.
Power to Gas and Power to Liquid Technologies	– Transformation of excess electricity into stored fuel; – Possibility of achieving efficiency of up to 80% (according to 2018 data); – Use of existing gas infrastructure; – Optimization of logistics processes during gas liquefaction; – Versatility of use of the obtained fuel.	– Low efficiency in early systems (up to 50% in 2013); – High investment costs for infrastructure; – Energy-intensive conversion process; – Technological complexity of processes; – Energy losses during multi-stage conversion.
Digitalization based on Big Data	– Determination of optimal transport routes; – Reduction of empty vehicle runs; – Consolidation of cargo batches; – Optimization of cargo delivery procedures; – Reduction of warehouse capacity and waste; – Minimization of production losses – Assessment; of environmental risks.	– High initial investment in IT infrastructure; – Need for qualified personnel; – Problems with ensuring data security; – Difficulty of integration with existing systems; – Dependence on the quality and completeness of data.

3.5. Barriers to the implementation of green economy principles and ways to overcome them

The primary factor hindering the development of green logistics practices is the lack of motivation on the part of end consumers of products. When faced with a choice between product items, consumers are primarily guided by price considerations, giving preference to products with a lower cost, even if the alternative option is characterized by improved environmental characteristics. Environmental aspects of production or the product itself become significant as a criterion for consumer choice only if the price parameters of the alternatives under consideration are comparable.

It should be emphasised that representatives of the consumer segment in the age range from twenty-five to thirty-five years old, with an average level of material well-being, demonstrate a tendency to purchase products from manufacturers with a positive environmental reputation and are ready to bear additional financial costs for products with improved environmental properties. Over the past ten years, there has been a tendency towards increasing public awareness of the negative environmental consequences of economic activity and the principles of rational nature management. In case of stabilization of the economic situation in the country, reduction of poverty among the population and growth of citizens' incomes, environmental characteristics of goods or features of their production process can transform into one of the key factors in making consumer decisions.

The second significant obstacle is the lack of motivation of manufacturing enterprises to implement environmental innovations. Any progressive methodological approaches and technological solutions in the field of resource- and energy-saving technologies imply significant capital investments characterized by long periods of return on investment. The lack of effective incentive mechanisms in combination with the limited financial resources of enterprises creates conditions under which the implementation of environmental technological solutions becomes economically inexpedient.

The third limiting factor is the lack of mandatory state regulatory instruments and the corresponding legal framework that contribute to the motivation of economic entities to adopt a strategy of environmentally oriented logistics. The Russian legislative system in the field of environmental regulation demonstrates a significant lag behind similar legal mechanisms operating in economically developed countries of the world community. Federal Law No. 7 "On Environmental Protection" was put into effect in 2002, but only during the last five-year period have the preconditions for the formation of an effective model of state regulation of environmental activities emerged [15].

Existing barriers require appropriate public policy measures (Figure).

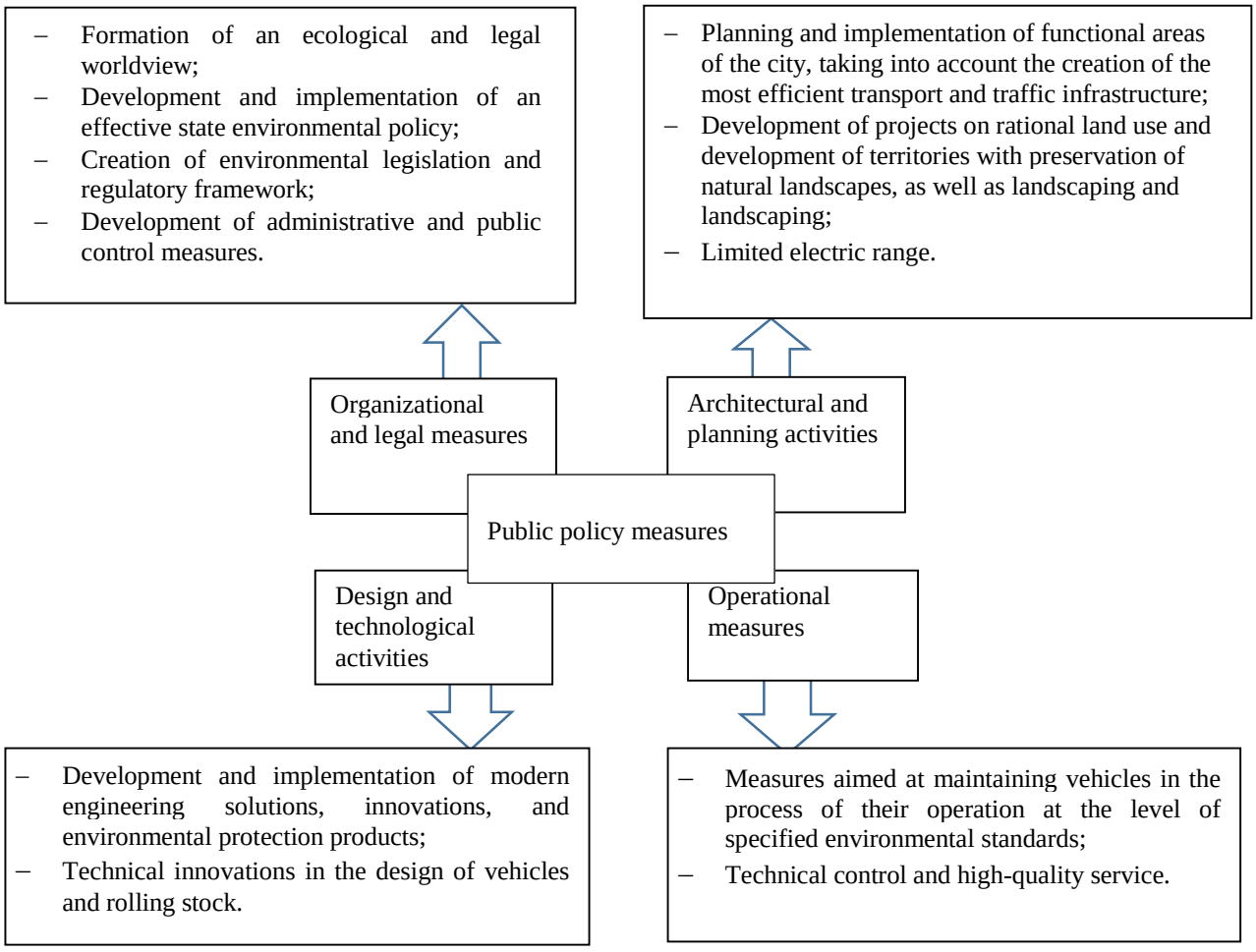


Figure. Proposals for the implementation of public policy measures for the development of "green logistics"

4. Discussion

Based on the above, it should be emphasized that “green logistics” transforms waste management from a cost element into an element of sustainable development. It not only reduces the burden on ecosystems, but also creates economic benefits. It facilitates the transition to a circular economy. For businesses, this is a tool for increasing competitiveness in the context of tightening environmental standards and growing consumer demand for “green” solutions.

5. Conclusions

There are two main approaches to understanding “green logistics” in the scientific literature, the first defining it as a set of progressive methodological solutions and technologies to reduce the destructive impact on the natural environment, the second representing a specialized subsystem of logistics activities that forms an effective transport infrastructure within the framework of sustainable development.

A modern systems approach considers “green logistics” as an integral component of the overall logistics architecture of an enterprise, taking into account economic, social and environmental factors, the key areas being optimization of transportation, implementation of separate waste collection to improve recycling efficiency, development of a circular economy through integration with recycling enterprises, the use of reusable containers to reduce waste, and utilization of IoT technologies to optimize logistics processes.

The main areas of technological development are represented by electrification of transport and introduction of hybrid power plants, Power to Gas and Power to Liquid technologies for optimizing energy consumption and digitalization based on Big Data for optimization of logistics routes.

The main barriers to the development of “green logistics” are insufficient motivation of consumers, lack of economic incentives for enterprises and insufficient government regulation and regulatory framework.

In order to develop “green logistics”, it is necessary to strengthen government regulation through a balanced system of restrictive and incentive measures, form motivational preferences for enterprises implementing environmental technologies, stimulate waste recycling as an alternative raw material, implement a systematic interdisciplinary approach to supply chain management and integrate environmental standards into the business practices of Russian enterprises

Thus, “green logistics” in waste management not only reduces the burden on ecosystems, but also creates economic benefits, facilitating the transition to a circular economy and increasing business competitiveness in the face of increasingly stringent environmental regulations.

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BIOPHARMACEUTICAL TRENDS AND THEIR ECONOMIC IMPACT: A SCOPING REVIEW

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Abstract. The article examines the structure of the scientific field related to the study of biopharmaceutical trends and their impact on the economies of countries. The analysis of 13 articles from peer-reviewed journals corresponding to the topic, year and other criteria of PRISMA-ScR retrieved from the original selection of 460 articles from the Scopus database made it possible to identify key trends in the biopharmaceutical industry. It is shown that biopharmaceuticals are considered to be a key factor in healthcare modernization and long-term economic growth in the modern scientific agenda.

Keywords: biopharmaceuticals, biopharmaceutical industry, PRISMA-ScR, development trends.

БИОФАРМАЦЕВТИЧЕСКИЕ ТРЕНДЫ И ИХ ВЛИЯНИЕ НА ЭКОНОМИКУ: АНАЛИЗ ПРЕДМЕТНОГО ПОЛЯ

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Аннотация. В статье освещается структура научного поля, связанного с исследованием биофармацевтических трендов, и влияние данных трендов на экономику. Анализ 460 публикаций из базы данных Scopus с финальной выборкой, составившей 13 статей из рецензированных журналов, соответствующих теме, годам и другим критериям PRISMA-ScR, показал, что в современной научной повестке биофармацевтика рассматривается как ключевой фактор модернизации здравоохранения и долгосрочного экономического роста.

Ключевые слова: биофармацевтика, биофармацевтическая промышленность, PRISMA-ScR, тенденции развития.

1. Introduction

Forecasting trends in biopharmaceuticals is crucial for the sustainable development of the industry. This sector is at the intersection of scientific developments and economic challenges, therefore, the purpose of this study is to systematize key trends from the last five years and evaluate their impact on the economy of Russia in terms of import dependence using the methodology of a review study according to the PRISMA-ScR standard [1], as well as to offer practical recommendations to integrate the domestic sector into the global biopharmaceutical ecosystem.

Biopharmaceutical trends have a significant impact on the economies of Russia and other countries, marking an important intersection between innovation in healthcare and geopolitics. Over the past few years, the industry has faced major challenges in medicine, technology and economics. The COVID-19 pandemic accelerated the development of mRNA technology [2, 3]; the use of artificial intelligence and big data has accelerated drug target discovery, optimized clinical trials and predicted treatment outcomes [4]. The ESG agenda drives innovation, cost reduction and market position [5, 6]. Russia's development is constrained by imports, but government initiatives (such as Pharma 2030) encourage localization [7]. Overall, the relationship between biopharmaceutical trends and their economic impact is complex. While the Russian pharmaceutical sector demonstrates resilience and adaptability in the face of significant external pressure, ongoing global changes in healthcare needs, regulatory frameworks, and international cooperation will determine the future of the biopharmaceutical industry in both domestic and foreign markets [8, 9]. In this regard, the identification of key areas of scientific activity in the field of biopharmaceuticals and their impact on the economies of countries is a relevant task.

2. Methods

2.1. Protocol and registration

This review article is not registered in international databases. No pre-defined protocol was used to conduct the study. The entire research process was conducted in accordance with the recommendations of PRISMA-ScR.

2.2. Eligibility criteria

The review included publications that meet several criteria. Articles and reviews were selected as the type of publication. To obtain up-to-date data, only the works published since 2020 were considered. Equally important is the condition that the subject of the publications matches the topic of the review, for example, the presence of keywords such as 'biopharma', 'biosimilar', 'biologic', 'monoclonal antibody'. Special attention was also paid to the number of citations of articles: publications that had less than 10 citations were excluded.

The review included publications that meet the following criteria:

– research articles and review papers were selected as the type of publication for the consistency of the analysis;

– the works published since 2020 were considered in order to obtain up-to-date data;

– only the publications matching the topic of the review, i.e. the ones containing the keywords ‘biopharma’, ‘biosimilar’, ‘biologic’, ‘monoclonal antibody’ were taken into account;

– publications that had less than 10 citations were excluded to filter out the ones with limited academic impact or visibility;

– only publications in the English language were included to ensure the broadest comprehensibility and consistency in the analysis;

– studies that were not peer-reviewed, such as preprints and conference abstracts, were excluded to maintain the quality and reliability of the data.

2.3. Information sources

The article provides an overview of publications in the English-language source Scopus. No other sources of information were used in the selection process.

2.4. Search

A search was conducted in the Scopus database for publications with the query “biopharmaceutical* AND trend OR economics OR industry”. The database produced 460 publications, including articles, reviews, conference proceedings, and books. Further, data sources were selected according to the following criteria: keywords, year of publication, type of publication, citation.

2.5. Selection of sources of evidence

The search strategy consisted of several stages.

1. Identification of publications: 460 publications matching the topic were found in the Scopus database (matching was achieved thanks to an accurate search query).

2. Primary analysis: after applying a filter by publication type and year, articles and reviews published between 2020 and 2025 related to biopharmaceutical topics were selected with the citation rate exceeding 10, which led to the exclusion of 423 publications.

3. Substantive analysis: all articles were checked for compliance with criteria by subject (by keywords). As a result, 24 more publications were excluded.

The final sample consisted of 13 publications, which are articles from peer-reviewed journals.

2.6. Data charting process

All the sources included in the final selection were uploaded and collected in one collection in the Zoreto bibliographic data management program. This application makes it possible to organize a collection of sources according to different criteria, conduct quick analysis and download publications in real time thanks to a special software extension.

2.7. Data items

The Zotero program provides for adding the following information about publications: author, record type, date, year, publisher, publication, attachments, and other additional parameters describing publications and user work (for example, volume, language, pages, notes, and others). In this case, the following data was specified for each article: author, type of entry, publication, attachments (Figure 1).

Title	Creator	Item Type	Year	Publication	Language
Data integrity within the ...	Alosert et al.	Journal Article	2022	Biotechnology Journal	en
Integrating ESG Pillars for...	Bhattacharya ...	Journal Article	2023	Australasian Accounting, Business and ...	
2D and 3D inkjet printing...	Evans et al.	Journal Article	2021	International Journal of Pharmaceutics	en
Applications of microphy...	Irrechukwu	Journal Article	2023	ALTEX	
Capillary electrophoresis ...	Kaur et al.	Journal Article	2021	TrAC Trends in Analytical Chemistry	en
A New Digital Value Chai...	Kim et al.	Journal Article	2022	Journal of Open Innovation: Technolog...	en
A Market Shaping Appro...	Mazzucato a...	Journal Article	2021	Journal of Law, Medicine & Ethics	en
Challenges and best prac...	Mökander et ...	Journal Article	2022	Frontiers in Computer Science	
Challenges Faced by the ...	Rahalkar et al.	Journal Article	2021	Pharmaceutical Medicine	en
Towards a widespread ad...	Richelle et al.	Journal Article	2020	npj Systems Biology and Applications	en
A critical review of recent...	Rolinger et al.	Journal Article	2020	Analytical and Bioanalytical Chemistry	en
A Field Study on the Imp...	Silva et al.	Journal Article	2020	Journal of Open Innovation: Technolog...	en

Figure 1. The format of the table in the Zoreto program

2.8. Critical appraisal of individual sources of evidence

Critical evaluation of each publication was not carried out. Attention was paid to thematic filtering and citations. Publications that did not fulfil the minimum requirements (e.g. without citations) were excluded at the filtering stage.

2.9. Synthesis of results

The results are based on two main approaches. Firstly, a quantitative analysis was carried out, including counting the number of publications by year, document type, citations and keywords. Secondly, a qualitative analysis was carried out to identify areas for further research.

After all filters were applied, 13 publications were included in the final sample, which served as the basis for further analyses.

3. Results

3.1. Selection of sources of evidence

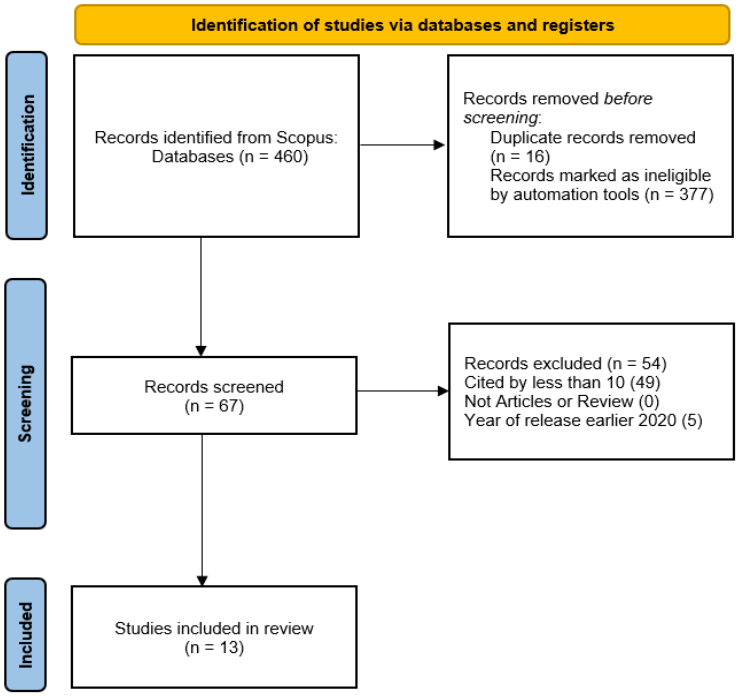


Figure 2. The flowchart of the process of forming the final research sample

At the identification stage, 460 publications were retrieved from the Scopus database. After step-by-step application of the inclusion criteria – by document type,

subject, year of publication, citation, and accessibility – the final sample included 13 publications that met all the conditions. The detailed sequence of publication selection is presented in the flowchart (Figure 2).

3.2. Characteristics of sources of evidence

We summarised the data of the included publications in the Table.

Table – Characteristics of the included publications

Category	Details
Document type	Research papers and articles
Language	English (all publications)
Top journal	*Journal of Open Innovation: Technology, Market, and Complexity* (2 articles)
Frequent keywords	Biopharmaceutical Industry, Biopharmaceuticals, Biologics
Relevance to review	Confirmed (keywords align with the topic of biopharmaceuticals/biologics)

3.3. Critical appraisal within sources of evidence

Since this study is a cartographic (survey) study within the framework of the subject field analysis, no formal assessment of the quality of individual publications (e. g., JBI or GRADE scale) was carried out. Instead, citations were used as a proxy indicator of the significance of publications. All included articles have more than 10 citations, which suggests the scientific significance of the content.

3.4. Results of individual sources of evidence

The selected sources discuss various trends applied in biopharmaceuticals and their impact on the economies of companies and countries.

Modern biopharmaceuticals are undergoing a transformation influenced by digital technology and automation. The adoption of Process Analytical Technology (PAT), cloud platforms, automation and machine learning is significantly increasing the requirements for Data Integrity (DI), which is becoming critical for regulatory compliance and product quality assurance. H. Alosert et al. [10] came to the coclusion that companies investing in digital solutions adapt faster to market changes, increasing productivity and competitiveness, while DI breaches can lead to financial losses and loss of investor confidence.

The integration of ESG (environmental, social and governance factors) is becoming the basis for sustainable development and business model innovation in biopharma. A. Bhattacharya et al. emphasised, that the management pillar of ESG makes the greatest contribution to the business model, while social and environmental aspects become a priority at the mature stages of a company's development [11]. This enhances investment attractiveness, reduces regulatory and reputational risks, and promotes long-term growth.

In article [12] it is noted that transition from traditional to continuous production, introduction of new technological platforms and improvement of quality control allow

to reduce production costs, increase production volumes and accelerate the launch of drugs on the market.

L. Rolinger et al. came to conclusion, that modern mass spectrometry is becoming a key tool for quality control and certification of biologics, which reduces the risks of product recalls and increases confidence in foreign markets [13].

3D cellular models and organoids are becoming the standard for preclinical research, allowing for reduced cost and development time, as well as less reliance on animal models. It is claimed that this speeds up preclinical stages and helps to bring innovations to market faster [14].

Artificial intelligence (AI) is used to accelerate the search for drug targets, optimize clinical trials and predict drug efficacy. J. Mökander et al. confirm that AI can analyse large data sets, identify patterns and accelerate decision making, reducing the time and cost of new drug development [15]. Another trend that can be identified is the use of digital twins and system modelling, which allows predicting drug interactions at the body level, integrating multi-omics data for personalised medicine [16, 17].

Automation and robotisation span from the laboratory to industrial production by implementing automated process control systems (SCADA, MES). This reduces personnel costs, improves reproducibility and reduces errors [18].

Tightening regulatory requirements necessitate investments in compliance with GMP, GDP, etc. standards. H. Rahalkar et al. in their study came to the conclusion that countries with flexible regulation and innovation support bring biologics to the market faster and get economic returns [19].

The COVID-19 pandemic accelerated the adoption of digital and remote technologies, as well as increased investment in flexible manufacturing facilities and platform solutions, which increased the industry's resilience to external shocks [20].

It can also be concluded that open access to scientific data and publications (Creative Commons) facilitates faster dissemination of best practices and technologies, reducing barriers to industry development across countries [21, 22].

3.5. Synthesis of results

A systematic selection and analysis of 13 publications meeting the inclusion criteria identified key trends in biopharmaceuticals and their impact on national economies.

The analysis shows that current biopharmaceutical trends – digitalisation, ESG integration, innovative manufacturing and preclinical technologies, and regulatory changes – are closely linked to economic growth and competitiveness of the industry at the national and global levels. These trends form the basis for the sustainable development of biopharmaceuticals, helping to accelerate the launch of innovative drugs on the market, reduce costs and improve product quality.

4. Discussion

4.1. Summary of evidence

The review identified the main trends in the development of the biopharmaceutical industry over the past five years, as well as their impact on the economies of countries. The analysis of 13 relevant articles allowed us to identify key trends reflecting the current state and prospects of the sector, including:

1. Digitalisation and automation (introduction of PAT, cloud platforms, machine learning) [10];

2. ESG integration (implementation of environmental, social and governance aspects) [11];

3. Continuous manufacturing and innovation platforms (transition to new technological solutions) [12];

4. Modern quality control methods (e.g. mass spectrometry) [13];

5. Innovations in preclinical research (3D cellular models) [14];

6. Artificial intelligence and modelling (AI and digital twins) [15-17];

7. Automation and robotization [18].

These results obtained meet the objectives of the current review: the main scientific and technological trends in biopharmaceuticals are identified, as well as their impact on the economies of companies and countries. The findings are relevant to researchers, industry representatives, regulators and investors, as they identify growth points and potential barriers to the sector's development.

4.2. Limitations

This review article has a number of limitations. Firstly, only English-language publications from Scopus were analysed, which may have led to the omission of significant papers in other languages or from other databases. Second, no formal assessment of the quality of publications (e.g., by JBI or GRADE scales) was performed; significance was assessed by the number of citations. Third, only publications from the last five years were considered, which may have limited the identification of long-term trends.

4.3. Conclusions

Analysis of the subject area has shown that biopharmaceuticals are in a phase of transformation influenced by digitalisation, ESG agenda, innovative manufacturing and preclinical technologies, and changes in the regulatory environment [10-17]. These trends are accelerating the commercial distribution of new drugs, improving product quality and industry resilience to challenges [12]. At the same time, the integration of ESG and digital solutions is becoming a key factor in the long-term competitiveness and investment attractiveness of companies.

For Russia and other countries, it is important not only to introduce modern technologies, but also to form a flexible regulatory environment, provide broad access to scientific knowledge and support localisation of production. In the future, more comprehensive interdisciplinary research is needed, including quantitative assessment of the economic effect of introducing new trends, as well as analysing the factors that promote or hinder their spread.

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ANALYSIS OF SALES OF PRODUCTS OF FRUIT SUB-COMPLEX ORGANIZATIONS OF THE AGRO-INDUSTRIAL COMPLEX OF THE KRASNODAR TERRITORY

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Abstract. This article analyzes the sales of fruit products from organizations in the Krasnodar Krai agro-industrial complex. The structure and dynamics of pome and stone fruit sales by volume across Krasnodar Krai districts are examined. A decline in apple sales profits and product profitability at JSC Sad-Gigant is identified. A factor and index analysis of apple sales profits, as well as a factor analysis of product profitability, identifies the key metrics that influence changes in the financial performance of JSC Sad-Gigant. Measures to improve the operational efficiency of JSC Sad-Gigant are proposed.

Keywords: pome and stone fruit sales, sales profits, profitability, efficiency, factor analysis.

АНАЛИЗ РЕАЛИЗАЦИИ ПРОДУКЦИИ ОРГАНИЗАЦИЙ ПЛОДОВОГО ПОДКОМПЛЕКСА АПК КРАСНОДАРСКОГО КРАЯ

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Аннотация. Проведен анализ продаж продукции организаций плодового подкомплекса АПК Краснодарского края. Рассмотрена структура и динамика реализации плодов семечковых и косточковых культур в натуральном выражении по районам Краснодарского края. Выявлена проблема снижения прибыли от продаж яблок и рентабельности продукции в АО «Сад-Гигант». На основе факторного и индексного анализа прибыли от продаж яблок, а также факторного анализа рентабельности продукции были выявлены показатели, которые оказывают ключевое влияние на изменение финансовых результатов АО «Сад-Гигант». Предложены меры по повышению эффективности функционирования АО «Сад-Гигант».

Ключевые слова: реализация плодов семечковых и косточковых культур, прибыль от продаж, рентабельность, эффективность, факторный анализ.

The primary objective of commercial organizations is to generate profit, which plays a key role in upgrading fixed assets, implementing innovations, and developing and releasing new products [1, 2].

Currently, research into the cause-and-effect relationships between profit (profitability) and the factors influencing its dynamics is particularly relevant in the context of the fruit sub-complex of the Krasnodar Krai agro-industrial complex, as organizations in this sector specialize in the sale of perishable products, the production of which is largely dependent on weather and climate conditions [3]. These factors define fruit growing as a high-risk activity, therefore, organizations in this sub-sector need to ensure high financial results and production profitability in order to build financial reserves to cover potential losses and ensure financial stability.

Based on the data in the table, we highlight the largest regions of the Krasnodar Krai by sales volumes of pome and stone fruits (Table 1).

Table 1 – Structure and dynamics of sales of pome and stone fruits in physical terms by districts of Krasnodar Krai in 2021-2023

District	2021 г.		2022 г.		2023 г.		2023 г. к 2021 г.	
	thousand centners	%	thousand centners	%	thousand centners	%	Absolute deviation, (+, -)	Growth rate, %
Abinsky District	624	17,7	750	17,4	752	16,7	128	120,5
Anapa District	112	3,2	132	3,1	108	2,4	-4	96,2
Vyselkovsky District	155	4,4	164	3,8	183	4,1	28	118,4
Krasnodar City	141	4,0	158	3,7	183	4,1	42	129,9
Dinsky District	372	10,6	358	8,3	467	10,4	94	125,3
Yeisk District	91	2,6	120	2,8	161	3,6	70	177,5
Kavkazsky District	57	1,6	89	2,1	107	2,4	50	186,7
Leningradsky District	334	9,5	516	12,0	552	12,3	219	165,5
Slavyansky District	*738*	*21,0*	*1 020*	*23,7*	*900*	*20,0*	*162*	*122,0*
Timashevsky District	187	5,3	246	5,7	270	6,0	83	144,6
Tuapse District	90	2,6	103	2,4	84	1,9	-6	93,6
Shcherbinovsky District	77	2,2	82	1,9	122	2,7	45	157,9
Others	544	15,4	571	13,3	618	13,7	74	113,6
Total	3 522	100,0	4 309	100,0	4 508	100,0	986	128,0

In 2023, the Slavyansky (20.0 %, 900,000 centners), Abinsky (16.7 %, 752,000 centners), and Leningradsky (12.3 %, 552,000 centners) districts will be the region's leaders in pome and stone fruit sales, the majority of which are apples (95.4 %). Not only do they hold first place in terms of quantity, but they also demonstrate steady growth over the three-year period.

The Slavyansky District stands out as the region's leading fruit producer. Despite a 11.8 % decline in sales last year compared to the previous year, it continues to maintain its strong position, with an overall growth rate of 22.0 % compared to 2021. It should be noted that the majority of these sales were driven by Sad-Gigant JSC, which sold 654.2 thousand centners of pome and stone fruits in 2023, of which 93.4 %, or 610.9 thousand centners, were apples.

Nevertheless, Sad-Gigant JSC has seen a decline in its financial performance over the past year (in 2023, revenue decreased by 34.3 %, and sales profit by 42.4 % compared to 2022), necessitating an investigation into the causes of these trends. Specifically, a factor and index analysis of sales profitability, as well as a factor analysis of product profitability (Table 2), were applied.

Table 2 – Initial data for analyzing changes in sales profitability and product profitability (apples) at Sad-Gigant JSC in 2022-2023 [4]

Indicator	2022 г. (0)	2023 г.(1)
Sales volume, centners (q)	832045	610902
Sales price per centner, thousand rubles (p)	5,256	4,700
Sales revenue, thousand rubles (pq)	4 372 890	2 871 245
Cost price per centner, thousand rubles (z)	1,296	1,594
Cost price, thousand rubles (zq)	1 078 442	973 640
Sales profit, thousand rubles	3 294 448	1 897 605
Sales profit per centner, thousand rubles	3,959	3,106
Product profitability, %	305,5	194,9

1. Factor analysis of sales profit.

Factor analysis of sales profit is a research method aimed at identifying and quantifying the impact of various factors on profit.

The deviation in sales profit for Sad-Gigant JSC's apples was determined due to changes in:

a) the average selling price per centner of apples:

$$\Delta П(p) = \sum(q_1p_1 – q_1z_1) – \sum(q_1p_0 – q_1z_1) \quad (1)$$

$\Delta П(p)$ = (2871245–973640)–(3210652–973640) = –339407 thousand rubles

b) the cost price of 1 centner of apples:

$$\Delta П(z) = \sum(q_1p_0 – q_1z_1) – \sum(q_1p_0 – q_1z_0) \quad (2)$$

$\Delta П(z)$ = (3210652–973640)–(3210652–791811) = –181829 thousand rubles

c) the volume of apple sales:

$$\Delta П(q) = \sum(q_1p_0 – q_1z_0) – \sum(q_0p_0 – q_0z_0) \quad (3)$$

$\Delta П(q)$ = (3210652–791811)–(4372890–1078442) = –875607 thousand rubles

Interrelationship: $\Delta П = \Delta П(p) + \Delta П(z) + \Delta П(q)$ = –339407–181829–875607 = –1 396 843 thousand rubles.

Thus, the decline in sales profits for Sad-Gigant JSC's apples in 2023 was primarily due to a decrease in sales volume, and was least affected by a decrease in unit cost.

2. Index analysis of sales profits.

Index analysis is a research method aimed at assessing the impact of cost, price, and sales volume on changes in sales profits.

The index model is as follows:

$$\frac{\sum p_1q_1-\sum z_1q_1}{\sum p_0q_0-\sum z_0q_0}=\frac{\sum p_1q_1-\sum z_1q_1}{\sum p_1q_1-\sum z_0q_1}\times\frac{\sum p_1q_1-\sum z_0q_1}{\sum p_0q_1-\sum z_0q_1}\times\frac{\sum p_0q_1-\sum z_0q_1}{\sum p_0q_0-\sum z_0q_0} \quad (4)$$

Overall index of change in sales profit::

$$I=\frac{1897605}{3294448}=0{,}576$$

a) the impact of cost price on profit:

$$\frac{\sum p_1q_1-\sum z_1q_1}{\sum p_1q_1-\sum z_0q_1}=\frac{1897605}{2871245-791811}=0{,}913$$

b) the impact of price on profit:

$$\frac{\sum p_1q_1-\sum z_0q_1}{\sum p_0q_1-\sum z_0q_1}=\frac{2871245-791811}{2418841}=0{,}860$$

c) the impact of sales volume on profit:

$$\frac{\sum p_0q_1-\sum z_0q_1}{\sum p_0q_0-\sum z_0q_0}=\frac{2418841}{3294448}=0{,}734$$

Total: $I=0{,}913\times0{,}860\times0{,}734=0{,}576$

The results of the index analysis show that the greatest negative impact on Sad-Gigant JSC's profit was caused by a decline in apple sales volumes, followed by a decrease in product prices. Cost price also played a role, but its impact was relatively less.

3. Factor analysis of product profitability.

Factor analysis of product profitability aims to study and evaluate the impact of various indicators on profitability, thereby identifying the main causes of changes in the efficiency of enterprise resource utilization.

The factor model of profitability is as follows:

$$\Delta R=\frac{\sum \mathrm{pq}-\sum \mathrm{zq}}{\sum \mathrm{zq}} \quad (5)$$

The overall change in the profitability of JSC Sad Gigant's products was determined as follows:

$$\Delta R=\frac{\sum p_1q_1-\sum z_1q_1}{\sum z_1q_1}-\frac{\sum p_0q_0-\sum z_0q_0}{\sum z_0q_0} \quad (6)$$

$$\Delta R=\frac{1897605}{973640}-\frac{3294448}{1078442}=-110{,}6\%$$

including:

a) due to price changes:

$$\Delta r_p=\frac{\sum p_1q_1-\sum z_1q_1}{\sum z_1q_1}-\frac{\sum p_0q_1-\sum z_1q_1}{\sum z_1q_1} \quad (7)$$

$$\Delta r_p=\frac{1897605}{973640}-\frac{3210652-973640}{973640}=-34{,}9\%$$

b) due to changes in cost price:

$$\Delta r_z=\frac{\sum p_0q_1-\sum z_1q_1}{\sum z_1q_1}-\frac{\sum p_0q_1-\sum z_0q_1}{\sum z_0q_1} \quad (8)$$

$$\Delta r_z=\frac{3210652-973640}{973640}-\frac{2418841}{791811}=-75{,}7\%$$

c) due to changes in the product structure:

$$\Delta r_q = \frac{\sum p0q1 - \sum z_0 q_1}{\sum z_0 q_1} - \frac{\sum p_0 q_0 - \sum z_0 q_0}{\sum z_0 q_0} \quad (9)$$

$$\Delta r_q = \frac{2418841}{791811} - \frac{3294448}{1078442} = -0{,}00005\%$$

Interrelationship: ΔR = Δr(p) + Δr(z) + Δr(q) = –34,860 – 75,725 – 0,00005 = = –110,584 %.

A factor analysis revealed an overall decrease in profitability of 110.6 percentage points, indicating a significant deterioration in the company's efficiency in using resources to generate sales profit. The main factors influencing this change were as follows:

1. Price changes caused a decrease in profitability of 34.9 percentage points, which may indicate a decrease in average apple selling prices or an increase in the share of low-margin products in total sales.

2. Changes in cost had the greatest negative impact, reducing profitability by 75.7 percentage points. This indicator indicates a significant increase in production and sales costs per unit of output at Sad-Gigant JSC.

3. Changes in product structure had virtually no impact on profitability, as the corresponding indicator amounted to 0.00005 percentage points. This indicates the stability of the product range and the absence of significant changes in its structure at JSC Sad-Gigant that could affect the overall level of profitability.

Thus, a factor and index analysis of apple sales profits revealed that the greatest negative impact on JSC Sad-Gigant's profits was due to lower apple prices and reduced sales volumes. Therefore, to improve the operational efficiency of JSC Sad-Gigant, it is advisable to implement the following measures:

– Product diversification by introducing new apple varieties with special characteristics that could attract additional demand (e. g., organic or premium varieties), which will expand the target audience and mitigate the risks associated with a decline in demand for standard varieties [5];

– Improving the marketing strategy, including creating advertising campaigns aimed at increasing brand awareness;

– Investing in storage and processing technologies to extend the shelf life of apples without compromising quality will allow for better supply management and avoid sharp price drops during peak season.

In turn, the greatest impact on the decline in apple sales profitability was the increase in unit costs. Therefore, Sad-Gigant JSC needs to conduct a comprehensive cost analysis and, based on this, develop strategies to improve cost management by optimizing fertilizer and crop protection products, implementing energy-saving technologies, expanding automation and mechanization processes, streamlining logistics, and implementing innovative storage systems.

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DIGITAL LAND MANAGEMENT AS A DRIVER OF AGRO-INDUSTRIAL COMPLEX DEVELOPMENT: TOOLS AND PERSPECTIVES

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Abstract. The article examines the process of digital transformation of the land management system in the context of agro-industrial complex (AIC) development. The relevance of the research stems from the need to improve the efficiency of land resource management through the adoption of modern information technologies. The study reveals the potential of digital tools such as geographic information systems (GIS) and software for economic modelling in optimising land management processes, and substantiates their significance for the sustainable development of the AIC.

Keywords: digital land management, regional economy, economic modelling, agro-industrial complex (AIC), digital agriculture, land resource management.

ЦИФРОВОЕ ЗЕМЛЕУСТРОЙСТВО КАК ФАКТОР РАЗВИТИЯ АГРОПРОМЫШЛЕННОГО КОМПЛЕКСА: ИНСТРУМЕНТЫ И ПЕРСПЕКТИВЫ

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Аннотация. В статье исследуется процесс цифровой трансформации системы землеустройства в контексте развития агропромышленного комплекса (АПК). Актуальность работы обусловлена необходимостью повышения эффективности управления земельными ресурсами за счет внедрения современных информационных технологий. Выявлен потенциал цифровых инструментов, таких как геоинформационные системы и программное обеспечение для экономического моделирования в оптимизации процессов землеустройства, и обоснована их значимость для устойчивого развития АПК.

Ключевые слова: цифровое землеустройство, региональная экономика, экономическое моделирование, АПК, цифровое сельское хозяйство, управление земельными ресурсами.

In today's world, digital devices are an integral part of our lives. Digital technologies have been able to penetrate into all spheres of human life. Thanks to new technologies, production is improved, economic indicators are increased, and production costs are reduced [1].

In the modern agro-industrial complex, digital technologies have ceased to be exotic. They have penetrated into all areas: from satellite monitoring of fields to economic modeling of investment projects. And this is not just a fashion trend, it is a response to the challenges of the time.:

– the need to increase yields with limited resources;

– the need to reduce production costs;

– the State's requirement for transparency in the management of land assets.

As researchers S. Volkov, V. Khlystun and N. Komov rightly point out, one of the main problems of modern land management lies in the weakening of managerial functions. Planning, organization of optimal land use, and land protection – all these processes suffer due to the imperfections of current land policy [2].

It is very important to move along the path of innovative development of land management in modern Russia, especially in the light of the emergence of the digital economy, which is considered by economists to be the fourth industrial revolution.

Within the framework of this digital economy, which is based on e-business and commerce, complex scientific, technological and commercial solutions in the field of innovative land management are actively being worked out. Its main goal is to optimize the use of land resources using modern digital technologies.

R. Nastirov also spoke positively about the introduction of the digital economy and digital land management in order to ensure the rational use of land. He says that the purpose of state accounting of land resources as the basis of the national wealth of the country and the main source of material well-being is to obtain systematic information about the quantity, quality condition and legal status of lands necessary for making managerial decisions aimed at ensuring their rational and effective use [3].

Thus, the main task in the formation of norms, organizational structures, as well as operations that allow to detect, accumulate, and update information about subjects of agricultural relations is to stimulate the selection of the type of their more optimal use and promote the greatest involvement of land resources in civil turnover [4].

In this relationship, along with the formation of an appropriate regulatory framework, the characterizing importance for the company of a stable and liquid real estate market [5].

The importance of digital agriculture is spelled out in the order of the Deputy Chairman of the Government of the Russian Federation A. V. Gordeev dated 19.10.2018 № AG-P11-23pr: “To develop a draft concept for Digital Agriculture, including measures to support the implementation in 2019-2020 of complex scientific and technical projects “Digital land use”, “Digital technologies in agricultural management”, as well as a network of regional pilot projects aimed at companies in the field of adaptive landscape agriculture and agrotechnologies”.

T. V. Papaskiri offers proposals on the concept of digital land management. He argues that the creation of digital agriculture based on smart land use cannot be carried out without the creation of digital land management. In fact, digital land management is the basis – the territorial spatial reference of all digital agriculture, including all issues of precision agriculture based on adaptive landscape approaches, issues of land monitoring based on monitoring the condition of fields, effective planning and rational use of land resources using GIS, CAD and information and communication

technologies (ICT), as well as based on comprehensive consideration of a large number of factors influencing design and management decisions.

In the field of our professional activity, digital land management is conditioned by the active use of geoinformation technologies in order to obtain digital maps, cartograms of projects and other electronic products. Developing in modern conditions, the use of GIS systems in geodesy, real estate cadastre, land management and mapping is becoming more widespread.

Thanks to the capabilities of GIS technologies, it is now possible not only to save information about various changes in land management facilities, but also to record them. This makes it possible to significantly increase efficiency and speed up the implementation of land management tasks. Geoinformation systems are used to collect, store, analyze, and graphically represent spatial information about various objects, which are then displayed in GIS [6].

The use of GIS greatly simplifies the work with information about land management and the creation of digital maps. According to the territorial coverage, the following types of GIS are distinguished:

1) Mass GIS (Global GIS);

2) Subcontinental GIS – state, municipal, regional (regional GIS);

3) Sub-regional GIS – local, regional (local GIS);

GIS technologies allow us to answer a number of questions that help in planning effective land use:

1) What is in a particular location;

2) Where is the specific location;

3) What has changed in a particular place in a particular time period;

4) What spatial structures exist in a particular location;

5) What happens if you add a new object to a specific location.

GIS technologies make it possible to model various design solutions and track how they will affect the area under study. It is also possible to engage in monitoring, to monitor how certain design solutions change over time.

The two most popular computer-aided design and geoinformation systems, AutoCAD and MapInfo Pro, are widely used in practical work and educational institutions. They are an indispensable tool for land surveyors and cadastral engineers, and also serve as the main educational material for students [6].

AutoCAD has a powerful design system, has a variety of graphic elements and a three-dimensional modeling function, allowing you to effectively solve engineering problems related to land management [7].

The MapInfo Pro program is an indispensable tool for monitoring land plots in land management. Geoinformation systems are widely used in this field to provide convenient means of working with geographic data. And you can start the workflow in the program by linking satellite images from applications such as SASPlanet. Then, layers are created for various objects and lands, and enlarged images help with rendering.

When managing land resources, digital software products should also be used to prepare projects for effective land use and rational use of each land plot. Recently, business projects that are designed to use various land plots and make a profit have

become popular. Business projects include projects for planting garden plantings, vineyards, crop rotations, and so on. To obtain a competent business model for a future project, it is necessary to use professional economic programs. These include the Alt-Invest software product.

The Alt-Invest software product is a computer model, with its help the user can perform a preliminary assessment of the commercial viability of the project. Figure 1 shows a screenshot of the Alt-Invest Approx program with the calculation of the project for laying an orchard [8].

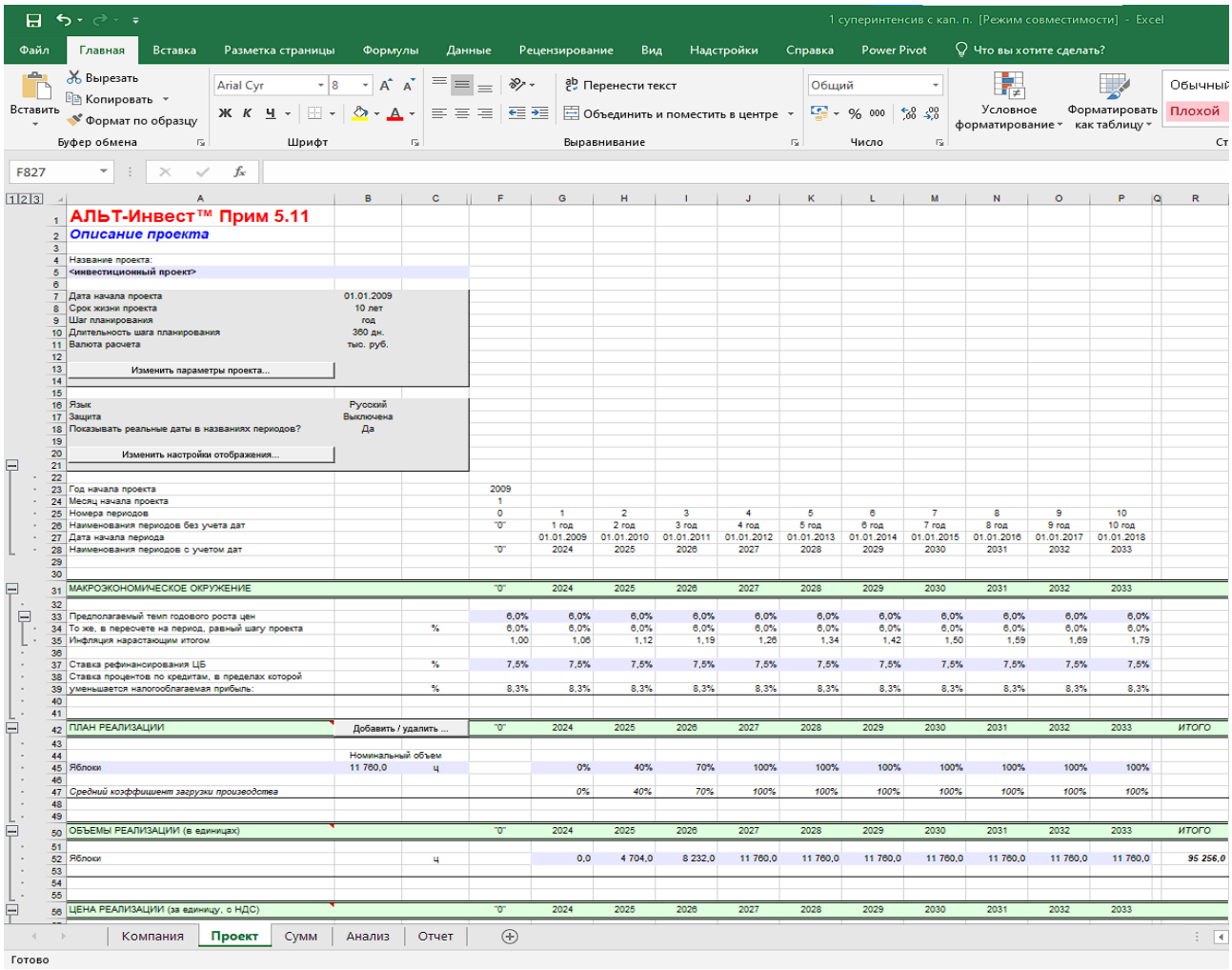


Figure 1. Alt-Invest program interface

Key advantages of the Alt-Invest software product:

1) Fast results – From the initial data to the completed budget in 1-2 hours. Automation and thoughtful formats will help you prepare reports and analytics quickly and error-free.

2) Proven solutions – The Alt-Invest program has been developing since 1993, its reliability has been verified by thousands of specialists. Work with software solutions used every day by leading banks, major corporations, and consulting companies.

3) Transparency of business and budget – The solution based on MS Excel makes it possible to always trace the sources of any figure and indicator, to study the

data from any point of view. The built-in security features of the model will help to avoid distortions in calculations.

4) Russian and international standards – All reports and indicators in the model comply with international standards and industry practice. The model easily switches between Russian and English.

5) In-depth analysis – Analytical reports and tools will tell you a lot of useful things about your business: financial indicators, schedules, development scenarios, consideration of various economic and market factors.

6) Scalability – The model allows you to analyze both small investment projects and the budgets of large companies, and the Alt-Invest Sum version will help you plan the holding's activities with many projects.

Figure 2 shows a fragment of calculations related to the sensitivity of the project.

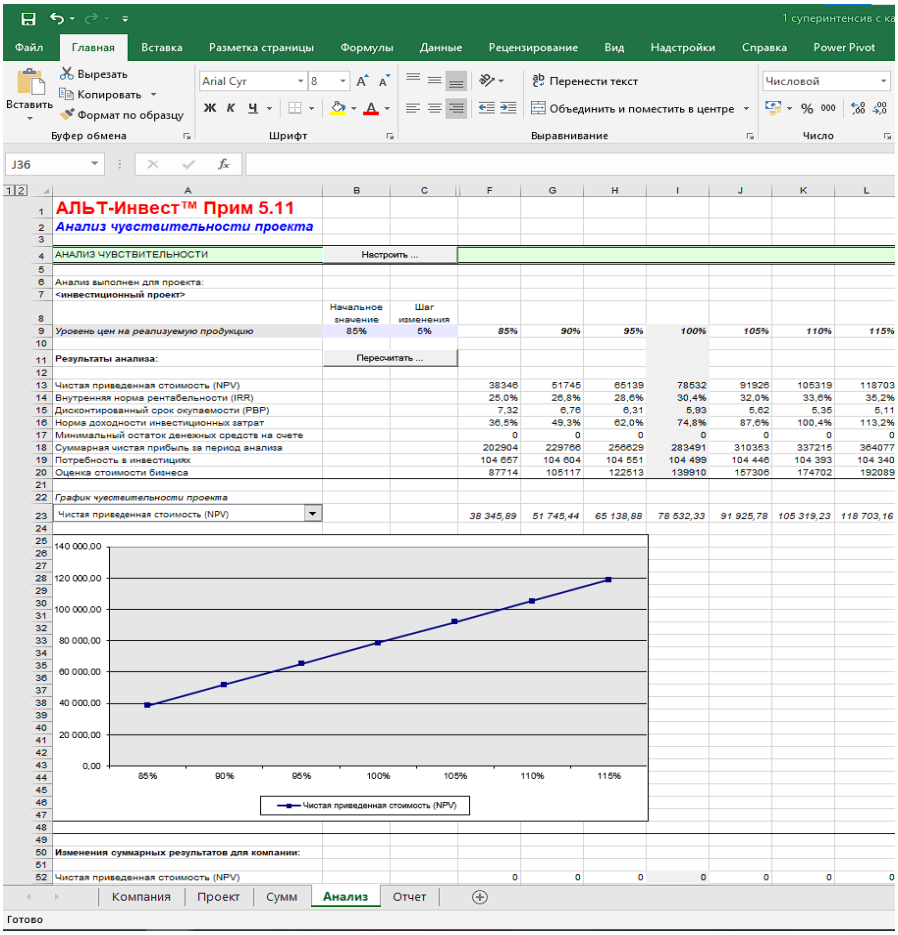


Figure 2. Project sensitivity analysis

The full capabilities of the Alt-Invest system can be divided into 4 blocks:

1) Planning: modeling of inflation, taxes, investments, operating expenses;

2) Analysis: calculation of profitability, financial stability, discounted cash flows (NPV, IRR, PBP);

3) Reporting: formation of balance sheets, profit and loss statements, forecasts of tax payments;

4) Automation: formula protection, model navigation, Windows and Mac compatibility.

The modern digital economy requires a specialist who is focused on using the latest geoinformation technologies and understands their importance on a par with a technical surveyor-land surveyor. As a result of the introduction of new technologies, the role of the land surveyor is undergoing radical changes, which leads to a merger of field and desk work, and also leads to a merger of specializations in the field of land management, geodesy and economics.

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ASSESSMENT OF THE STATE AND WAYS TO IMPROVE OPERATIONS IN THE FIELD OF MUNICIPAL SOLID WASTE MANAGEMENT

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Abstract. The environmental situation in Russia is worsening due to landfills, particularly in the Leningrad Region, polluting soil, water, and air. Unlike foreign countries with 80 % waste recycling, Russia relies on landfilling. This article examines landfill management in Russia, compares it with foreign practices, and suggests solutions using eco-friendly technologies.

Keywords: ecology, landfills, waste disposal, recycling, Leningrad Region, waste management.

ОЦЕНКА СОСТОЯНИЯ И ПУТИ УСОВЕРШЕНСТВОВАНИЯ РАБОТЫ В СФЕРЕ ОБРАЩЕНИЯ С ТКО

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Аннотация. Экологическая ситуация в России ухудшается из-за свалок, особенно в Ленинградской области, что загрязняет почву, воду и воздух. В отличие от зарубежных стран, где переработка отходов достигает 80 %, в РФ преобладает захоронение. В статье анализируются меры по управлению свалками в России, сравнивается с зарубежным опытом и предлагаются решения с применением экологически безопасных технологий.

Ключевые слова: экология, свалки, захоронение отходов, переработка, Ленинградская область, рециклинг.

Ecology is a key domain that determines the quality of life of the population and the sustainability of natural ecosystems. In the Russian Federation, the issue of waste

management has taken on a critical character due to the prevalence of outdated disposal methods and the insufficient development of recycling infrastructure. According to the Federal Service for Supervision of Natural Resources (Rosprirodnadzor), in 2019 Russia generated approximately 70 million tons of municipal solid waste (MSW), over 90% of which was sent to landfills. In regions such as the Leningrad Region, a significant portion of land is already occupied by dumps, which limits the possibilities for creating new landfills and increases the environmental burden.

In contrast to foreign countries, where waste recycling and minimization technologies are actively developing, Russia faces problems of overflowing landfills, leakage of toxic substances, and a low level of recycling. The purpose of this article is to examine current measures for managing existing dumps in Russia, compare them with international practices, and propose solutions to improve the environmental situation.

1. Environmental Situation in the Russian Federation

1.1. The Problem of Landfills and Their Current Status

Russia has approximately 1,000 official MSW landfills, 15,000 authorized dumps, and 17,000 unauthorized dumps, occupying a total area of about 4 million hectares. According to 2019 data, around 7.8 billion tons of waste are generated annually in the country, of which municipal solid waste (MSW) accounts for only 0.8% (61 million tons), while the majority consists of industrial waste, primarily from mineral extraction.

The situation in the Leningrad Region is particularly challenging. The region receives a significant portion of waste from Saint Petersburg, which leads to landfill overcapacity. For example, the Krasny Bor landfill in the Leningrad Region, intended for hazardous waste, has long exceeded its design capacity, and its operation is accompanied by leakage of toxic substances into the environment. In 2024, more than 500 unauthorized dumps were recorded in the region, exacerbating groundwater and soil contamination.

For clarity, below is statistical data on MSW volumes in Russia over recent years. According to the data, 65 million tons of MSW were generated in 2018, 70 million tons in 2019, and the volume increased to 72 million tons in 2020 [5]. Meanwhile, the recycling rate remains extremely low: in 2019 only 5–7 % of MSW was recycled, while over 90 % was sent to landfills [5].

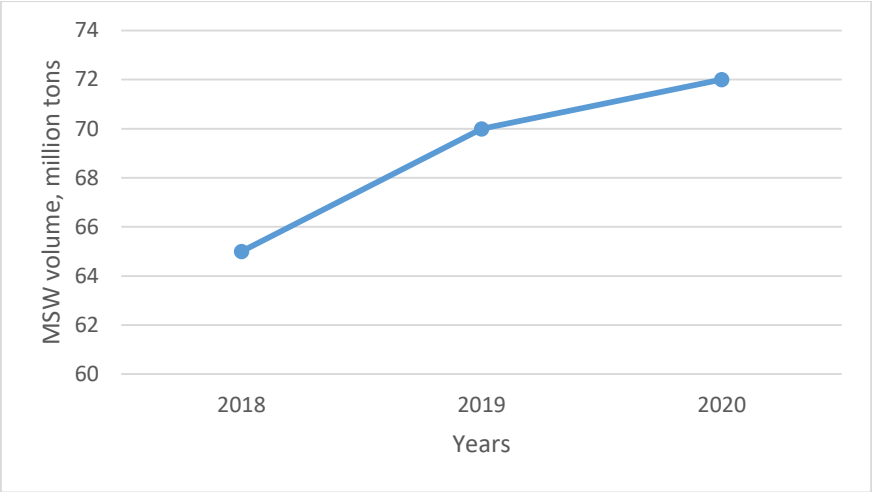


Figure 1. Dynamics of MSW generation in Russia (2018–2022)

1.2. Environmental and Health Consequences

Landfills in Russia pose a serious threat to the environment and public health. The decomposition of organic waste at landfills releases methane – a greenhouse gas that contributes to climate change. According to 2017 data, the municipal solid waste (MSW) management sector is the second-largest source of methane emissions in Russia, accounting for 18.1 % of the total volume [6]. Leachate – a toxic liquid formed during waste decomposition – infiltrates soil and groundwater, contaminating them with heavy metals and chemical substances. For example, in 2018 in Volokolamsk (Moscow Region), more than 200 schoolchildren were hospitalized due to gas emissions from the local landfill [7].

In the Leningrad Region, landfills such as the site near Kirovsk have led to contamination of the Tosna River, which caused a massive fish die-off in 2024 [1]. This threatens not only the local ecosystem but also the ecology of the Baltic Sea, with which many regional water bodies are connected.


Figure 2. Unauthorized landfill in the Leningrad Region near the town of Luga (2024)

1.3. Current Measures for Managing Existing Landfills

In recent years, Russia has taken steps to improve the management of existing landfills as part of the national project “Ecology,” launched in 2018 [3]. The main measures include:

– **Elimination of unauthorized dumps.** Within the “Clean Country” initiative, the plan is to eliminate 191 illegal landfills identified in 2018. By 2024, some of them had been closed, but progress remains slow due to insufficient funding and organizational challenges [1].

– **Landfill reclamation.** Reclamation is carried out to restore land previously occupied by dumps. For example, the Kuchino landfill in the Moscow Region, closed in 2017 by presidential order, is undergoing reclamation using geomembranes and leachate collection systems [7]. In the Leningrad Region, the reclamation of the “Novy Svet-Eco” landfill began in 2023, but the process has been delayed due to financing difficulties [4].

– **Installation of landfill gas collection systems.** At some sites, such as the “Yuzhny” landfill in the Leningrad Region, methane capture systems are being implemented, but this practice is used at less than 5 % of Russian landfills [1].

– **Infrastructure modernization.** In regions such as the Moscow Region, sorting complexes have been built that extract up to 10–15 % of recyclable materials from waste before disposal [7]. In Kazan, a pilot project for separate waste collection has been operating since 2020, covering 50 % of residential areas [8].



Figure 3. Photo: Reclamation of the “Kuchino” landfill (2023)

Despite these measures, more than 90% of MSW is still sent to landfills without prior sorting [5]. Many landfills do not meet sanitary standards, and leachate filtration systems are absent at 30 % of sites. Outdated infrastructure (50–70 %) limits management efficiency [4].

2. International Experience in Landfill Management

2.1. Innovative Methods of Recycling and Reclamation

Foreign countries demonstrate successful examples of landfill management and waste minimization. In Western European countries such as Germany and Sweden, the share of waste landfilling is less than 1–2 % thanks to the following approaches [2]:

– **Reclamation followed by land reuse.** In Sweden, closed landfills are transformed into parks or recreational areas. For example, a landfill in Malmö was reclaimed and converted into a park using landfill gas collection systems for energy production [2].

– **Landfill gas collection and utilization systems.** In Germany, more than 80 % of landfills are equipped with methane capture systems, which are used for electricity generation. This reduces greenhouse gas emissions and provides economic benefits [2].

– **Separate waste collection and recycling.** In Japan, up to 80 % of waste is sorted at the collection stage, which minimizes the volume of landfilled waste. Landfills are used only for non-recyclable residues, and their volume is further reduced through waste compaction [2].



Figure 4. Reclaimed landfill in Barcelona, Spain.

Description: The photograph shows a reclaimed landfill in Malmö, transformed into a public park. The image depicts green lawns, walking paths, and a playground, as well as a sign indicating that the area was previously a landfill. The photo highlights successful international experience in land reuse.

2.2. Landfill Minimization

In Europe, waste landfilling has been reduced to a minimum. In Denmark, Waste-to-Energy technologies process up to 60 % of waste into energy for heating and electricity supply [2]. Closed landfills are reclaimed using multilayer protective liners to prevent leachate leakage.

2.3. Educational Programs and Environmental Awareness

Abroad, great attention is paid to environmental education. In schools in Germany and Japan, children are taught the principles of separate waste collection and recycling, which fosters a high level of environmental responsibility [2]. Companies receive tax incentives for implementing "green" technologies, and the public participates in community clean-up initiatives.

3. Comparison of Approaches in Russia and Foreign Countries

Table – Comparison of Approaches in Russia and Foreign Countries

Comparison Parameter	Russia	Foreign Countries
Waste recycling rate	7 % (according to the Ministry of Natural Resources, 2024), 5 % in the Leningrad Region (regional report, 2023)	67 % in Germany (2023), 99 % in Sweden (including Waste-to-Energy, 2022)
Disposal method	Landfilling: 90 % in Russia (Rosprirodnadzor, 2024), 95 % in the Leningrad Region (2023)	Landfilling: <1 % in Germany (2023), 1 % in Japan (2022)
Condition of landfills	70 % of landfills do not meet sanitary standards; 50 % of equipment is over 20 years old (Rosprirodnadzor, 2024)	Germany: 100 % of landfills equipped with leachate filtration and gas collection systems (2023)
Reclamation	10% of closed landfills (Moscow Region, Krasnodar Krai, 2024), 5 % in the Leningrad Region (2023)	Sweden: 90 % of closed landfills reclaimed as parks (2022)
Environmental awareness	30 % of the population are aware of separate waste collection (VCIOM survey, 2023), 25 % in the Leningrad Region (2023)	Germany: 85 % sort waste at home (2023)
Funding	10 billion RUB/year (federal budget, 2024)	5.2 billion EUR/year (federal and private investments, 2023)
Recycling technologies	Mechanical sorting (70 % of capacity), composting (20 %), pilot incineration in the Moscow Region (2023)	Denmark: 60 % of MSW processed at Waste-to-Energy plants (2023)
Legislation	Federal Law No. 89 of 1998, amendments 2019 (requirements for sorting and recycling)	EU: Directive 2008/98/EC (50 % of household waste to be recycled by 2020)
Economic incentives	Tax benefits for recyclers up to 15 % (2023), no deposit return systems	Germany: €0.25 refund per returned bottle, subsidies up to 30 % for plants (2023)

The main difference lies in the approach: Russia focuses on a temporary solution through landfilling, whereas foreign countries invest in long-term strategies for recycling and landfill minimization [2, 5].

4. Ways to Address Environmental Issues in Russia

4.1. Modernization of Existing Landfills

Equipping landfills with landfill gas collection and leachate filtration systems will help reduce environmental damage. For example, experience in Germany shows that such systems pay off through energy sales [2]. In the Leningrad Region, landfills such as “Yuzhny” could be modernized for methane capture [1].

4.2. Development of Recycling Infrastructure

The construction of sorting facilities and waste processing plants will reduce the volume of landfilling. In the Moscow Region, seven out of 13 planned processing plants have been built, which could serve as an example for the Leningrad Region, where land from closed landfills could be used for such facilities [7].

4.3. Implementation of Separate Waste Collection

Pilot projects, such as the waste sorting program in Kazan, where 50 % of residential areas are equipped with separate collection containers, demonstrate potential for scaling up [8]. Similar initiatives need to be implemented at the national level, accompanied by public awareness campaigns.

4.4. Adoption of Environmentally Friendly Technologies

New materials, such as expanded graphite, rice husks, or modified cellulose, can be adapted for cleaning landfill sites from petroleum products and other pollutants. For example, rice husks can capture toxic substances from leachate [9].

4.5. Legislative Measures and Economic Incentives

Strengthening landfill monitoring, imposing fines for unauthorized dumping, and providing subsidies for recycling companies will help improve the situation. Deposit return systems for packaging, as implemented in Europe, could further encourage recycling [2].

4.6. Enhancing Environmental Responsibility

Educational campaigns in schools and the media, along with citizen involvement in environmental initiatives, will increase awareness. The experience in Kazan, where environmental lessons are conducted, could be scaled up [8].

Conclusion

The environmental situation in Russia, particularly in regions with a high density of landfills, such as the Leningrad Region, requires urgent action. Current measures, such as reclamation and the elimination of unauthorized dumps, are insufficient due to low recycling rates and outdated infrastructure [1, 4]. International experience shows

that landfill minimization, modernization of sites, and the development of environmental awareness effectively address the problem [2].

The proposed measures, including landfill modernization, implementation of separate waste collection, adoption of environmentally safe technologies, and educational programs, can serve as a foundation for sustainable development. Joint efforts by the government, businesses, and society are necessary to preserve natural heritage and ensure environmental safety.

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NATURAL SORBENTS BASED ON MOSS AND PEAT IN MODERN ADSORPTION TECHNOLOGIES FOR THE PURIFICATION AND DISPOSAL OF PULP AND PAPER INDUSTRY WASTE

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Abstract. The article focuses on the study of the efficiency of natural sorbents based on moss and peat, as well as ash waste from the pulp and paper industry for the adsorption purification of the environment. The chemical composition, porous structure, and unique ion-exchange properties of these materials, due to the functional groups of humic substances, are discussed in detail. It is shown that moss and peat have a high capacity to bind heavy metals, organic compounds, and petroleum products. Special attention is paid to sorbent modification technologies to enhance their efficiency. An innovative approach to ash waste utilization is discussed, proposing its use as coagulants and sorbents for industrial wastewater treatment. It is emphasized that the integration of natural sorbents and recycled ash waste enables the creation of comprehensive, economically and environmentally efficient treatment systems. The conclusion is drawn about the promise of large-scale implementation of these technologies to reduce the anthropogenic burden and promote sustainable industrial development.

Keywords: natural sorbents, adsorption, moss, peat, ash waste, pulp and paper industry, wastewater treatment, humic substances, heavy metals.

ПРИРОДНЫЕ СОРБЕНТЫ НА ОСНОВЕ МХА И ТОРФА В СОВРЕМЕННЫХ АДСОРБЦИОННЫХ ТЕХНОЛОГИЯХ ОЧИСТКИ И УТИЛИЗАЦИИ ОТХОДОВ ЦЕЛЛЮЛОЗНО-БУМАЖНОЙ ПРОМЫШЛЕННОСТИ

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Аннотация. Статья посвящена изучению эффективности природных сорбентов на основе мха и торфа, а также золошлаковых отходов целлюлозно-бумажной промышленности для адсорбционной очистки окружающей среды.

Подробно рассмотрен химический состав, пористая структура и уникальные ионообменные свойства этих материалов, обусловленные функциональными группами гуминовых веществ. Показано, что мох и торф обладают высокой способностью связывать тяжелые металлы, органические соединения и нефтепродукты. Особое внимание уделяется технологиям модификации сорбентов с целью повышения их эффективности. Обсуждается инновационный подход к утилизации золошлаковых отходов, предполагающий их использование в качестве коагулянтов и сорбентов для очистки промышленных сточных вод. Подчеркивается, что интеграция природных сорбентов и переработанных золошлаковых отходов позволяет создавать комплексные, экономически и экологически эффективные системы очистки. Сделан вывод о перспективности широкомасштабного внедрения этих технологий для снижения антропогенной нагрузки и содействия устойчивому промышленному развитию.

Ключевые слова: природные сорбенты, адсорбция, мох, торф, золошлаковые отходы, целлюлозно-бумажная промышленность, очистка сточных вод, гуминовые вещества, тяжелые металлы.

Adsorption is one of the key processes in chemical technology and ecology, which makes it possible to effectively remove pollutants from various media. In recent decades, natural materials with high sorption activity and environmental safety have been increasingly considered as adsorbents. These materials include moss and peat, natural sorbents rich in humic substances that are formed during the decomposition of plant residues and have unique ion-exchange and sorption properties.

Moss, especially sphagnum moss, and peat are characterized by a developed porous structure and a large number of functional groups (for example, carboxyl and hydroxyl) capable of binding both organic and inorganic pollutants, including heavy metals, organic compounds, petroleum products, and radionuclides. These properties make them effective for wastewater treatment and oil spill response. Modification of natural peat, for example, heat treatment, makes it possible to increase its oil capacity and reduce its hydrophilicity, which expands the scope of its practical application.

In addition, modern technologies for waste disposal in the pulp and paper industry offer innovative solutions. Ash waste generated during the combustion of wood and biomass residues contains natural compounds of aluminum, silicon and iron and can be used as coagulants and sorbents for effective treatment of industrial wastewater. Their use not only helps to reduce pollution, but also solves the problem of waste disposal at the production site, which increases environmental and economic efficiency [1].

Thus, the integration of natural sorbents based on moss and peat with technologies for processing ash residues from pulp and paper production opens up promising areas in the field of adsorption purification and sustainable waste management. These natural materials not only provide a high degree of purification, but also comply with the principles of green chemistry and cyclical economics, helping to reduce the burden on the environment while maintaining economic benefits.

Moss and peat are natural organomineral materials formed as a result of prolonged decomposition and humification of plant residues in conditions of high humidity and low oxygen access. The main chemical component of these biosorbents is humic substances, which make up from 40 to 70 % of the organic matter of peat and

moss. Humic substances include humins, fulvic acids, and humic acids, which have a complex polymer structure with numerous functional groups (carboxylic, hydroxyl, and phenolic), which causes their high reactivity and ion-exchange properties.

Peat and moss also contain hydrocarbons, cellulose, lignin, proteins, and mineral impurities that affect the structure and chemical activity of the sorbent. The specific surface area of moss and peat varies from 50 to 200 m2/g due to its developed porous structure, which plays a key role in the adsorption of pollutants. Porosity provides not only a large contact area of the sorbent with the contaminant, but also creates conditions for the physical and chemical retention of substances [2].

The adsorption properties of moss and peat are related to their ability to complex and ion exchange, which makes it possible to effectively capture both heavy metal cations (for example, lead, cadmium, copper) and organic pollutants, including petroleum products. The carboxylic and phenolic groups of the functional components of humic substances act as active binding sites, influencing sorption capacity and selectivity towards different types of pollutants.

In addition, natural sorbents can undergo additional chemical and physical modification (for example, carbonation, activation), which can significantly increase their sorption efficiency by changing the surface and creating additional active centers. Thermal modification of peat, for example, improves its hydrophobic properties and increases its oil capacity, which makes it in demand for oil spill response.

Thus, the chemical composition and physical structure of moss and peat form a complex of properties that ensure their high efficiency in the adsorption processes of purification of polluted waters and atmospheric air, which is confirmed by numerous studies and industrial applications [3].

The pulp and paper industry produces significant amounts of solid waste, including ash residues generated by the combustion of by products such as bark, wood chips, sewage sludge and wood waste. These ash wastes contain mineral compounds of aluminum, silicon, iron, calcium, magnesium and other elements, which makes them promising raw materials for recycling in various technological processes.

The chemical composition of the ash includes oxides sio_2, al_2o_3, fe_2o_3, CaO, MgO and other compounds that contribute to the formation of strong structures when used in building materials such as cement and concrete. Due to these components, ash demonstrates good astringent and strengthening properties, which allows it to be used as a mineral additive that reduces the consumption of traditional resources. This area contributes not only to the rational use of recycled materials, but also to the greening of the economy by reducing waste accumulation and reducing the extraction of natural resources.

In addition to the construction industry, a new technology for using ash waste in industrial wastewater treatment has been developed. Ash is used as coagulants-flocculants due to the aluminum compounds and other elements contained in it, which have the ability to cause aggregation and precipitation of suspended impurities. Studies have shown that the efficiency of wastewater treatment using such ash reagents is comparable to the use of traditional commercial coagulants, such as aluminum sulfate, however, the use of ash waste is beneficial from an economic and environmental point of view, since it allows for the disposal of by-products of production directly at the enterprise, reducing costs and harmful effects on the environment [3, 4].

The technology provides for the preliminary preparation of ash by drying, grinding and, if necessary, modifications to increase reactivity. The coagulant from the ash is introduced into sewage treatment plants, where it helps to precipitate colloidal and dissolved pollutants such as heavy metals, organic compounds and suspended particles. In addition, ash waste has the potential to be used in complex environmental technologies, for example, as filtrating and sorption materials, which expands the range of possible applications [5].

Thus, the new technology for the use of ash waste from the pulp and paper industry is an effective and environmentally sustainable way to solve two problems simultaneously: the disposal of industrial waste and the treatment of polluted industrial waters. Further development and implementation of such technologies contribute to reducing the environmental impact on the environment, rational use of resources and promotion of the principles of circular economy.

Natural sorbents such as moss and peat, as well as ash waste from the pulp and paper industry, represent a class of highly effective adsorbents with extensive potential for use in industrial and environmental practice. High porosity, well-developed specific surface area and chemical diversity of functional groups make natural sorbents particularly attractive for the selective removal of pollutants from aqueous and gaseous media. In particular, the carboxyl, hydroxyl, and phenolic groups of humic substances in peat provide complexation and ion exchange with heavy metals and organic compounds, which expands the scope of their application in wastewater treatment and oil spill response [6, 7].

Compared to synthetic sorbents, natural materials have significant advantages, including biocompatibility, accessibility, environmental safety, and lower production costs. Natural sorbents are able to function without additional chemical activation, which reduces energy consumption and minimizes the carbon footprint. In addition, they are characterized by high resistance to biodegradation and minimal secondary environmental pollution after sorption.

The integrated use of recycled materials – ash waste and natural sorbents – opens up new horizons for the implementation of the principles of a cyclical economy. Ash wastes rich in minerals and metal oxides can act simultaneously as coagulants and sorbents, which makes it possible to create integrated treatment systems with improved efficiency in removing various types of pollutants. The integration of these materials into technological processes reduces the burden on primary resources, promotes waste recycling at the site of their formation and expands the range of high-tech products such as building materials with improved performance characteristics [6, 7].

The environmental and economic efficiency of using natural sorbents and ash waste is manifested in reducing the accumulation of harmful waste, reducing the use of chemically synthesized reagents and reducing disposal costs. The high sorption capacity, combined with the availability and low cost of raw materials, creates the prerequisites for the widespread introduction of these materials into wastewater and surface water treatment, gas purification and land reclamation processes. Thus, the prospect of large-scale industrial implementation of these technologies meets modern requirements for sustainable development and environmental protection, stimulating innovations in environmental chemistry and resource-saving technologies.

This integrated approach contributes to the achievement of multifaceted goals: improving environmental safety efficiency, maintaining ecosystem quality, and developing new areas of industrial production with minimal environmental footprint.

The conducted studies have confirmed the high efficiency of natural sorbents, such as moss and peat, in the processes of adsorption purification of various pollutants, including heavy metals, organic compounds and petroleum products. Their unique chemical composition, based on the richness of humic substances with numerous functional groups, ensures selective and stable binding of pollutants, which makes these materials promising for environmentally friendly water and air purification technologies. In addition, the use of ash waste from the pulp and paper industry as coagulants and sorbents demonstrates the successful solution of industrial waste recycling issues and helps reduce the environmental impact on the environment.

The totality of the data obtained confirms the expediency of an integrated approach involving the integration of natural sorbents and technologically prepared ash waste, which makes it possible to increase the efficiency of wastewater treatment, optimize costs and improve the environmental safety of industrial processes. Efficient use of recycled materials is becoming an important area of industry development, focused on the implementation of the principles of sustainable development and circular economy.

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INNOVATIONS IN ELECTRICITY: DISTRIBUTED GENERATION AND THE SMART GRID REVOLUTION

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Abstract. This article looks at how distributed energy and smart grids are changing electricity systems. It talks about the problems with old-fashioned power grids and shows how adding small renewable energy sources, along with smart monitoring, can make power networks better, more sustainable, and tougher. It points out some big challenges, like energy storage, keeping the network stable, and dealing with regulations. The article also shows off some cool new stuff that helps manage energy in real-time and get people more involved. By talking about these tech and infrastructure improvements, it makes clear that young scientists and engineers are key to building the clean and smart energy systems of the future.

Keywords: distributed energy, smart grid, renewable energy, energy storage, distributed generation, energy management, grid stability, smart meters, decentralized power systems, sustainable energy.

ИННОВАЦИИ В ЭЛЕКТРОЭНЕРГЕТИКЕ: РАСПРЕДЕЛЕННАЯ ГЕНЕРАЦИЯ И РЕВОЛЮЦИЯ УМНЫХ СЕТЕЙ

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Аннотация. В статье рассматривается преобразующее влияние распределенной генерации электроэнергии и технологий умных сетей на современные энергосистемы. Обсуждаются ограничения традиционных централизованных электросетей и подчеркивается, как интеграция мелкомасштабных возобновляемых источников вместе с интеллектуальными системами мониторинга и управления создает более эффективные, устойчивые и надежные энергосети. В работе акцентируется внимание на ключевых вызовах, связанных с хранением энергии, стабильностью сети и нормативным регулированием. Представлены современные инновации, обеспечивающие

управление энергией в реальном времени и активное вовлечение потребителей. Отмечается важная роль молодых ученых и инженеров в формировании будущего чистой и умной энергетики.

Ключевые слова: распределенная энергетика, умная сеть, возобновляемая энергия, хранение энергии, распределенная генерация, управление энергией, стабильность сети, умные счетчики, децентрализованные энергосистемы, устойчивая энергетика.

The energy biz is really changing these days. It used to be pretty basic: power plants made the energy, sent it all over the place with wires, and we just flipped a switch. It seemed easy. But then we saw that this way of doing things has problems. Burning old fuels messes up the environment, we're running out of oil and coal, and the power grids lose a lot of energy sending it around. Plus, they can't always handle all the energy we use (Figure 1).

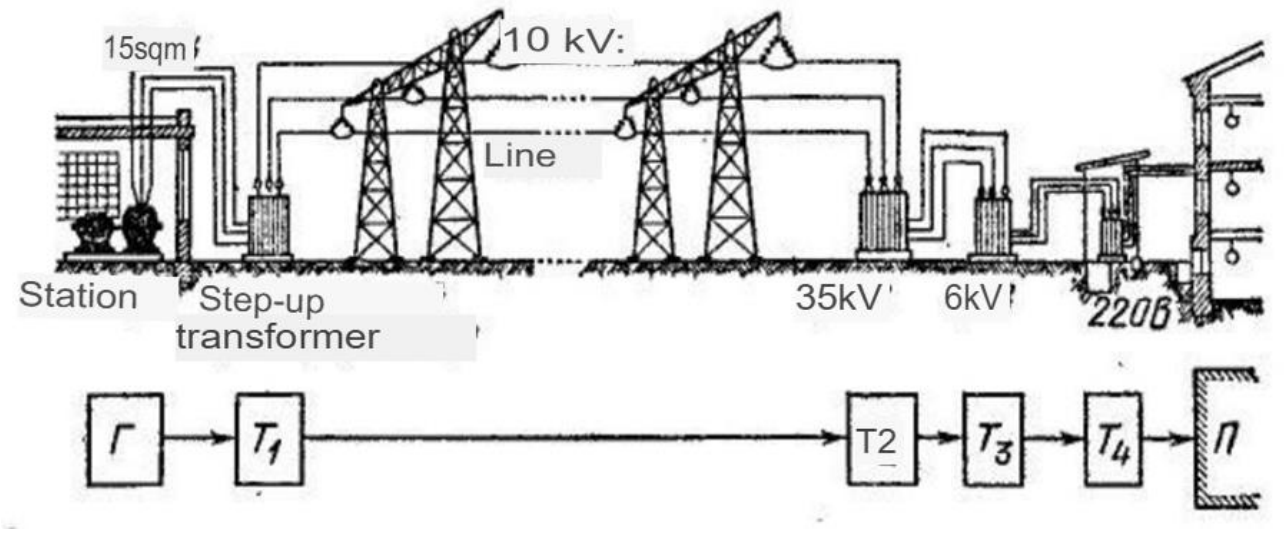


Figure 1. The general scheme of the traditional central power system

New tech lets us handle energy in a whole new way. Forget those giant power plants. Think lots of small energy sources right by our homes – on roofs, in neighborhoods. Plus, we've got smart systems that keep tabs on energy use and output in real time, sending power where it's needed ASAP and storing it in batteries.

This piece is all about this new approach – how these spread-out energy sources and smart grids are shaking up how we think about power. It's not just tech; it’s a way to make energy greener, easier, and more dependable. The cool thing is, this is actually happening now, giving young scientists and engineers a chance to help out and be part of the change [1].

Right now, the energy scene has some major issues. For one, the world's energy appetite is growing – electronics, cars, factories, you name it, all want more and more electricity. But we can’t keep burning tons of coal or oil like before, 'cause that screws up the planet big time. Global warming is a real issue, and people are dealing with it now.

Fossil fuels aren't sticking around forever. They're going to disappear eventually, so we need to find replacements ASAP. That’s why switching to clean energy options, like solar and wind, isn't just a fad; it's absolutely essential for us to survive.

But a snag is our current setup. Traditional power grids were made for big, central plants that run all the time, sending energy all over the place. This leads to wasted power and failures because of overloads or accidents. So, even if people want to help the planet, tech issues are getting in the way of making our power supply better.

These problems – rising needs, environmental worries, and tech challenges – mean we need fresher ideas. We can't just keep doing things the same old way. That's why new solutions are popping up, which we’ll get into next.

When people say distributed energy, they're talking about making power not just at big, faraway plants, but right where it's used, even at people's homes. Ever think about every house having solar panels or a small wind thingy around? They'd make power that you could either use right away or send to the grid if you had extra [2].

It's convenient and pretty neat for a few reasons. First off, you don’t lose a ton of energy sending power all over the place. It just goes straight where it needs to go. Second, if you've got your power makers, you don't have to depend as much on big grids and companies. Even if something goes wrong somewhere, you can still get energy.

Another good thing is that this kind of system makes it easier to make the most of sun and wind power. Solar and wind energy change depending on the weather and time. If you've only got one source, it's hard to handle these ups and downs. But with a bunch of small generators all over, power coming in and being used can be balanced, so energy isn’t wasted, and the whole thing runs better.

Basically, distributed energy is like a bunch of tiny lights all hooked up. Together, they make a super bright and bendy light that's way more reliable and eco-friendly.

Smart grids really turn your regular power grid up a notch. Before, energy flowed just one way – from a big plant to you. But smart grids can do much more. They don’t just send power; they also grab tons of info on how much power is needed, when it’s needed, how different parts of the grid are doing, and even check the power quality itself [3].

Think about having a smart meter and sensors at home that constantly send info to some control room. Smart programs look at this info and figure out the best way to send out power. So, if a lot of solar panels in one area are making extra power, smart grids will send that power somewhere it’s needed or stick it in batteries to save for later (Figure 2).

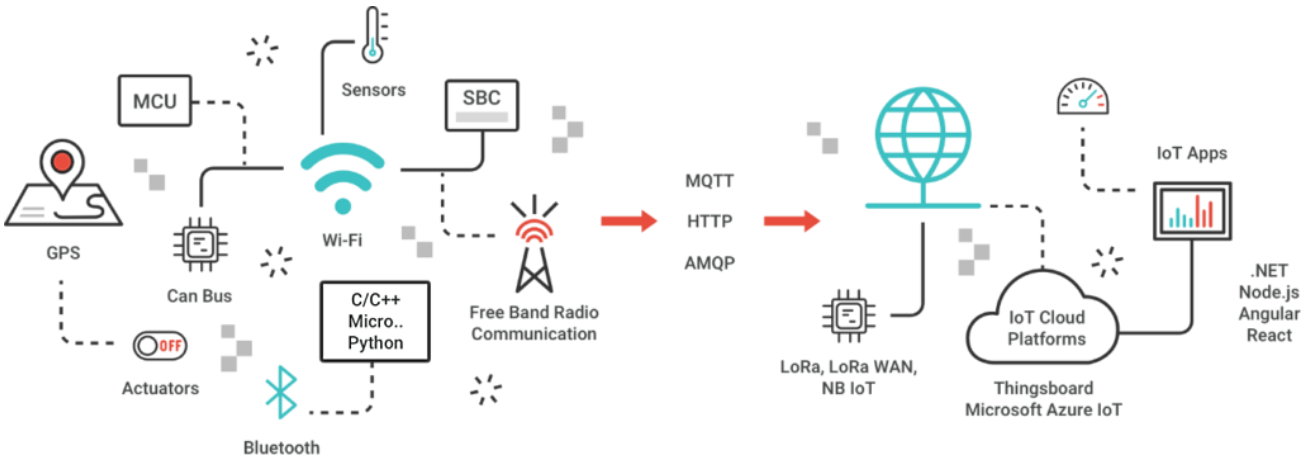


Figure 2. The scheme of a smart network with IoT elements

Smart grids are pretty quick to react to changes. Like, if everyone suddenly cranks up their AC, the grid spots the spike in demand and boosts the energy supply right away. This keeps things from overloading and shutting down, so your power stays on [4].

They also use IoT stuff, where all the devices chat with each other like one big energy thing. This helps to see what's going on and make fast choices.

So, smart grids make the power grid way more flexible and smart. This means we can use all our energy sources better and live more comfortably.

Things like solar panels and wind turbines are cool since they're clean and use free energy. The issue is, they depend on the weather for their operation: sun and wind aren't always around. That makes it tricky to use them and keep the power grid from crashing and staying steady (Figure 3).


Figure 3. Solar panels in cloudy weather

Smart grids can really save the day. Think of them as a brain that can quickly figure things out. If solar power suddenly drops or there's too much, it knows what to do. Say it gets cloudy; the system can switch things around, use energy from batteries, or tap into other sources [5].

Plus, smart grids can guess what's coming. They look at the weather and how much power people are using to figure out how much energy will be needed soon. This helps save resources and cuts down on waste.

Basically, a smart grid keeps all sorts of renewable sources and batteries working together, so we get steady, green energy without any hiccups. This makes eco-friendly tech way better and ready to take over from old power plants.

Even though smart grids and energy tech are already pretty cool, there's still more to do. For starters, we need better energy storage. Batteries should be cheaper, hold more power, and last longer, so we can save extra power for when we need it (Figure 4).

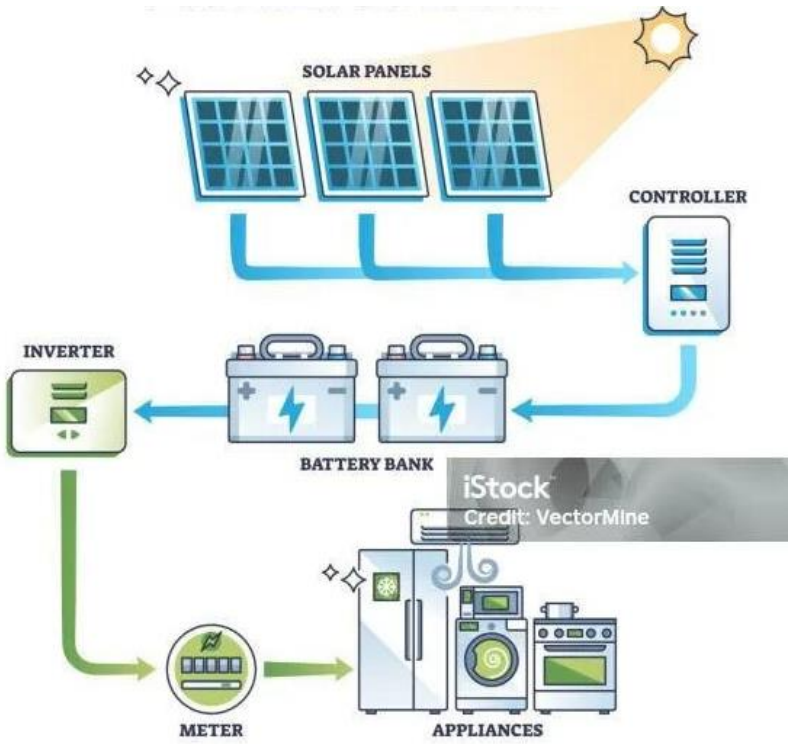


Figure 4. The scheme of solar panels for energy storage

Next up, we need to set up standards and rules that everyone agrees on. This way, devices and systems from different companies can easily talk to each other and play nice in one big network without crashing. This is a tough job that calls for both tech smarts and good organization [6].

It's also key to get laws and rules in place so governments and businesses can quickly start using and backing these technologies. Without the right legal stuff and backing, it's hard to make big changes happen.

For young scientists and engineers like us, big chances are popping up everywhere – from inventing new battery stuff to making smart ways to control energy. Young people can really help make a more sustainable energy future.

Also, switching to spread-out, smart, and green energy isn't just about the tech. It messes with our lifestyles, economies, and even how we think about using energy, pushing us to be more aware and responsible.

Basically, you could say that spread-out energy with smart grids is where energy is at. These technologies aren't just cool gadgets; they're flipping how we get and use

energy. Instead of huge, pricey power plants and risky power lines, we're getting a system that's bendy, tough, and way friendlier to the planet.

For young scientists and engineers, this is a goldmine. We can invent new stuff, crack tough problems, make lives better, and save the planet at the same time. This field needs new ideas, zing, and a want to make the world better – and now's the time to jump in!

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ANALYSIS OF DATA TRANSMISSION ARCHITECTURES AND IMPLEMENTATION OF THE MPPT ALGORITHM FOR POWER CELLS USING CLOUD TECHNOLOGIES

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Abstract. The article is devoted to the study of data transfer architectures in the context of managing distributed power generation based on solar panels. Three main data transfer schemes are considered and compared: direct transfer to the cloud, the use of edge computing, and a hybrid architecture. An implementation of the Perturb and Observe (P&O) algorithm for Maximum Power Point Tracking (MPPT) in the Julia language is presented adapting for integration with cloud platforms. The influence of algorithm parameters on its efficiency is analyzed, and directions for further optimization are proposed.

Keywords: distributed generation, energy cells, cloud technologies, edge computing, MPPT, Perturb and Observe, solar panels, Julia language, real-time control, hybrid architecture.

АНАЛИЗ АРХИТЕКТУР ПЕРЕДАЧИ ДАННЫХ И РЕАЛИЗАЦИЯ АЛГОРИТМА MPPT ДЛЯ ЭНЕРГЕТИЧЕСКИХ ЯЧЕЕК С ИСПОЛЬЗОВАНИЕМ ОБЛАЧНЫХ ТЕХНОЛОГИЙ

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Аннотация. Статья посвящена исследованию архитектур передачи данных в контексте управления распределенной генерацией электроэнергии на основе солнечных панелей. Рассмотрены и сопоставлены три основные схемы передачи данных: прямая передача в облако, использование граничных вычислений и гибридная архитектура. Представлена реализация алгоритма Perturb and Observe (P&O) для отслеживания точки максимальной мощности (MPPT) на языке Julia, адаптированная для интеграции с облачными платформами. Проанализировано влияние параметров алгоритма на его эффективность и предложены направления для дальнейшей оптимизации.

Ключевые слова: распределенная генерация, энергетические ячейки, облачные технологии, граничные вычисления, MPPT, Perturb and Observe, солнечные панели, язык Julia, управление в реальном времени, гибридная архитектура.

The optimization of individual DPG elements, particularly solar power plants (SPPs), becomes a crucial issue in light of the growing interest in distributed power generation (DPG), driven by the desire for energy decarbonization, improved energy efficiency, and enhanced power supply reliability. One of the key aspects of efficient SPP operation is maximizing energy production by tracking the maximum power point (MPPT) of solar panels. An important element in achieving this goal is the selection of a suitable data transfer architecture that ensures the collection, processing, and analysis of information about the operation of the SPP [1].

The research problem lies in the need to choose the optimal data transfer strategy from energy cells (ECs) (solar panels and related equipment) to the cloud infrastructure, considering the specifics of MPPT algorithms and ensuring a balance between cost, performance, and system reliability.

The relevance of the work is due to the rapid development of cloud computing and edge computing technologies, which open up new opportunities for managing and monitoring distributed energy resources. The use of cloud technologies allows aggregating data from a large number of SPPs, conducting comprehensive analysis, and optimizing the operation of the system as a whole.

The scientific novelty of the work lies in the modification and adaptation of the "Perturb and Observe" algorithm for its effective deployment within a cloud infrastructure. The developed approach allows to apply this algorithm not only for local control but also for monitoring and diagnostic tasks in distributed generation systems. The obtained results create a basis for building intelligent control systems characterized by increased efficiency and scalability.

The volume of energy resource consumption is increasing every day. Collecting data about their use requires accelerated decision-making and rapid processing, but today's technologies cannot cope with these tasks; they do not meet modern realities [2, 3].

To begin, it should be noted that data transfer schemes in cloud technologies for energy cells can vary.

I. Direct Data Transfer to the Cloud (Classic Cloud Architecture).

1. Energy Cell: Sensors (current, voltage, temperature, power sensors, etc.) collect data on equipment operation.

2. Gateway: A controller or specialized device that aggregates data from sensors, converts it into the required format (e. g., JSON, MQTT protocol), and establishes a secure connection with the cloud (e. g., HTTPS, TLS).

3. Internet: A communication channel (wired, wireless) for transferring data to the cloud.

4. Cloud Platform:

1) Data Reception Server: Receives data from gateways and places it in the storage system.

2) Data Storage System: Stores data (e.g., cloud databases, object storage).

3) Data Processing Service: Processes data, performs analytics, and generates reports.

4) Visualization System: Displays data in a user-friendly format.

5) Control System: Based on data analysis, generates control commands that are transmitted to the energy cell through the gateway.

II. Using Edge Computing

1. Energy Cell.

2. Edge Node: A more powerful device than a simple gateway. It performs preliminary data processing (filtering, aggregation, local analytics), makes real-time decisions (e.g., automatic load switching in the event of an accident), and sends only aggregated or important data to the cloud.

3. Internet: A communication channel.

4. Cloud Platform: Similar to scheme I, but with a lower load on the data reception system.

III. Hybrid Architecture (Cloud and Fog Computing).

1. Energy Cell.

2. Fog Layer: A hierarchy of edge nodes located closer to the energy cells. They perform local data processing, coordinate the operation of several cells, and exchange data with each other.

3. Internet: A communication channel.

4. Cloud Platform: Performs global analytics, long-term forecasting, and provides centralized management [2, 4-7].

Table presents a comparison of the investigated data transfer types.

Table – Cloud Data Transfer

Characteristics	**Data transfer schemes in cloud technologies**		
	Direct data transfer to the cloud	**Edge computing**	**Hybrid architecture**
Difficulty of implementation	Low	Average	High
Scalability	High	Average	High
Network requirements	High	Low	Average
Data transmission delay	High	Low	Average
Reliability	Low	Average	High
Safety	Low	Average	High
Price	Low	Average	High
Advantages	Ease of implementation and scalability. Centralized data management and storage. Ability to conduct comprehensive data	Reduced load on the network and cloud infrastructure. Reduced data transfer latency and increased response	Optimal distribution of computing load between the cloud and edge nodes. System flexibility and scalability.

	analysis using powerful cloud resources.	time to changes in the EC operation. Increased system reliability due to autonomous operation of edge nodes. Reduced security requirements for transmitted data.	High reliability and fault tolerance. Support for various use cases and performance requirements.
Flaws	High network bandwidth and data transfer latency requirements. Risk of bottlenecks in the communication channel and cloud infrastructure. Dependence on a stable internet connection. Increased security requirements for transmitted data.	More complex architecture and personnel qualification requirements. Need to ensure edge node security. Limited computing resources of edge nodes.	The most complex architecture and personnel qualification requirements. The need to coordinate the work of various system components. High security requirements.

During the study, the program code of the Perturb and Observe algorithm was implemented in the Engee software environment. Description of its operating principle:

1. The code initializes the initial values of voltage, current, and duty cycle.
2. In the “for” loop, the perturb_and_observe function is called 100 times.
3. Inside the perturb_and_observe function, the duty cycle changes slightly.
4. Instead of reading data from sensors, the code models new voltage and current based on the current value of the duty cycle.
5. The code calculates power and compares it with the previous power.
6. Depending on whether the power has increased or decreased, the code either continues to move in the same direction or changes the direction of the duty cycle change.
7. The results (voltage, current, duty cycle, power) are displayed on the screen.

Parameters that are obtained at the output of the code:

1. V_panel (panel voltage): measured in volts (V). Shows the voltage generated by the solar panel at the current time.
2. I_panel (panel current): measured in amperes (A). Shows the current generated by the solar panel at the current time.
3. Duty_cycle: A dimensionless quantity representing the fraction of time during which the key (transistor) in the DC/DC converter is in the on state. Affects the output

voltage of the converter. Used by the MPPT algorithm to control the operation of the inverter. Values are in the range (0, 1).

4. P_panel (panel power): measured in watts (W). Calculated as V_panel * I_panel. Represents the power generated by the solar panel. The goal of the MPPT algorithm is to maximize this value [8-10].

Thus:

1. The basic idea of the Perturb and Observe algorithm is clearly demonstrated: changing the duty cycle and observing the change in power. The algorithm seeks to find the duty cycle value at which the power generated by the panel is maximum.

2. In a real solar panel there is a complex relationship between power, voltage, current, and duty cycle. In our simplified code, we model this relationship using sin and cos functions. By changing these functions, you can explore the behavior of the P&O algorithm with different solar panel characteristics.

3. Increasing the step_size parameter allows you to speed up the process of finding the extremum, but leads to an increase in oscillations around the operating point, which negatively affects the stability of the system.

It should also be noted that in real operating conditions, consistently low values of the output power P_panel may indicate partial shading, contamination, or mechanical damage to the photovoltaic module. If the duty cycle value stabilizes at boundary values (0 or 1), this may indicate the inability of the algorithm to determine the maximum power point due to incorrect settings or hardware malfunctions. Monitoring the dynamics of changes in key parameters over time provides opportunities for diagnosing malfunctions in the operation of a solar power plant and allows timely corrective measures to be taken.

In conclusion, the analysis of the results of the simplified implementation of the P&O algorithm allows us to identify the fundamental patterns of its functioning and to investigate the behavior of the system under various external conditions and parameter settings. Targeted variation of model parameters and equipment characteristics makes it possible to predict the efficiency of the algorithm in real conditions and optimize it for specific applications.

It should be noted that the Julia software environment provides performance comparable to C/C++, which makes it possible to use it for real-time control tasks.

The Perturb and Observe method is used in many controllers. The disadvantage of the method is the constant need to carry out measurements, during which the generation of energy from the modules is interrupted. In order to optimally track the maximum power point of a solar battery and receive the maximum amount of energy from the sun, various manufacturers select search parameters (depth and frequency of iterations, the frequency of a full scan) [10].

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DEVELOPMENT OF A DIGITAL TWIN TO OPTIMIZE THE ENERGY CONSUMPTION OF A PUMPING STATION USING THE EXAMPLE OF USING RUSSIAN SOFTWARE

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Abstract. The article discusses the urgent task of improving the energy efficiency of pumping stations, which are one of the main consumers of electricity in water supply and sanitation systems. A solution method based on the creation and use of a digital twin is proposed. The paper describes the structure of a digital twin, which includes a mathematical model of the technological process, a module for collecting data from an automated process control system and an optimization module. Special attention is paid to the use of Russian software. A bundle from the PILOT PLM system is proposed as a platform for creating a digital twin.: PLM and VIM simulation software, and the Python programming environment for implementing optimization algorithms.

Keywords: digital twin, energy saving, pumping station, optimization, simulation modeling, Russian software, import substitution, automated process control system, PILOT: PLM, VIM.

РАЗРАБОТКА ЦИФРОВОГО ДВОЙНИКА ДЛЯ ОПТИМИЗАЦИИ ЭНЕРГОПОТРЕБЛЕНИЯ НАСОСНОЙ СТАНЦИИ НА ПРИМЕРЕ ИСПОЛЬЗОВАНИЯ РОССИЙСКОГО ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ

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Аннотация. В статье рассматривается актуальная задача повышения энергоэффективности насосных станций, являющихся одними из основных потребителей электроэнергии в системах водоснабжения и водоотведения. Предложен метод решения на основе создания и использования цифрового двойника. В работе описана структура цифрового двойника, включающая математическую модель технологического процесса, модуль сбора данных с АСУ ТП и модуль оптимизации. Особое внимание уделено применению российского программного обеспечения. В качестве платформы для создания цифрового двойника предложена связка из PLM-системы «ЛОЦМАН: PLM» и

ПО для имитационного моделирования «VIM», а для реализации алгоритмов оптимизации – среда программирования Python.

Ключевые слова: цифровой двойник, энергосбережение, насосная станция, оптимизация, имитационное моделирование, российское ПО, импортозамещение, АСУ ТП, «ЛОЦМАН: PLM», VIM.

A digital twin is a dynamic digital model that reproduces the behavior and state of a real object based on data from monitoring systems. In industry, digital twins are used to analyze, predict, and optimize equipment and production processes. In modern conditions, the use of a digital twin is not just an “optimization”, but a strategic measure to ensure reliability and technological independence. The digital twin allows you to turn a passive response object into an intelligent, predictive asset and managed through software.

Pumping stations are critically important objects of municipal and industrial infrastructure. At the same time, they are characterized by a high level of energy consumption, reaching 70-80 % of the total cost of their operation [1]. Existing automation systems, as a rule, solve the problems of pressure or level stabilization, but rarely optimize energy consumption in conditions of varying load (daily fluctuations in water consumption).

Let's consider the principle of operation using the example of a drainage HC of sewage treatment plants. In this case, it is based on pumping excess water from underground and surface facilities, preventing its accumulation, possible damage to structures and swampy areas. Excess water accumulates in the settling tanks and enters the reservoir of the drainage pumping station. In addition, excess water can be reused in the process for flushing and regenerating wastewater treatment plants.

The technological equipment of the drainage pumping station of the Yoshkar-Ola sewage treatment plants includes two centrifugal pumps H1, H2, a drainage pump H3, two reservoirs, shut-off valves. Measuring devices include a hydrostatic level sensor, a float level indicator, and a pressure gauge.

The technological equipment is regulated by an automatic control system (ACS). The centrifugal pumps are controlled according to the readings of the level sensor and two-level detectors in the receiving tank. The drainage pump is controlled by the level indicator in the drainage pit.

When a certain water level in the drainage tank is reached, the control system activates the drainage pump, which directs the water to the receiving tank. The receiving tank also receives a stream of water from secondary settling tanks and other treatment facilities. Upon reaching the required level in the receiving tank, the water is distributed to two centrifugal pumps, after which it is either reused or discharged into reservoirs. This is done in order to normalize the flow of excess water in order to avoid overloading.

Various technical solutions can be used to optimize the operation of the drainage system, one of which may be the use of a digital twin. At the moment, there are significant restrictions on the supply of foreign software.

A modern approach to solving this problem is to use the concept of a digital twin [2]. A digital twin is not just a static model, but a dynamic virtual copy of a physical

object that exchanges data with it and can be used for analysis, forecasting, and optimization. In the context of pumping stations, the data center allows not only monitoring the current state, but also selecting the most energy-efficient combinations of operating pumps in advanced simulation mode and setting optimal settings for frequency converters.

In the context of current geopolitical realities and the course towards technological sovereignty, the use of domestic software is becoming particularly relevant [3]. However, the scientific literature does not sufficiently cover the experience of building a data center based on Russian software products.

The aim of the work is to develop an architecture and methodology for creating a digital twin of a pumping station to optimize its energy consumption using Russian software.

Consider a typical pumping station with several (n) pumping units, some of which are equipped with frequency converters. The control task is to maintain the Rhp pressure in the pressure manifold with variable Qpotp consumption.

The objective function is to minimize the total power consumption of pumping units over a period of time T.

The task is complicated by the non-linearity of the pump characteristics and the need for discrete control (turning on/off the units).

The architecture of the proposed digital twin includes three main modules:

1. Physical object: Pumps, valves, sensors (flow, pressure), PLC, automated control system.

2. Data collection module: (Communication with the automated process control system via the OPC UA server).

3. The virtual model.

The last module also consists of the following links:

- Mathematical model. The model is based on the characteristics of pumps H(Q) and their energy characteristics P(Q), which are approximated by polynomials of the 2nd degree. The collector model is described by the pressure and flow balance equation. The dynamics of pressure changes is taken into account through the continuity equation.

- Simulation software (Russian software "VIM"). To create an industrial digital twin, it is advisable to use the following Russian products:

- Optimization module (Python algorithm).

As an example of domestic software, we highlight the following:

1. “PILOT: PLM” (ASCON company). This system is used as a single platform for managing all the data of the digital twin: 3D models of equipment, pump passports, electrical diagrams, operational documentation [4]. It serves as a “single source of truth”.

2. "VIM" (Virtual Information Model, Eidos company). This is the Russian equivalent of products such as Siemens Tecnomatix or Rockwell Emulate3D. VIM is designed to create 3D visualization and simulation of technological processes [5]. As part of our data center, VIM implements a dynamic model of the hydraulic system of a pumping station that visually displays flows, pressures, and equipment conditions.

3. The Python programming environment. Python with SciPy and Pandas libraries is used to implement optimization algorithms (for example, the branch and boundary method for combinatorial pump selection and gradient methods for finding the optimal frequency of emergency situations). This tool is an open-source global standard and is not subject to sanctions restrictions.

The main reasons for the import substitution of software are the reduction of the level of dependence of the Russian industry on foreign suppliers, as well as the maintenance of the economic component of the national market.

The algorithm of the data center in online optimization mode is as follows:

1. Current data is received from the automated process control system (via the OPC UA server) into the VIM and Python-based model: Qpotp, Rfact, pump status.

2. Based on the forecast of water consumption for the next time horizon (30-60 minutes), an optimization algorithm is launched.

3. Various pumping station operation scenarios are played out in the VIM virtual environment, and an objective function is calculated for each scenario [6].

4. The optimal mode found (the composition of the operating pumps and the frequency settings for the emergency) is transmitted to the automated process control system as a recommendation to the operator or directly to the controllers (in automatic control mode).

To test the effectiveness of the technique, a model of a pumping station with three pumping units (2 main emergency units, 1 backup) was created. Based on historical data on daily water consumption, two scenarios were calculated:

Scenario 1 (Basic): Operation according to a set pressure schedule.

Scenario 2 (With CD): Work on optimizing the composition of units and frequency settings according to the proposed methodology.

The calculation results (Table) showed that using a digital twin reduces energy consumption by 14.2 % during peak hours and by an average of 12.8 % per day.

Table. Comparison of energy consumption by scenarios

Time period	**Energy consumption (Baseline scenario)**	**Energy consumption**
Night (0:00-6:00)	850	780
Morning (6:00-10:00)	1250	1070
Day (10:00-18:00)	1100	960
Evening (18:00-23:00)	1300	1115
Amount per day	4500	3925

Visualization in the VIM environment made it possible to analyze transients during pump switching and ensure that there are no critical pressure drops.

The paper presents a practical methodology for developing a digital twin of a pumping station, focused on optimizing energy consumption. The key advantage of the proposed approach is its realizability based on Russian software: the PLM system “PILOT: PLM” and the simulation software “VIM”.

The numerical experiment confirmed the high efficiency of the technique, demonstrating a potential reduction in energy consumption by 12-15 %. This result

indicates a significant economic potential for the introduction of digital twins in housing and communal services and industrial enterprises.

There is a steady trend towards the introduction of digital twins in Russia, which is supported at the state level. The most significant results have been achieved in high-tech industries (aircraft manufacturing, nuclear power, petrochemical industry), where the complexity of products and high risks justify investments in this technology. For example, in the oil and gas complex, data centers are mainly used to optimize gas transportation modes (selection of operating units, pressure adjustment), predictive maintenance of equipment, and emergency simulation for operator training.

The prospects for further research are related to the integration of more complex machine learning algorithms for accurate load forecasting and taking into account equipment wear into predictive maintenance planning models.

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DESIGNING USER INTERFACES FOR PEOPLE WITH AUTISM SPECTRUM DISORDER

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Abstract. This paper discusses the key principles and methods of designing user interfaces tailored to the needs of users with autism spectrum disorder (ASD). The neurocognitive features of this group of users, such as sensory sensitivity, difficulties in processing abstract information, and the need for predictability, are analyzed. Based on the analysis, practical recommendations are formulated to ensure clarity, consistency, flexibility and accessibility of digital products. It is proved that taking into account the features of neurodiversity in design not only expands accessibility, but also contributes to the creation of more intuitive and comfortable interfaces for all categories of users.

Keywords: autism spectrum disorder (ASD), user interface (UI), user experience (UX), inclusive design, neurodiversity, accessibility, sensory overload.

ПРОЕКТИРОВАНИЕ ПОЛЬЗОВАТЕЛЬСКИХ ИНТЕРФЕЙСОВ ДЛЯ ЛИЦ С РАССТРОЙСТВОМ АУТИСТИЧЕСКОГО СПЕКТРА

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Аннотация. В работе рассматриваются ключевые принципы и методы проектирования пользовательских интерфейсов, ориентированных на потребности пользователей с расстройством аутистического спектра (РАС). Анализируются нейрокогнитивные особенности данной группы пользователей, такие как сенсорная чувствительность, трудности обработки абстрактной информации и потребность в предсказуемости. На основе проведенного анализа формулируются практические рекомендации по обеспечению ясности, согласованности, гибкости и доступности цифровых продуктов. Доказывается, что учет особенностей нейроразнообразия в дизайне не только расширяет доступность, но и способствует созданию более интуитивных и комфортных интерфейсов для всех категорий пользователей.

Ключевые слова: расстройство аутистического спектра (РАС), пользовательский интерфейс (UI), пользовательский опыт (UX), инклюзивный дизайн, нейроразнообразие, доступность, сенсорная перегрузка.

The modern digital environment is characterized by a high degree of visual and information complexity and workload, which creates significant barriers for users with neurocognitive development features. Autism spectrum disorder (ASD), which is a pervasive disorder of neuropsychiatric development, causes specific perception, information processing and interaction with the world. According to the World Health Organization, approximately 1 in 127 persons has an autism spectrum disorder [1], which highlights the scale of the potential audience in need of accessible interfaces. Studies conducted in the Russian Federation confirm the global trend in the prevalence of ASD, which actualizes the development of digital solutions focused on them [2]. Adults with ASD are characterized by difficulties in social interaction, including difficulties with "reading between the lines", interpreting non-verbal signals, and a tendency to literally understand information. These features, often accompanied by increased sensory sensitivity and a need for routine, make many traditional interfaces overloaded, unpredictable and, as a result, inaccessible.

This leads to the need to develop design approaches that take into account the principles of neurodiversity. Inclusive design, focused on users with ASD, allows not only to eliminate existing barriers, but also to create more versatile, clear and effective digital products, the benefits of which extend to the entire user audience.

For effective design, it is necessary to understand the specifics of the perception and processing of information from the target audience of the product. ASD is characterized by permanent deficits in social communication and social interaction, as well as limited, repetitive patterns of behavior, interests, or activities.

For neuro-different people, there are several key difficulties affecting interface design. Firstly, it is difficult to process complex and abstract information. Users with ASD often have difficulty interpreting metaphors, idioms, sarcasm, and humor. In the context of the interface, this means that elements such as iconography based on abstract concepts or text messages containing ambiguities can be misunderstood and the credibility of the product undermined. Secondly, there is often an increased or decreased sensory sensitivity. Hypersensitivity to visual stimuli (bright colors, flashing elements, high contrast) and auditory cues (sudden sounds, auto-replayed audio) can lead to sensory overload, discomfort, and fatigue. Thirdly, the need for predictability and routine makes it difficult to navigate interfaces with non-standard logic, inconsistent structure, or unexpected changes (pop-up windows, dynamically rearranging menus). Research shows that inconsistency in interfaces is one of the key factors causing anxiety and cognitive overload in users with ASD [3].

These features form specific user barriers. Sensory overload causes the user to lose focus and experience anxiety, forcing them to leave the interface. Difficulties with information processing lead to errors in the interpretation of content and functionality, which reduces the effectiveness of interaction. The unpredictability of navigation is disorienting, increases cognitive load and makes it difficult to achieve the target action. All this leaves a negative impression on the neuro-excellent user of the product.

To overcome these barriers systematically, we need not a set of disparate techniques, but a holistic, methodologically sound set of design principles. This complex is formed on the basis of a deep understanding of the neurocognitive features

of ASD, which makes it possible to move from reactive elimination of deficiencies to proactive creation of an initially accessible digital environment.

The key idea is the paradigm of neuro-inclusive design, which considers the peculiarities of perception and processing of information in ASD not as a deviation from a certain "norm", but as part of the continuum of human neurodiversity. This approach suggests that design decisions should be based on data from neuroscience and cognitive psychology, explaining, for example, the mechanisms of sensory filtering, the difficulties of integrating information from different modalities, or the specifics of executive functions.

Thus, each principle in the proposed complex has a clear neurocognitive rationale. The principle of clarity and unambiguity is directly related to the difficulties of the theory of consciousness and understanding the implicit context. This principle is fully consistent with the WCAG recommendations, in particular, with success criterion 3.1.5, which prescribes providing transcriptions of idioms and complex terms [4]. The principle of visual rest is a response to atypical sensory processing and increased excitability of the nervous system. The principle of structural consistency correlates with the need for predictability due to the functioning of the prefrontal cortex and amygdala, which are responsible for anticipating events and regulating anxiety. Finally, the principle of flexibility and control takes into account a wide range of individual profiles within the RAS, providing the user with tools for self-regulation and interface adaptation to their unique neurocognitive patterns.

The implementation of this set of principles requires the designer not only to follow technical recommendations, but also to develop "empathy for perception" – the ability to model user experience based on an understanding of the underlying neurobiological mechanisms. This ensures the creation of digital products that are not only functionally accessible, but also psychologically comfortable, which ultimately determines the depth and stability of user interaction with the interface.

The principle of clarity suggests that the purpose, functionality, and content of an interface should be understandable to the user without the need for guesswork or interpretation. This is achieved by using a simple, literal and unambiguous language. Idioms, metaphors, and sarcasm should be avoided. All text elements, such as labels, instructions, and error messages, should be concise and specific. Visual elements, such as icons, should be as recognizable as possible and, if necessary, duplicated with text explanations. Feedback from the system should be timely, clear, and consistent. You should also use unified visual cues: green and a check mark for a successful action, red and a cross for an error.

The interface should be visually calm. It is recommended to use a subdued, harmonious color palette, avoiding pure black text on a pure white background, which creates excessive contrast. Soft, pastel or even slightly dirty shades are preferred (Fig. 1). It is also important to provide the user with a choice between light and dark themes (Fig. 2). Animations and transitions should be kept to the required minimum, smooth and not repetitive or stopping at the touch of a button. It is critically important to give the user full control over the media content: exclude auto-playback of video and audio, and provide "pause" or "stop" buttons for the necessary animations.

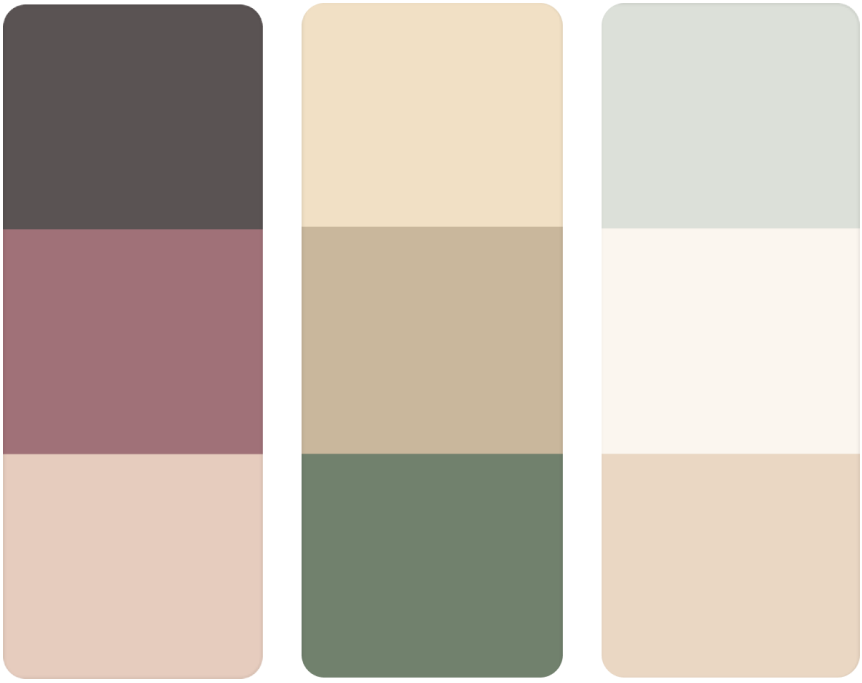


Figure 1. Examples of color palettes

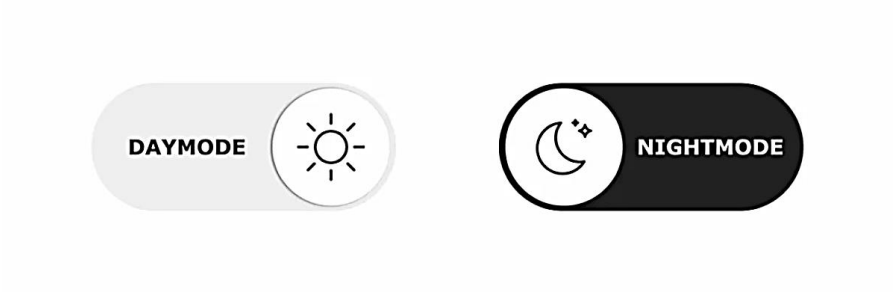


Figure 2. Light and dark themes

Users with ASD rely heavily on routine and predictability. This requires a high degree of structural consistency from the interface. Navigation, the location of key elements and the logic of interaction should remain unchanged on all pages and screens of the application (Fig. 3). It is necessary to adhere to generally accepted standards and conventions in design so as not to force the user to re-learn the logic of the interface. Any changes that may be perceived as sudden should either be minimized or preceded by clear notification. The implementation of this principle reduces anxiety and cognitive load, allowing the user to form a stable mental model of the interface.



Figure 3. Inconsistency in the design of icons in the interface

Given the wide range of sensory and cognitive profiles within the RAS, the interface should provide opportunities for personalization. The user should be able to

adapt the interface to their individual needs. These settings include: choose between a light and dark theme, control the volume of audio signals, and the ability to hide or display certain information blocks. Flexibility also manifests itself in providing alternative ways to complete tasks and the ability to control the pace of interaction: there are no time limits for performing critical actions.

Creating interfaces for a diverse audience requires a revision of traditional design and testing methods. The key approach is focused on the experience of a User with Autism (Autism Customer/User Experience – ACU) [5].

Introducing users with ASD into the testing process at an early stage is not just a recommendation, but a necessity. Standard usability testing methods may require adaptation: conducting sessions in a calm environment, providing a clear and structured scenario, allowing the test taker to pause, and using nonverbal feedback methods. This approach allows us to identify barriers that may go unnoticed by neurotypical designers and researchers.

The inclusivity provided by the ACU experience promotes a culture in which diverse cognitive styles are respected and valued. Creating accessible and adaptable interfaces allows people with ASD to actively participate in socio-economic life, including education, employment, and communication. In addition, accounting for neurodiversity serves as a driver of innovation. The unique perception of the world, characteristic of many people with autism, allows them to find non-standard solutions and identify non-obvious design problems, which ultimately leads to the creation of more thoughtful, versatile and competitive products. Collaboration with diverse users at the design and validation stages ensures that the product meets the real needs of a wide audience.

Designing user interfaces for people with autism spectrum disorder is a complex task that requires a deep understanding of the neurocognitive foundations of their interaction with the digital environment [6]. The application of the principles of clarity, visual rest, structural consistency, and flexibility makes it possible to systematically eliminate key barriers associated with sensory overload, information processing difficulties, and the need for predictability.

It is important to emphasize that a design that takes into account the needs of users with ASD is not a purely niche solution. On the contrary, it approaches the ideal of universal design, creating more comfortable, intuitive and cognitive load-reducing interfaces for all users without exception [7]. The implementation of the ACU methodology and the active involvement of diverse users in the development process opens up new opportunities for creating innovative, inclusive and socially responsible digital products, thereby contributing to building a more accessible digital society.

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FAILURE PREDICTION OF AVIATION SYSTEMS USING ENSEMBLE MACHINE LEARNING MODELS

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Abstract. This study investigates methods for predicting failures in aviation systems using telemetry data and ensemble machine learning models. It is demonstrated that incorporating degradation dynamics features improves the accuracy of remaining useful life estimation. The CatBoost model achieved the best performance in terms of F1-score and RMSE, while offering interpretability and robustness to noise. The proposed approach enables predictive maintenance and enhances the reliability of aviation equipment.

Keywords: machine learning, aviation systems, ensemble models, time series, predictive maintenance.

ПРОГНОЗИРОВАНИЕ ОТКАЗОВ АВИАЦИОННЫХ СИСТЕМ С ИСПОЛЬЗОВАНИЕМ АНСАМБЛЕВЫХ МОДЕЛЕЙ МАШИННОГО ОБУЧЕНИЯ

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Аннотация. В работе исследуются методы прогнозирования отказов авиационных систем на основе телеметрических данных с применением ансамблевых моделей машинного обучения. Показано, что использование признаков динамики деградации повышает точность оценки остаточного ресурса. Модель CatBoost продемонстрировала наилучшие результаты по метрикам F1 и RMSE, обеспечивая интерпретируемость и устойчивость к шуму. Предложенный подход позволяет реализовать предиктивное обслуживание и повысить надежность авиационной техники.

Ключевые слова: машинное обучение, авиационные системы, ансамблевые модели, временные ряды, предиктивное обслуживание.

Introduction

Modern aircraft are increasingly filled with complex monitoring and control systems where thousands of sensors continuously record temperature, pressure,

vibration, rotational speeds and other parameters. These data streams make it possible not only to service components on a fixed schedule but also to anticipate potential failures in advance. Even small shifts in vibration levels or oil temperature may indicate the early stages of wear, providing time for scheduled maintenance and reducing the risk of an in-flight malfunction [1].

Working with telemetry is challenging. The data are noisy, often incomplete and strongly dependent on operating modes and external conditions. Simple statistical approaches perform poorly in such settings, so ensemble machine learning methods such as Random Forest, XGBoost and CatBoost are used. By aggregating the outputs of multiple models, they help increase overall accuracy and stability compared to relying on a single model.

Machine learning offers powerful tools for analyzing high-dimensional telemetry, detecting latent patterns and building accurate predictive models. The goal of this study is to develop a model that estimates the remaining useful life (RUL) of components and warns about possible faults by combining time series analysis with ensemble learning. This task lies at the core of predictive analytics, enabling a shift from scheduled maintenance to condition-based maintenance.

Data Source and Preprocessing

To evaluate the feasibility of predicting failures, a real dataset was used that simulates degradation of a turbofan engine known as the C-MAPSS-1 Turbofan Engine Degradation Dataset. It is publicly available and widely applied in remaining useful life studies [2]. The dataset contains records for several identical engines, each operated until failure under different conditions. Every entry corresponds to a single engine cycle and includes dozens of parameters describing the state of key components: temperature and pressure at different combustion stages, rotor speed, fuel flow, vibration levels and other physical measurements.

The dataset represents multivariate time series because each engine follows its own aging trajectory. This structure makes it possible to examine not only individual sensors but also their interactions, which is crucial for detecting early signs of wear.

Before training the model, the data required careful preprocessing. Abnormal entries not related to real physical behavior were removed, and missing values were filled using interpolation or the median of neighboring points. If a missing value is denoted as x_{miss}, it can be estimated with linear interpolation:

$$x_{\text{miss}} = x_i + \frac{x_{i+1}-x_i}{t_{i+1}-t_i}(t_{\text{miss}} - t_i),$$

where x_i and x_{i+1} are neighboring known values, and t denotes the corresponding time points.

After that, the data were normalized to eliminate the influence of differing parameter scales. For each feature x, the standard deviation σ and the mean μ were computed, and the values were converted to Z-scores:

$$z = \frac{x-\mu}{\sigma}.$$

This approach ensures that all sensors contribute equally during model training and prevents the prediction from being biased toward features with larger numerical ranges.

Special attention was given to the temporal structure of the data. For each engine, the cycle index t was preserved, allowing the model to take into account the context of previous states when forming features and predicting RUL.

Finally, the data were split into training and test sets by entire engines to avoid information leakage. All cycles from a given engine were placed either in the training set or in the test set. This provides a fair assessment of the model's ability to generalize its learned patterns to new hardware instances. Changes in system characteristics lead to a situation in which the engine's condition gradually moves, or tends to move, through the sequence from fully functional to operable to inoperable states [3].

The preprocessing stage is a critical component of the study because it transforms noisy and heterogeneous telemetry into a structured dataset suitable for constructing informative features and training ensemble machine learning models.

Feature Construction

After preprocessing, the next step is to extract features from the time series that truly capture engine degradation. A single sensor reading is not very informative by itself, so the dynamics over time become essential. Sliding-window statistics are used for this purpose: the mean, standard deviation, minimum and maximum computed over a window of length w.

The sliding mean for a feature X is computed as

$$MA(t) = \frac{1}{w} \sum_{i=t-w+1}^{t} X(i)$$

and the sliding standard deviation is computed as

$$MStd(t) = \sqrt{\frac{1}{w}\sum_{i=t-w+1}^{t}\big(X(i) - MA(t)\big)^2}.$$

These metrics capture local fluctuations and rising instability. For instance, a sudden increase in the sliding standard deviation of oil temperature may indicate the onset of bearing wear.

To examine trends, the slope of a linear regression within the window is estimated:

$$y = a + bt,\ b = \frac{\sum_{i=1}^{w}(t_i - \bar{t})(X_i - \bar{X})}{\sum_{i=1}^{w}(t_i - \bar{t})^2}.$$

The sign and magnitude of b show the direction and rate of change. A positive slope indicates growing deviation, while a negative one suggests stabilization.

Correlations between channels are also taken into account:

$$\rho_{XY} = \frac{\mathrm{cov}(X,Y)}{\sigma_X \sigma_Y} = \frac{\frac{1}{w}\sum_{i=1}^{w}(X_i - \bar{X})(Y_i - \bar{Y})}{\sigma_X \sigma_Y}.$$

This helps reveal hidden patterns, such as a coupling between vibration and temperature within certain operating regimes.

To reduce dimensionality, features with low variance or strong collinearity are removed. The remaining set captures both the dynamics and the interactions of engine parameters and is ready for training ensemble models.

Model Selection

After feature construction, the next step is to develop an algorithm capable of predicting engine failure probability or remaining useful life. Ensemble methods were employed, combining multiple models to reduce the impact of random errors.

Random Forest builds N decision trees independently and averages their predictions:

$$\hat{y} = \frac{1}{N}\sum_{i=1}^{N} f_i(X),$$

where $f_i(X)$ is the prediction of the i-th tree, and $\hat{y}$ is the final prediction. For classification, $\hat{y}$ is interpreted as the probability of failure:

$$P(\text{ failure } | X) = \frac{\text{number of trees predicting failure}}{N}.$$

Gradient boosting methods (XGBoost, CatBoost) build trees sequentially, correcting errors of previous ones:

$$F_m(X) = F_{m-1}(X) + \eta f_m(X),$$

where $F_m(X)$ is the ensemble after the m-th tree, η is the learning rate, and $f_m(X)$ minimizes the loss function $\mathcal{L}$:

$$f_m = \arg\min_f \sum_{i=1}^{n} \mathcal{L}\big(y_i, F_{m-1}(X_i) + f(X_i)\big).$$

For RUL regression, the mean squared error (MSE) is typically used as the loss function:

$$\mathcal{L}(y, \hat{y}) = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y_i})^2, \quad \text{RMSE} = \sqrt{\mathcal{L}(y, \hat{y})}.$$

For binary classification, when the model estimates the risk of failure in the next N cycles, the logistic function is applied:

$$\text{P(отказ|X)} = \frac{1}{1 + e^{-F(X)}}, \qquad F(X) = \sum_{m=1}^{M} \eta f_m(X),$$

and optimization is performed using the log-loss function:

$$\mathcal{L} = -\frac{1}{n}\sum_{i=1}^{n}[y_i \log \hat{y_i} + (1 - y_i)\log(1 - \hat{y_i})].$$

Hyperparameters (tree depth, number of trees, learning rate, regularization) were tuned using cross-validation to minimize errors on the validation set.

Ensemble methods are well suited for telemetry data because they:

- Capture nonlinear interactions between features.
- Remain stable with noisy and incomplete data.
- Provide feature importance estimates:

$$\text{Importance}(X_j) = \frac{1}{N}\sum_{i=1}^{N} \Delta\mathcal{L}_i(X_j),$$

where $\Delta\mathcal{L}_i(X_j)$ is the reduction in the loss function when splitting on feature X_j in the i-th tree.

Ultimately, ensemble models not only predict failure probability and RUL but also identify which engine parameters drive degradation, a critical aspect for practical applications in aviation.

Model performance evaluation

After training, it is essential to verify that the model genuinely predicts failures rather than memorizing random patterns. Both classification and regression metrics are used for this purpose [4].

For binary classification (failure/no failure), the following metrics are applied:

- Precision – the proportion of correct alerts among all positive predictions:

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}},$$

where TP is the number of true positives and FP is the number of false alarms.

- Recall – the ability to identify all actual failures:

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}},$$

where FN represents missed failures.

- F1-score – the harmonic mean of *Precision* and *Recall*:

$$\text{F1} = 2 \cdot \frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}}$$

- ROC-AUC – the area under the receiver operating characteristic curve, showing how confidently the model separates normal from pre-failure states:

$$\text{AUC} = \int_0^1 \text{TPR}(\text{FPR})\ \text{dFPR},$$

where TPR = *Recall*, and $\text{FPR} = \frac{\text{FP}}{\text{FP+TN}}$ is the false positive rate.

For regression (RUL estimation), the key metric is the root mean squared error (RMSE):

$$\text{RMSE} = \sqrt{\frac{1}{\text{n}} \sum_{\text{i}=1}^{\text{n}} (\text{y}_\text{i} - \hat{y}_\text{i})^2},$$

where y_i is the true remaining useful life and $\hat{y}_i$ is the model prediction. Lower RMSE indicates more accurate failure time predictions.

To assess robustness, cross-validation is performed: engine data are divided into independent subsets, and metrics are computed for each. This tests the model's ability to generalize patterns to new units rather than memorizing specific trajectories.

Error distributions over time are also analyzed to identify where the model loses accuracy – early in degradation or under highly variable operating conditions. Particular attention is given to false negatives, situations where a failure is not predicted:

$$\text{FN rate} = \frac{\text{FN}}{\text{TP} + \text{FN}}.$$

This approach helps identify underweighted features and areas where the model needs improvement. Performance evaluation demonstrates how well the algorithm meets real operational requirements and provides a basis for selecting the optimal ensemble configuration. It enables adaptive management depending on specific operating conditions, economic feasibility, and the control of operational tolerances for various components [5].

Results

The models were tested on data not used during training to evaluate their ability to detect patterns on new engines. The analysis proceeded in several stages: computational preparation, feature importance assessment, algorithm comparison, and forecast visualization. Computations were performed in a Python environment using scikit-learn, pandas, NumPy, CatBoost, and XGBoost.

Random Forest was used to assess the contribution of each feature (Figure). Let X_j be the j-th feature; its importance can be measured by the reduction in the loss function:

$$\text{Importance}(X_j) = \frac{1}{N}\sum_{i=1}^{N} \Delta\mathcal{L}_i(X_j),$$

where $\Delta\mathcal{L}_i(X_j)$ is the decrease in error when splitting on feature X_j in the i-th tree, and N is the number of trees.

The most important features were compressor temperature readings, turbine outlet pressure, and vibration amplitude. Together, these three accounted for over 60 % of the total informativeness. Less critical were fuel flow and rotor speed, which reflect operating conditions but not direct degradation. This result aligns with the physics of wear processes and increases engineers' confidence in the model.

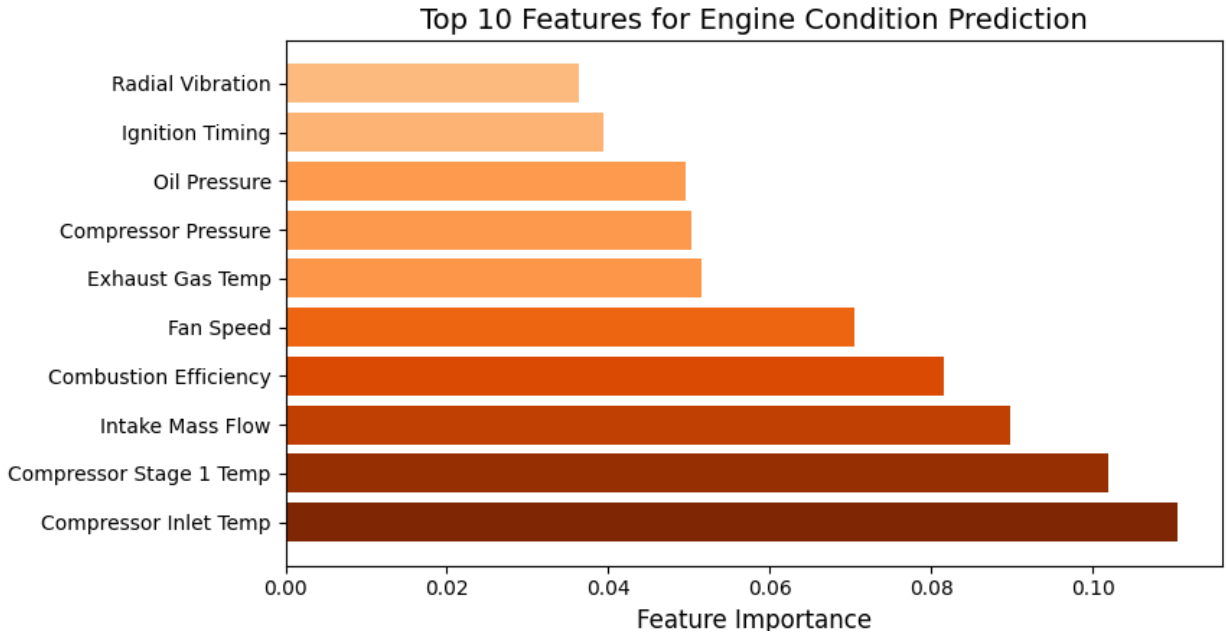


Figure. Feature importance analysis

Four algorithms were tested: CatBoost, XGBoost, Random Forest, and logistic regression. For classification, F1-score, Precision, Recall, and ROC-AUC metrics were used [6]:

$$\text{Precision} = \frac{TP}{TP + FP}, \ \text{Recall} = \frac{TP}{TP + FN},$$

$$F1 = 2 \cdot \frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}}, \ \text{ROC-AUC} = \int_0^1 \text{TPR}(FPR)\ dFPR.$$

CatBoost showed the best performance: F1 = 0.94, ROC-AUC = 0.97. XGBoost was less robust to noise, Random Forest was more interpretable, and logistic regression served as a baseline (Table).

For RUL regression, CatBoost achieved RMSE = 9.3 cycles, meaning the average prediction error was under ten cycles, which is practically applicable for maintenance planning.

Table – Model comparison results

Model	**F1-Score**	**Precision**	**Recall**	**ROC-AUC**
CatBoost	0.94	0.95	0.93	0.97
XGBoost	0.91	0.92	0.90	0.95
Random Forest	0.89	0.90	0.88	0.93
Логистическая регрессия	0.87	0.88	0.86	0.91

Predictions were plotted along the time axis: actual failure times $y(t)$ were compared with predicted $\hat{y}$. In several cases, the model provided warnings 20–30 cycles in advance, leaving sufficient time for scheduled maintenance.

The model's behavior during early degradation stages was also analyzed. Prediction accuracy decreased when signals were weak, but during later stages, when slopes and variances of features became more pronounced, the model reliably detected approaching failures.

Conclusion

The solutions developed in this study enable forecasting changes in the condition of individual components within aviation systems. Telemetry contains persistent degradation indicators that can be extracted through sliding statistics, local trends, and parameter interactions [7]:

$$\text{MA(t)}, \text{MStd(t)}, \text{b}, \rho_{XY}, \Delta\text{X(t)}.$$

In practice, the CatBoost model proved most effective, consistently predicting both failure probability and remaining engine life while providing interpretable feature importance scores. This allows engineers to understand the physical drivers behind predictions rather than relying on a "black box".

Practical advantages of this approach include:

– Early failure warnings – the model detects degradation 20–30 cycles before actual failure, enabling maintenance planning without aircraft downtime.

– Reduction of unnecessary inspections – high accuracy and low false positive rates minimize unneeded interventions.

– Robustness to noise and missing data – ensemble methods maintain stability even when telemetry is partially incomplete.

– Integration with existing systems – predictions can be updated in real time as new data become available.

Future research directions include:

– Using recurrent neural networks that can work directly with time series without manual feature construction, capturing long-term dependencies:

$$h_t = f(h_{t-1}, X_t), \qquad \widehat{y_t} = g(h_t),$$

where h_t is the hidden state at step *t*.

– Integrating external factors such as weather, flight mode, and altitude to improve prediction accuracy.

– Applying explainable AI methods to visualize prediction drivers and adjust models according to engineering logic.

Overall, the results demonstrate that intelligent technical data analysis systems can form the basis for predictive maintenance in aviation. This approach reduces operational risks, optimizes maintenance planning, and improves the overall reliability of the fleet.

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PROJECT-BASED LEARNING AND DIGITAL ECOSYSTEMS IN MODERN HIGHER EDUCATION: SYSTEMIC INTEGRATION AND STRATEGIC DEVELOPMENT PROSPECTS

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Abstract. In article examines the multidimensional integration of project-based learning methodologies into the evolving digital ecosystems of contemporary universities. The research employs a systematic approach to analyze how electronic document management systems function as the fundamental infrastructure supporting educational innovation and administrative efficiency. Through detailed case studies and theoretical analysis, the article identifies key success factors for implementing digital transformation in higher education institutions, with particular focus on overcoming psychological barriers and organizational resistance. The study demonstrates how the synergistic combination of project-based pedagogy and digital ecosystem development creates optimal conditions for preparing students for the challenges of Industry 5.0. The authors propose a conceptual framework for integrating human and machine intelligence in educational processes, emphasizing the crucial role of electronic document management systems in facilitating collaborative learning environments. The research findings highlight the importance of systemic preparation for group work, strategic management of team dynamics, and balanced assessment of individual and collective contributions in project activities. Practical recommendations are provided for educational institutions embarking on digital transformation journeys, with special attention to change management strategies and staff development programs.

Keywords: project-based learning, digital ecosystem, electronic document management, higher education transformation, collaborative learning, Industry 5.0, educational innovation, digital pedagogy, organizational change, team dynamics.

ПРОЕКТНОЕ ОБУЧЕНИЕ И ЦИФРОВЫЕ ЭКОСИСТЕМЫ В СОВРЕМЕННОМ ВЫСШЕМ ОБРАЗОВАНИИ: ИНТЕГРАЦИЯ И ПЕРСПЕКТИВЫ РАЗВИТИЯ

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Аннотация. В статье рассматривается многомерная интеграция методологий проектного обучения в развивающиеся цифровые экосистемы

современных университетов. В исследовании используется системный подход к анализу функционирования систем электронного документооборота в качестве фундаментальной инфраструктуры, поддерживающей образовательные инновации и административную эффективность. На основе подробных тематических исследований и теоретического анализа в статье определяются ключевые факторы успеха внедрения цифровой трансформации в высших учебных заведениях, с особым акцентом на преодоление психологических барьеров и организационного сопротивления. В исследовании показано, как синергетическое сочетание проектной педагогики и развития цифровой экосистемы создает оптимальные условия для подготовки студентов к вызовам Индустрии 5.0. Авторы предлагают концептуальную основу для интеграции человеческого и машинного интеллекта в образовательные процессы, подчеркивая решающую роль систем электронного документооборота в создании среды совместного обучения. Результаты исследования подчеркивают важность системной подготовки к групповой работе, стратегического управления командной динамикой и сбалансированной оценки индивидуального и коллективного вклада в проектную деятельность. Даны практические рекомендации для образовательных учреждений, вступающих на путь цифровой трансформации, с особым акцентом на стратегии управления изменениями и программы повышения квалификации персонала.

Ключевые слова: проектное обучение, цифровая экосистема, электронный документооборот, высшее образование, групповая динамика, цифровая трансформация, модели университета, групповая работа.

Introduction

The contemporary landscape of higher education is undergoing a profound transformation driven by rapid technological advancement and evolving societal needs. This paradigm shift necessitates a fundamental rethinking of traditional pedagogical approaches and institutional structures. The digital revolution has created both unprecedented challenges and remarkable opportunities for educational institutions worldwide [1]. In this context, project-based learning (PBL) has emerged as a particularly promising methodology that aligns with the demands of the modern knowledge economy, while digital ecosystems provide the necessary infrastructure to support innovative educational practices [2].

Main part

The convergence of pedagogical innovation and digital transformation represents a critical frontier in higher education development. As Kosterev A. G. and Kim M. Yu. note in their analysis of the Russian higher education system, the sector faces the complex challenge of integrating fragments of previous educational models with selectively borrowed elements from Western systems [3]. This hybrid approach, while potentially problematic in some aspects, creates unique opportunities for developing distinctive educational methodologies that combine the strengths of different traditions.

The present research aims to provide a comprehensive examination of how project-based learning can be effectively integrated into the digital ecosystems of modern universities. By analyzing empirical evidence from Russian higher education institutions and drawing on international best practices, this study seeks to develop a holistic framework for educational innovation that balances technological advancement with pedagogical effectiveness. Special attention is given to the role of electronic document management systems (EDMS) as the “circulatory system” of the university's digital infrastructure, facilitating seamless information flow and supporting collaborative learning processes [4].

The concept of the university has evolved significantly through several distinct phases, commonly categorized as University 1.0 through 4.0. University 1.0 represented the traditional teaching-centered model, focusing primarily on knowledge transmission from instructor to student. University 2.0 introduced research as a core function, creating the familiar Humboldtian model of integrating teaching and scientific inquiry. University 3.0 added the innovation and entrepreneurship dimension, emphasizing knowledge transfer and economic impact. The contemporary University 4.0 model represents an innovation-driven institution deeply integrated with industry and society, characterized by digital permeation and global connectivity [5].

This evolutionary process has been accompanied by the development of increasingly sophisticated digital ecosystems. These ecosystems encompass a wide array of interconnected components: learning management systems (LMS), research databases and repositories, administrative platforms, communication tools, and crucially, electronic document management systems. As Sannikov D. V. and Shirinkina E. V. compellingly argue, an EDMS functions not merely as a tool for automating paperwork but as the essential “circulatory system” of the entire digital organism of the university [4]. This metaphor aptly captures the critical role of document management in enabling seamless information exchange and supporting strategic digital transformation initiatives throughout the institution.

The implementation of systems like Directum RX in institutions such as Yugra State University provides a compelling case study of EDMS integration in Russian higher education. This implementation demonstrates tangible benefits including significantly increased administrative efficiency, enhanced transparency of processes, and robust support for collaborative academic activities [4]. However, this transition is frequently hindered by what the authors term “fear of uncertainty” among staff and faculty – a psychological barrier that manifests as resistance to change and must be systematically addressed through comprehensive change management strategies and targeted training programs [4].

The digital ecosystem of a modern university extends far beyond technical infrastructure. It represents a complex socio-technical system where human actors, technological tools, and institutional processes interact in dynamic ways. This perspective aligns with Simonin P.V. and colleagues' conceptualization of digital ecosystems in Industry 5.0, which emphasizes the integration of human and machine intelligence in collaborative processes [6]. In the educational context, this translates to

creating environments where pedagogical expertise (human intelligence) and digital capabilities (machine intelligence) synergize to enhance learning outcomes.

Project-based learning represents a significant departure from traditional transmission-based pedagogical models. Rooted in constructivist learning theories, PBL shifts the educational focus from passive knowledge acquisition to active, student-driven inquiry and authentic problem-solving. This methodology positions students as active constructors of knowledge rather than passive recipients of information, aligning with contemporary understanding of effective learning processes [7].

As Sannikov D. V. and Shirinkina E. V. emphasize in their research on educational technologies, project-based learning serves as a "universal tool" applicable across various stages of educational programs and disciplinary contexts [8]. Its implementation requires careful instructional design that considers both long-term learning objectives and the need for rapid team formation to address specific tasks within constrained timeframes, such as single lessons or workshop sessions [8].

The effective implementation of PBL presents several significant challenges that educators must navigate. These include forming functionally effective student teams, skillfully managing group dynamics throughout the project lifecycle, employing appropriate collaboration techniques at different learning stages, and maintaining a crucial balance between individual accountability and collective effort [8]. These challenges necessitate specialized pedagogical expertise and systematic preparation, particularly in designing and facilitating group work that maximizes learning outcomes for all participants.

Research consistently indicates that well-implemented PBL produces significant educational benefits. These include enhanced student engagement and motivation, deeper conceptual understanding of subject matter, and development of essential soft skills such as communication, leadership, critical thinking, and adaptability [9]. These outcomes align closely with the demands of the modern labor market, particularly in knowledge-intensive sectors that characterize Industry 4.0 and emerging Industry 5.0 environments. The development of these competencies makes PBL not merely a pedagogical choice but a strategic imperative for higher education institutions preparing students for complex professional landscapes.

The theoretical underpinnings of PBL connect interestingly with broader discussions about educational quality and systemic development. As noted in analyses of higher education transformations, the quality of educational processes is ultimately determined by the breadth of social demand for them and generally reflects the current level of systemic complexity of society [3]. In this context, PBL represents an educational approach particularly suited to complex, knowledge-intensive societies that value innovation, collaboration, and adaptive problem-solving.

The full potential of project-based learning is realized when it is seamlessly integrated into the university's digital ecosystem. In this integrated model, the electronic document management system evolves beyond its administrative function to become an educational platform that supports the entire project lifecycle. The EDMS can serve as the central hub for managing project documentation, tracking progress,

facilitating communication among team members and supervisors, and archiving final outcomes for future reference and assessment [4, 10].

This digital support structure effectively mitigates many of the logistical challenges traditionally associated with PBL implementation. Coordination of group work, monitoring of individual contributions, management of project timelines, and ensuring equitable participation from all team members become more manageable through appropriate digital tools [11]. When these tools are integrated within a unified ecosystem, they create a coherent and efficient project management environment that reduces administrative overhead for both students and instructors.

The integration of PBL with digital ecosystems reflects broader trends in human-technology collaboration. Simonin P. V. and colleagues, in their research on Industry 5.0, emphasize the importance of "metacognitive interaction between humans and technologies" that bridges the material world of technical systems and the intellectual world of human cognition [6]. In the educational context, this translates to creating learning environments where digital tools enhance rather than replace human pedagogical relationships, supporting what might be termed "cognitive collaboration" between students, instructors, and technology.

This perspective aligns with emerging understanding of digital ecosystems as environments that facilitate what Babkin A. V. and colleagues describe as "neuro-digital transformation" – the integration of human cognitive processes with digital capabilities [12]. While their research focuses on industrial contexts, the conceptual framework applies equally to educational settings, where the goal is to enhance human learning and creativity through appropriate technological support.

Practical examples from Russian universities demonstrate the tangible benefits of this integration. At Yugra State University, the Directum RX EDMS was implemented not only for administrative purposes but also specifically configured to support educational projects and research collaborations [4]. This adaptation required customizing the system to handle academic workflows such as thesis supervision, group project coordination, interdisciplinary research initiatives, and collaborative publication processes. The results indicated improved traceability of project progress, more efficient communication between students and advisors, and enhanced ability to document and assess the development of student competencies throughout extended projects.

The successful implementation of integrated PBL within digital ecosystems requires a comprehensive systemic approach. This involves applying principles of decomposition, hierarchy, iterativity, and local optimization to educational design and institutional development [13]. The project lifecycle in education, from initial goal-setting (initialization) through execution to final evaluation, can be productively viewed through the lens of systems theory, similar to approaches used in managing complex regional projects in other sectors such as healthcare [13].

Akhokova A. V. and colleagues, in their research on project management in healthcare, emphasize that the initial goal-setting stage represents a particularly critical phase where "deep knowledge and ability to choose proper solution for optimizing

resources" is essential [13]. They note that this stage is often characterized by significant uncertainty and requires "application of effective technological routes of implementing project work at output" [13]. These insights apply equally to educational projects, where clear initial definition of objectives, careful identification of key participants, thorough analysis of stakeholder requirements, and realistic allocation of necessary resources fundamentally determine project success.

The digital ecosystem, particularly a well-designed EDMS, can provide structured support during this crucial initialization phase. Through templates, checklists, workflow automations, and decision-support tools, the system can guide instructors and students through the process of defining projects that are both educationally valuable and practically feasible [14]. This digital scaffolding is particularly valuable for less experienced instructors or in institutions with high turnover, helping to maintain quality standards and institutional memory.

The organizational structure of the university must be aligned to support this integrated model of education. Drawing on Mintzberg's classic typology of organizational structures, successful implementation requires coordinated action across multiple organizational elements [15]. The "strategic apex" (university leadership) must champion the initiative and allocate necessary resources; the "technostructure" (IT services, educational technology support, and methodological units) must provide the necessary tools and technical support; the "middle line" (department chairs and program directors) must facilitate implementation within their units; and the "operating core" (faculty and students) must be adequately trained, supported, and motivated to engage with the new processes and tools [15].

This organizational alignment often requires significant cultural change within the institution. As research on higher education transformation indicates, many universities experience a "prolonged separation with the Soviet past" while maintaining remnants of previous models that are "increasingly inadequate to surrounding socio-economic realities" [3]. Overcoming this legacy and fostering a culture that embraces both pedagogical innovation and digital fluency represents one of the most significant challenges in implementing integrated PBL and digital ecosystems.

Several Russian universities provide instructive case studies of integrating project-based learning with digital ecosystem development. The experience of Yugra State University with Directum RX implementation offers valuable insights into both the potential benefits and implementation challenges [4]. Beyond the administrative efficiencies gained, the university specifically adapted the EDMS to support educational innovation, creating customized workflows for project-based courses, undergraduate research initiatives, and interdisciplinary collaboration.

The implementation process revealed several critical success factors. Comprehensive training programs for both faculty and students proved essential for overcoming resistance and building digital fluency. The development of clear protocols and standards for digital project management helped create consistency across different departments and courses. Perhaps most importantly, the university leadership

maintained strategic commitment to the digital transformation throughout the implementation process, even when facing technical challenges and organizational resistance [4].

Another instructive example comes from Kabardino-Balkarian State University, where researchers have developed sophisticated approaches to project management in educational contexts. Akhokova A. V. and colleagues have explored the creation of "working prototype models" for project management that emphasize iterative development and systematic optimization [13, 16]. Their research highlights the importance of what they term "coarse approximation" – initial simplified models that are progressively refined through implementation experience [16]. This approach offers a valuable methodology for other institutions seeking to implement complex educational innovations.

The integration of PBL with digital tools also aligns with broader national initiatives in Russian higher education. As noted in analyses of recent reforms, Russian universities are navigating complex challenges related to "mythologization of Soviet and fetishization of Western" educational models [3]. The development of distinctive approaches that combine project-based methodologies with digital ecosystem development represents a promising path toward educational models that are both globally informed and contextually appropriate.

These case studies demonstrate that successful implementation requires attention to multiple dimensions simultaneously: technological infrastructure, pedagogical design, organizational support, and cultural change. Isolated initiatives focusing on only one of these dimensions are unlikely to achieve transformative results. The most successful implementations adopt a holistic approach that recognizes the interconnectedness of these different elements.

The integration of project-based learning with advanced digital ecosystems points toward the emergence of what might be termed "Education 5.0" – learning environments that fully leverage the potential of human-machine collaboration to enhance educational outcomes. This evolution parallels developments in Industry 5.0, which emphasizes "human-centric, sustainable and resilient" systems that leverage human creativity and intelligence in collaboration with advanced technologies [6, 12].

In educational contexts, this vision implies learning environments where digital tools handle routine administrative tasks, provide intelligent support for collaboration, and offer personalized learning pathways, while human instructors focus on facilitating deep learning, mentoring students, and designing meaningful educational experiences. This division of labor allows each element – human and machine – to focus on what they do best, creating synergistic effects that enhance overall educational quality.

The conceptual model of neuro-digital ecosystems proposed by Babkin A. V. and colleagues for industrial contexts offers intriguing possibilities for educational application [12]. Their framework emphasizes the integration of "neuro-digital platforms" that enable "meta-cognitive interaction between people and technologies" [12]. In education, this could translate to systems that adapt to individual learning

patterns, support collaborative problem-solving, and provide intelligent scaffolding for complex projects.

Future developments in this area will likely include more sophisticated learning analytics integrated with project management tools, AI-assisted formation of student teams based on complementary skills and learning styles, and intelligent systems for monitoring group dynamics and identifying teams that need facilitation support. These technological advancements, properly integrated with sound pedagogical principles, have the potential to significantly enhance the effectiveness of project-based learning while reducing the administrative burden on instructors.

However, these technological possibilities must be balanced with thoughtful consideration of educational values and human relationships. As research on digital transformation emphasizes, technology should enhance rather than replace the essential human elements of education – mentorship, inspiration, and the development of wisdom and character [3, 17]. The most successful implementations of integrated PBL and digital ecosystems will be those that leverage technology to strengthen rather than supplant human pedagogical relationships.

Conclusion and Recommendations

The integration of project-based learning into the digital ecosystems of universities, with electronic document management systems serving as foundational infrastructure, represents a powerful strategy for enhancing the quality, relevance, and efficiency of higher education. This approach fosters the development of both disciplinary knowledge and essential 21st-century skills, preparing students for the complex challenges of contemporary professional environments.

However, successful implementation requires a holistic, systemic approach that encompasses multiple dimensions: robust technological infrastructure, thoughtful pedagogical redesign, aligned organizational structures, supportive institutional policies, and meaningful cultural change. Overcoming psychological resistance and the "fear of uncertainty" represents a critical challenge that requires strong leadership, comprehensive communication, continuous professional development, and visible support for innovation.

Based on the analysis presented in this study, several specific recommendations emerge for institutions pursuing this path:

1. Develop a comprehensive digital strategy that explicitly connects technological infrastructure with pedagogical innovation, ensuring that system design supports educational goals rather than dictating them.

2. Implement phased adoption plans that allow for iterative refinement based on user feedback and evolving understanding of both technological and pedagogical requirements.

3. Invest significantly in professional development that builds both digital fluency and pedagogical expertise among faculty, recognizing that technological tools are only effective when wielded by skilled practitioners.

4. Create cross-functional implementation teams that include representatives from IT services, academic departments, administrative units, and student bodies to ensure that multiple perspectives inform system design and implementation.

5. Develop clear metrics for success that capture both educational outcomes and operational efficiencies, allowing for evidence-based refinement of implementation strategies.

6. Foster a culture of innovation and collaboration that rewards experimentation, shares best practices across departments, and views challenges as opportunities for learning and improvement.

The journey toward fully integrated project-based learning and digital ecosystems is complex and demanding, but the potential benefits for student learning, institutional effectiveness, and broader societal impact make it a worthwhile investment. As higher education continues to evolve in response to technological change and shifting societal needs, institutions that successfully navigate this integration will be best positioned to thrive in the emerging educational landscape.

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APPLICATION OF PRINCIPLES OF PERCEPTIVE PSYCHOLOGY IN VISUAL DESIGN

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Abstract. In the face of digital overload, design's ability to attract, hold, and direct user attention is critical. This article presents a comprehensive study of the application of perceptual psychology principles to visual design. It provides a detailed analysis of the key theoretical foundations of Gestalt psychology, the cognitive mechanisms of perception, and the psychosemantics of color and shape. The goal of the work is to demonstrate that relying on the laws of human perception enables a shift from subjective aesthetic creativity to the design of evidence-based, intuitive, and emotionally engaging digital products. This article is intended for designers, UX/UI researchers, marketers, and all professionals involved in creating user experiences.

Keywords: perceptual psychology, visual design, gestalt principles, user experience (UX), usability, cognitive load, visual hierarchy, psychology of color, psychology of forms.

ПРИМЕНЕНИЕ ПРИНЦИПОВ ПЕРЦЕПТИВНОЙ ПСИХОЛОГИИ В ВИЗУАЛЬНОМ ДИЗАЙНЕ

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Аннотация. В условиях цифровой перегрузки способность дизайна привлекать, удерживать и направлять внимание пользователя становится критически важной. Данная статья представляет собой комплексное исследование применения принципов перцептивной психологии в сфере визуального дизайна. Проводится детальный анализ ключевых теоретических основ гештальт-психологии, когнитивных механизмов восприятия и психосемантики цвета и формы. Цель работы – продемонстрировать, что опора на законы человеческого восприятия позволяет перейти от субъективного эстетического творчества к проектированию доказательно эффективных, интуитивно понятных и эмоционально вовлекающих цифровых продуктов. Статья адресована дизайнерам, UX/UI-исследователям, маркетологам и всем специалистам, занимающимся созданием пользовательского опыта.

Ключевые слова: перцептивная психология, визуальный дизайн, гештальт-принципы, пользовательский опыт (UX), юзабилити, когнитивная нагрузка, визуальная иерархия, психология цвета, психология форм.

Modern people are confronted daily with a gigantic volume of visual information: from smartphone and website interfaces to public navigation and advertising banners. Amidst this informational clutter, the product or service that makes interaction as seamless and intuitive as possible wins. Visual design is no longer just decoration; it has become a key communication tool between businesses and users.

However, creating “intuitive” design isn't a matter of innate talent or artistic taste. It's a science based on an understanding of how the human brain works. Perceptual psychology, which studies the processes of perceiving sensory information, provides designers with a solid foundation. The brain isn't a passive recipient of data; it actively filters, organizes, and interprets visual stimuli, relying on deeply ingrained, often unconscious, patterns and heuristics.

Driven by growing competition in digital markets and increasing user demands for simplicity and convenience, design based on psychology isn't a luxury, but a competitive advantage that enables the creation of products that are not only used but also loved.

Let's discuss the foundation of our discussion – Gestalt psychology. Emerging in the early 20th century, it postulated that humans perceive the surrounding world not as a collection of individual elements, but as holistic structures, images (from the German Gestalt – “form”, “image”). Our brain is evolutionarily programmed to seek order in chaos. This tendency to organize information is a mechanism of cognitive economy – a way to reduce mental effort (mental effort) to make quick decisions [1].

For a designer, this means that a chaotic, disorganized composition is perceived as “noise” and requires significant effort from the user to decode, causing discomfort and rejection. In contrast, a design built on Gestalt principles feels correct, understandable, and aesthetically pleasing, as it aligns with the brain's internal expectations. Nowadays, with the pernicious influence of social media, this has become especially noticeable: users don't like to think or search for complex meanings – they want everything “here and now”, otherwise they might dismiss anything as “unattractive” design or content. For modern designers, the ability to find the most essential, relevant, and simple images is almost an innate skill. This is especially true if they want their work to pay off and be in demand. Leading the crowd and experimenting is rare.

Let's look at each principle of perceptual psychology not superficially, but with a deep dive into its variations and nuances of application [2].

Proximity Principle

The point: Objects that are close to each other are perceived as a coherent group, while objects that are far apart are perceived as separate, independent units.

Practical application:

1. Forms and data entry: the most classic example. Grouping the “Email” and “Password” fields together with the “Login” button visually unites them into a single

“Login Form” block. The distance between this group and, for example, the “Forgot your password?” or “Register” links should be visually larger to differentiate them.

2. Navigation and menus: In a horizontal menu, the distance between items within the menu (e.g. Home, About Us, Services) should be less than the distance between the entire menu and the logo or search bar.

3. Product or post cards: In a product or blog feed, each product/post is a group of elements: image, title, description, price, button. Ensure that the internal padding within the card is smaller than the padding between the cards themselves. This prevents information from different cards from being “stuck together”.

Principle of Similarity

The idea is that elements that have similar visual characteristics (color, shape, size, orientation, texture) are perceived as belonging to the same class or having the same function.

Practical application:

1. Clickable Element System: All links in the text are formatted in the same color and possibly underlined. All interactive buttons have a consistent style (fill color, rounded corners). This creates an instantly recognizable pattern: “This element can be clicked”.

2. Visual hierarchy: Headings of the same level (H2) are formatted identically (size, weight, color), immediately indicating their equal importance. This helps users scan the page and understand its structure.

3. Distinguishing categories: on the map, different types of objects (restaurants, hotels, attractions) can be marked with icons of the same shape but different colors. Color becomes a grouping feature.

Closure Principle

The gist: when we see a complex or incomplete figure, our brain strives to mentally “complete” it into a simple, coherent form. We prefer complete forms to disjointed parts.

Practical application:

1. Logos: The famous logos of WWF (panda), IBM, and NBC utilize the principle of closure. We see not a collection of lines and spots, but a complete image. This makes the logo memorable and intellectually engaging (the user involuntarily becomes a participant in the perceptual process).

2. Interface icons: Many minimalist interface icons (for example, the triangle-shaped “play” icon) are not filled with a solid color, but rather outlined. The brain easily completes this shape.

3. Composition and Negative Space: A designer can deliberately use negative space to create hidden images, which adds depth and interest to a design.

Continuity Principle

The gist: the eye prefers movement along a smooth, continuous line or curve, rather than abrupt jumps or breaks. Elements arranged in a line or curve are perceived as connected.

Practical application:

1. Scrolling and layout: Arranging cards in a horizontal slider or elements in a long vertical ribbon naturally directs the user's eye. A line or row acts as a visual guide.

2. Navigation paths: on landing pages (landing page) content is often built on the principle of continuity, leading the user from the title to the description, then to the benefit blocks and, finally, to the key call to action (CTA).

3. Charts and Infographics: Lines in graphs and charts use continuity to show the relationship between data points or elements of a system.

Figure - Ground Principle

The gist: perception automatically divides the visual field into an object (figure), which is in the foreground and attracts the main attention, and the surrounding background (background), which recedes back.

Practical application:

1. Text readability: the most critical example is the contrast between the text (figure) and the background. Insufficient contrast makes the text unreadable, as the brain has difficulty separating the figure from the background.

2. Modal windows and popups: When a modal window appears on the screen, the rest of the interface dims or blurs, becoming the background. This clearly indicates that the window is the active element for interaction.

3. Complex compositions in branding: A classic example is the FedEx logo , where the negative space between the letters “E” and “x” forms an arrow. The arrow becomes a figure emerging from the background, conveying ideas of speed and precision.

Common Zone Principle

The gist (a more modern addition): Elements within a clearly defined area (e. g., in a frame, on a colored background, in a separate panel) are perceived as grouped.

Practical application:

1. Card design (Card UI): this principle has become dominant in modern web design. Each card (for example, on Pinterest, Facebook, Twitter) represents a “common area” that groups all the information about a single post, product, or pin.

2. Grouping settings: In control panels or forms with many fields, settings related to one topic (for example, “Privacy Settings”) are placed in a separate shaded panel or block with a heading.

Visual organization is only the first step. The second, no less important, is managing the user's limited cognitive resources. An overloaded interface leads to cognitive overload, frustration, and abandonment [3].

Hick-Hyman Law: Less is faster

Decision-making time increases linearly with the number and complexity of alternatives. Each additional choice requires the brain to process additional information, which takes time and mental energy. The paradox of choice: Psychologist Barry Schwartz has shown that an excess of options not only slows down decision-making but also increases anxiety and reduces satisfaction with the chosen option (after making a purchase, a person becomes more doubtful about whether they made the right choice).

Practical strategies:

1. Reduce menu items: Limit the main menu to 5-7 key items. Less important items can be moved to the website footer or a hamburger menu.

2. Progressive disclosure (Progressive Disclosure: This is a fundamental principle. Don't show the user everything at once. Provide information and options as needed. For example: multi-step forms (step 1: personal information, step 2: address, step 3: payment), using accordions (hidden blocks) for additional, optional information, and hiding complex settings under the “More” or “Advanced Settings” button.

3. Defaults (Smart Defaults: Pre-fill forms with the most likely values. This eliminates the need for users to make unnecessary selections (for example, pre-fill “1 guest, 1 room” in a hotel booking form).

Restorff effect (isolation effect)

An object that stands out most from its similar neighbors (by color, shape, size, etc.) is most likely to be remembered. The brain is evolutionarily tuned to detect anomalies in a homogeneous environment, as they can signal danger or opportunity.

Deep analysis for design:

1. Creating a visual hierarchy: This is the main tool for directing attention. The most important element on the page should be “isolated” from the rest by one or more parameters.

2. Call – to – Action (CTA) design: The CTA button is a classic object for applying the Restorff effect .

3. Color: Use of a contrasting, accent color that is not found anywhere else in the interface in such quantity.

4. Size: Make it big enough, but not gigantic (hyperbole can cause rejection).

5. White space: Provide enough “air” around the button so that it is visually separated from other elements.

6. Emphasizing discounts and special offers: highlighting prices or specific products in the catalog in color, bold font, or with a special badge (“-50 %”, “Hit!”).

7. Important notifications: Error messages (red), success messages (green), or system warnings should visually contrast with the background and other content [4].

Visceral reactions and aesthetically- usable effect

Psychologist Don Norman introduced the concept of “visceral reactions” – instantaneous, subconscious emotional responses to external stimuli (in our case, design). This ”like/dislike” reaction occurs in the first milliseconds of viewing. Aesthetic – usability effect The "appreciation effect" is when beautiful interfaces are perceived by users as easier to use. A positive emotional response to aesthetics makes users more tolerant of minor usability flaws and builds initial trust.

Deep analysis for design:

1. First impressions matter: design should evoke a positive visceral reaction from the very beginning. This creates a favorable context for all subsequent interactions.

2. Visual Content Quality: use high-quality, professional photography, selected for style and meaning. Services like Airbnb or Apple do this brilliantly – their interfaces invite you to touch, explore, and immerse yourself in them.

3. Cleanliness and Order: a neat grid, precise margins, harmonious typography, and sufficient negative space are subconsciously perceived as professionalism,

reliability, and order. Chaos and “visual noise”, on the other hand, are associated with unprofessionalism and unreliability.

And now we come to the most popular. Color and shape are powerful tools of nonverbal communication. They carry deep cultural and psychological connotations, capable of instantly conveying messages and shaping emotional context. Color influences mood, behavior, and brand perception. Its impact is threefold:

1. Physiological: some colors (red, orange) can increase heart rate and excitement, while others (blue, green) can calm you down.
2. Cultural: The meanings of flowers vary greatly across cultures.
3. Associative: colors evoke personal and general associations (blue – sky, sea; green – grass, nature).

The importance of cultural context: White is the color of weddings and purity in Europe, and the color of mourning in some Asian countries. Red is the color of good luck and happiness in China, and the color of grief in South Africa. Cross-cultural research is essential for international products [5].

Shapes, like colors, speak their own language, conveying a brand's character and values. And here too, everything is intuitive. Round shapes are most often chosen for children's clinics, animal-related projects, or foundations. Sharp shapes are associated with business , science, fashion, or high class [6].

In conclusion, I would like to say that the application of perceptual psychology principles in visual design is a manifesto for a scientifically grounded approach to digital product creation. It represents a shift from the designer-artist to the designer-architect of human experience. We examined how Gestalt principles provide clarity and organization, how cognitive laws help carefully manage user attention [7], and how the psychosemantics of color and shape foster deep emotional connections and trust.

This approach enables the creation of interfaces that not only solve problems but also make the process enjoyable, efficient, and intuitive. In an era where usability is becoming a key differentiator, a deep understanding of perceptual psychology is no longer an optional skill but a mandatory competency for any designer striving to create truly meaningful and successful products. The future of design lies in interdisciplinarity, at the intersection of aesthetics, technology, and an uncompromising understanding of human nature.

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DEVELOPMENT OF A DIGITAL TWIN ARCHITECTURE FOR COMPLEX MONITORING OF RAILWAY INFRASTRUCTURE AND POWER EQUIPMENT

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Abstract. The presented article proposes a multi-level architecture of a digital twin for integrated monitoring of railway and energy infrastructure. A methodology for integrating heterogeneous data based on time synchronization and unified formats has been developed. The scientific novelty is confirmed by the creation of a system of interdependent digital twins with cross-domain interaction. The practical significance of the work lies in the possibility of introducing Russian Railways and ROSSETI into digital transformation projects to transition to predictive maintenance and improve the safety of the transportation process.

Keywords: digital twin, railway infrastructure, power system, system analysis, diagnostics, monitoring, forecasting, automation.

РАЗРАБОТКА АРХИТЕКТУРЫ ЦИФРОВОГО ДВОЙНИКА ДЛЯ КОМПЛЕКСНОГО МОНИТОРИНГА СОСТОЯНИЯ ЖЕЛЕЗНОДОРОЖНОЙ ИНФРАСТРУКТУРЫ И ЭНЕРГЕТИЧЕСКОГО ОБОРУДОВАНИЯ

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Аннотация. В представленной статье предложена многоуровневая архитектура цифрового двойника для комплексного мониторинга железнодорожно-энергетической инфраструктуры. Разработана методика интеграции разнородных данных на основе временной синхронизации и унифицированных форматов. Научная новизна подтверждена созданием системы взаимозависимых цифровых двойников (System-of-Digital-Twins) с кросс-доменным взаимодействием. Практическая значимость работы

заключается в возможности внедрения в проекты цифровой трансформации ОАО «РЖД» и ПАО «Россети» для перехода к предиктивному обслуживанию и повышения безопасности перевозочного процесса.

Ключевые слова: цифровой двойник, железнодорожная инфраструктура, энергосистема, системный анализ, диагностика, мониторинг, прогнозирование, автоматизация.

Digitalization of the transport and energy infrastructure of the Russian Federation is a strategic direction of state policy, enshrined in the programs “Digital Economy” and “Integration of digital technologies into industry and transport” [1]. Within the framework of this course, a key role is assigned to the introduction of end-to-end technologies that can provide a synergistic effect from the integration of physical and information assets. Of particular importance in this area is the concept of a digital twin (CD), a dynamic virtual model of a physical object or system that allows real time analysis, prediction and optimization of its condition [2]. Unlike static digital models, a digital twin involves continuous two-way data exchange, which allows not only to reflect the current state of the facility, but also to conduct advanced simulation of various scenarios of its operation.

Figure 1 shows the generalized architecture of the digital twin information model.

The digital twin information model is the central element of the entire system. It is a digital copy of a real object, process, or system.

For a digital twin to work, data is needed that comes from various information systems. This data includes technical parameters, performance indicators and other important information about the condition of the facility.

The digital twin services perform modeling and analysis of the received data. They help predict the behavior of an object, conduct simulations, and analyze various work scenarios [3].

Organizational and technological solutions include management techniques, technological regulations, and operational standards that determine how the system should work.

Based on the analysis, analytical reports are generated that contain modeling results, forecasts, and recommendations for optimizing work. Users can send requests to the system to obtain specific information or perform special calculations.

The system also provides data for managing an object, process, or system – these are control commands and recommendations for optimal operating modes.

All this allows you to monitor and manage the state of a real object, process, or system, constantly comparing it with a digital model and making necessary adjustments to the operating mode [4].

Railway transport and energy represent a closely interrelated technological symbiosis. The condition of the track, contact network and power supply directly determines the safety and stability of the transportation process, forming a single cyber-physical complex. However, traditional diagnostic systems for the path and equipment of electric power grids have historically developed and function separately, which creates “information gaps” and complicates complex analysis and predictive maintenance. This leads to a situation where diagnostics of the mechanical parameters

of the path and monitoring of the power system modes are carried out in isolation, without taking into account their mutual influence. The solution to this problem is to create an integrated digital twin of the railway and energy infrastructure, combining data from sensors, telemetry systems, SCADA platforms and intelligent analysis modules in a single information and analytical circuit [5].

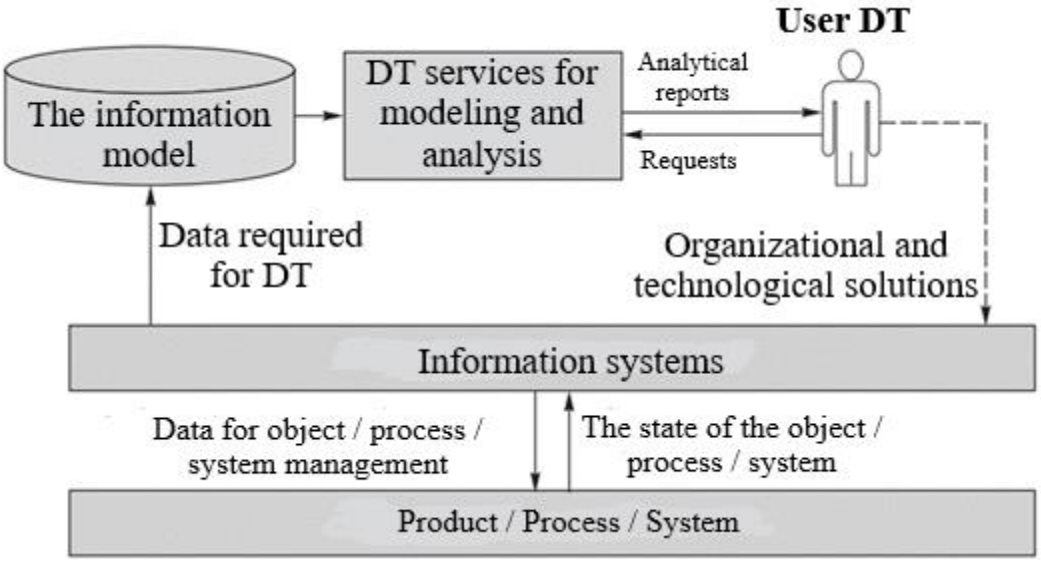


Figure. Generalized architecture of data centers for objects

The relevance of developing such integrated systems increases many times under the influence of a number of factors. Increasing traffic intensity and weight loads on rolling stock, the progressive aging of infrastructure, and the strategic transition from planned preventive to Condition-Based Maintenance models require the creation of intelligent systems capable of combining heterogeneous data and forming reliable digital representations of infrastructure facilities. These challenges are confirmed by objective data: according to Russian Railways, the wear of the upper structure of the track in a number of strategically important areas exceeds 50 %, and the share of contact network equipment with expired service life reaches 40 % [6]. At the same time, the energy component of the railway complex, which is under the jurisdiction of PJSC ROSSETI and PJSC FGC UES, is also experiencing significant stress due to the sharply variable and uneven schedules of traction consumption, which creates additional risks for the stability of the energy system as a whole [7].

The conducted system analysis shows that the key problem hindering the improvement of the management efficiency of this complex system is the structural fragmentation of information flows. Data on track geometry, inertial loads, traction current and voltage parameters, and equipment thermograms are generated in various, often incompatible formats, departmental standards and are not consolidated into a single time-coordinated model. This creates a “Data Silos” effect, when information exists in isolated repositories, which makes it impossible to conduct a comprehensive correlation and cause-effect analysis. As a result, the lack of a complete digital twin leads to delayed diagnostics, inefficient planning of repair campaigns, and, as a result, increased operational risks and unproductive costs. Thus, the task of synthesizing an

architecture that overcomes this fragmentation is not only a technical, but also an important economic problem.

Theoretical foundations of building digital doubles of infrastructure systems

The concept of a digital twin is based on the principles of system analysis and cyber-physical systems [7]. System analysis provides a methodological framework for studying a complex object as a whole, identifying the relationships between its components and the external environment, while cyber-physical systems act as a technological foundation, ensuring the fusion of computing resources and physical processes into a single control loop. In this paradigm, a digital twin is not just a static digital copy, but a dynamic, time-evolving system [8]. It can be considered as an interconnected three-component structure, where each element performs a strictly defined function.:

1. *A physical entity is a real object* (a section of track, transformer, substation) equipped with sensors, actuators, and telemetry tools that form its “nervous system”. It is important to emphasize that a physical object exists in conditions of uncertainty, stochastic external influences (weather, load) and natural wear and tear.;

2. *A virtual model* is not a passive digital representation, but a complex mathematical and visual representation with state parameters, including:

a) *Deterministic models* based on the laws of physics (for example, equations of carriage dynamics, models of electromechanical transients in the power system);

b) *Statistical and empirical models* based on historical data and reflecting patterns of degradation of materials and equipment;

c) *A visual component* that provides an intuitive perception of the spatial location of objects and their current metrics.

This model is the computational core of the twin, where simulation experiments are carried out that are impossible or expensive in the real world.

3. *Real–time data communication* is not just a transmission channel, but a two-way flow of information between the physical and virtual levels, closing the cyber-physical circuit. The direct flow (from the physical object to the model) ensures its constant updating and calibration, and the reverse flow (from the model to the object) allows you to transfer control actions or optimal operating scenarios, thus implementing predictive and adaptive control [9].

For railway and energy infrastructure systems characterized by distribution, scale, and high process dynamics, the basic three-component concept is transformed into a multi-level architecture. Such an architecture should include not only data collection, processing, storage, analysis, and visualization, but also mechanisms to ensure their integrity, security, and semantic compatibility. A critically important aspect is the mutual synchronization and interaction not of individual data, but of entire digital counterparts of various technological subsystems. For example, a digital twin of a railway track that analyzes dynamic loads from rolling stock must take into account the operating mode of traction substations and energy consumption parameters in real time, since voltage surges or frequency "subsidence" can directly affect the traction characteristics of locomotives and, as a result, the mechanical effects on the track. This forms a system of interdependent digital twins, where the output parameters of one

twin are the input effects for the other, which requires the development of coordinated models and protocols of inter-model interaction based on a single temporal basis and domain ontologies [10].

Architecture of the digital twin of the railway and energy infrastructure

The proposed architecture of the digital twin (Table 1) consists of four levels providing end-to-end interaction between the physical and analytical data space. This multi-level organization is not just a set of individual components, but an integrated system with well-defined interfaces and communication protocols, which ensures scalability, fault tolerance and security of the entire complex.

Table 1 – The structure of the architecture levels of the digital twin

Level	Main components	Data sources	Functions
Physical	Path geometry sensors, accelerometers, trackers (position sensors), voltage and current sensors, weather stations	Path Diagnostics system, SCADA-power supply system	Real-time primary data collection
Informational	Communication channels, IoT Gateways (IIoT), MQTT/IEC 61850 protocols	Servers of JSC "Russian Railways" and PJSC "Rosseti"	Data transmission and filtering, time synchronization
Analytical	Data processing platform (Spark, domestic analogues), machine learning algorithms	Archived and streamed data	Anomaly detection, failure prediction, risk assessment
Applied	Web interfaces, dashboards, reporting modules	End users (operators, engineers)	Visualization of the state and decision-making

The presented multi-level architecture of the digital twin forms an integrated cyberphysical system in which each level performs a strictly defined function, providing an end-to-end data flow from physical sensors to decision support systems.

The key advantage of this architecture is:

- End-to-end integration of heterogeneous data from the departmental systems of JSC Russian Railways and PJSC ROSSETI;
- Scalability due to modular construction of each level;
- Adaptability to changing operating conditions;
- Compliance with the principles of Industry 4.0 and the requirements of digital transformation.

The architecture makes it possible to overcome the traditional disconnection of monitoring systems and create a single information space for managing the railway and energy complex based on the principles of predictive analytics and a systematic approach. Of particular importance is the possibility of implementing end-to-end diagnostic processes that take into account the mutual influence of mechanical and electrical parameters of equipment.

The prospects for the development of architecture are associated with the introduction of domestic platform solutions for data processing and the strengthening of the role of artificial intelligence in predictive analytics tasks, which corresponds to the strategic directions of technological sovereignty and import substitution in critical infrastructure.

Data integration and analysis methods

The key task in building a digital twin is to combine heterogeneous data: inertial measurements, path geometry parameters, current loads and voltages. For this purpose, a unified information space is used, based on the principles of Data Lake and Data Fabric, which provides not only consolidation, but also semantic consistency of heterogeneous data. A special feature of the proposed approach is the creation of a multi-level data normalization system, including procedures for verifying authenticity and automatic replenishment of metadata.

Table 2 – Examples of combined data in a digital twin system

A source	Parameter	Refresh rate	Purpose of the analysis
Acceleration sensor (measuring car)	Acceleration, rolls, vibrations, railway track parameters	100 Hz	Diagnostics of defects in elements and malfunctions of the railway track
The modular component of the CD path	The state of the infrastructure	1-10 s	Analysis of railway track condition
Inspections	The state of the infrastructure	4 times a month	Virtual diagnostics of railway infrastructure
Geometric scanner	Geometry of the path	1 Hz	Control of the geometry of the path
Substation SCADA System	Voltage, Current, Frequency, Alarms	1–10 s	Analysis of the state of the power system
Weather station	Temperature, humidity, precipitation	10 minutes	Correlation of defects with weather conditions

The analysis of the data combined in the digital twin system demonstrates the fundamental possibility of creating a comprehensive time model of the infrastructure condition. Of particular importance is the multi-speed nature of incoming data, from high-frequency inertial measurements (100 Hz) to relatively slow meteorological

parameters (0,0017 Hz). Such polymodality requires the use of special time interpolation algorithms and multiscale analysis methods.

The key advantage of integrating the presented data is the ability to identify cross-domain dependencies, for example:

- correlation of the dynamic parameters of the path with the operating characteristics of the power system;
- establishment of dependencies of degradation of the contact network on climatic influences;
- identification of complex failures that manifest themselves simultaneously in mechanical and electrical parameters.

A promising direction for the development of the system is the introduction of machine learning methods for transferring knowledge between different parts of the infrastructure, as well as the creation of adaptive hybrid models combining physical principles with data-based machine learning approaches.

The integration of these data makes it possible to form a single time series of the infrastructure state, which makes it possible to use forecasting models based on regression, decision trees and recurrent neural networks (within the framework of domestic data analysis platforms). Ensemble approaches that combine different types of models to increase the accuracy and stability of forecasts demonstrate particular effectiveness.

Methodology of system analysis and diagnostics

The methodological basis of the research is based on the principles of system analysis: integrity, hierarchy, feedback and adaptability. In the context of railway and energy infrastructure, the principle of integrity is manifested in the need to consider the track, contact network and energy supply as a single technological complex, where a change in the state of any element causes cascading effects throughout the system. Hierarchy implies a multi-level representation of the infrastructure, from the macro level of network topology to the micro level of track defects and insulators.

The feedback principle is implemented through closed control loops, where diagnostic data directly affects operational decisions, and the principle of adaptivity ensures the system's ability to rebuild diagnostic algorithms in response to changes in external conditions and operating modes. In relation to the railway and energy infrastructure, this means that diagnostics must take into account the mutual influence of mechanical and electrical parameters through the establishment of cross-domain correlations.

The methodological feature of the proposed approach is the application of the apparatus of the theory of complex systems to formalize the relationships between subsystems. This allows us to move from traditional point–to-point monitoring to a comprehensive assessment of the state of the infrastructure based on the analysis of system invariants – stable relationships between parameters, the violation of which signals the development of defects.

For example, a short-term voltage drop at a traction substation can lead to a change in dynamic loads on the trackbed, which is detected by inertial sensors of the track. Within the digital twin, such relationships are identified automatically and become the basis for Causal Analysis models. To establish causal relationships, it is

proposed to use methods of boundary causal models (Structural Causal Models), which make it possible to distinguish real causal relationships from statistical correlations.

Of particular importance in the methodology is the principle of predictivity, implemented through the creation of advanced models of degradation of infrastructure elements. These models are based on the analysis of trajectories of parameter changes over time and allow predicting the moment when critical states are reached, taking into account the mutual influence of various factors. Thus, the rate of accumulation of fatigue damage to the rail bed can be adjusted taking into account the predicted modes of energy consumption and climatic influences.

The methodology provides for an iterative diagnostic process, where the analysis results continuously refine models and algorithms, creating a self-learning system. This ensures continuous improvement of diagnostic accuracy and adaptation to the changing operating conditions of the complex.

Scientific novelty and practical significance

The scientific novelty of the research lies in the following fundamental provisions that expand the methodological framework for building digital twins for complex infrastructural systems:

– development of a unified digital twin architecture that integrates monitoring of the path and the power system, based on the System-of-Digital-Twins concept. A special feature of the approach is the implementation of cross-domain interaction mechanisms that allow taking into account the mutual influence of electromechanical processes in real time. Unlike well-known solutions, the architecture provides for the creation of a single information core that ensures the semantic consistency of heterogeneous data.;

– the proposal of a methodology for integrating different types of data based on time synchronization and unified formats, including a multi-level data normalization and verification system. The technique is based on the use of adaptive temporal aggregation algorithms that take into account the multi-speed nature of information flows, from high-frequency inertial measurements to operational data of the power system.;

– formalization of a system model of interaction between physical and virtual infrastructure levels through the development of a domain ontology that establishes semantic relationships between railway and energy complex facilities. The model includes a formal description of the cause-and-effect relationships between the parameters of various technological systems.

The practical significance of the research is determined by the possibility of direct implementation of the developed solutions in the operational activities of infrastructure companies:

– improving the accuracy of diagnostics of track defects and power equipment through a comprehensive analysis based on the identification of cross-domain correlations. This allows you to switch from reactive to proactive maintenance, predicting the development of defects in the early stages.;

– reduction of unplanned repairs and energy losses through optimization of operating modes and planning of repair campaigns based on predictive models. The implementation of this approach ensures a reduction in operating costs by at least 15-

20 % by increasing repair intervals and minimizing downtime.;

– the possibility of using architecture in projects of digital transformation of JSC Russian Railways and PJSC ROSSETI as a technological foundation for creating a unified information space for infrastructure management. The developed solutions meet the requirements of industry standards and can be integrated with existing diagnostic and monitoring systems.

Conclusion

The development of a digital twin architecture for railway and energy infrastructure is a key step towards intelligent management of complex technical systems. The presented approach makes it possible to combine data on the mechanical and electrical condition of objects, implement predictive maintenance and improve the safety of the transportation process. The most important achievement of the conducted research was overcoming the traditional disconnection of monitoring systems through the creation of a single information and analytical space based on the principles of system analysis and technologies of cyberphysical systems.

Of particular importance is the developed mechanism of cross-domain correlation of parameters, which makes it possible to identify complex cause-and-effect relationships between the operating modes of power equipment and the dynamic characteristics of the path. This opens up opportunities for the transition from traditional preventive maintenance to adaptive models that take into account the actual technical condition of the infrastructure and the projected trajectory of its degradation.

A promising area of further research is the creation of a domestic platform for modeling and visualizing digital twins using Russian data storage and analysis technologies that meet information security requirements. The development of such a platform should include the creation of specialized tools for working with multi-speed time series, the implementation of machine learning algorithms for transferring models between infrastructure facilities, as well as the development of explicable artificial intelligence methods for interpreting predictive analytics results.

The key technological challenges in the way of practical implementation are ensuring stable operation in conditions of incompleteness and asynchrony of data, the creation of effective mechanisms for processing information in real time, as well as the development of adaptive algorithms capable of taking into account changing operating conditions of the infrastructure. Solving these tasks will create the basis for building a new generation of critical infrastructure management systems that correspond to the Industry 4.0 paradigm and ensure the technological sovereignty of the Russian Federation in the field of transport and energy systems.

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CURRENT TRENDS IN COMPUTER MODELING METHODS: A LITERATURE REVIEW

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Abstract. The article provides a literature review to identify the main directions of development of computer modeling methods and determining the current trends and in-demand technologies. The review includes 19 articles published in the period from 1990 to the present. The publications were analyzed, key methods described in the sources were highlighted, and trends in the development of computer modeling were identified. The issues of the expansion of capabilities and the broadening scope of applications of computer modeling methods are examined.

Keywords: computer modeling, methods, artificial intelligence, numerical methods, interdisciplinarity, algorithms.

СОВРЕМЕННЫЕ ТРЕНДЫ МЕТОДОВ КОМПЬЮТЕРНОГО МОДЕЛИРОВАНИЯ: ЛИТЕРАТУРНЫЙ ОБЗОР

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Аннотация. В статье приведен обзор литературы для выявления основных направлений развития методов компьютерного моделирования и определения современных трендов и востребованных технологий. Обзор включает 19 статей, опубликованных в период с 1990 года по настоящее время. Был проведен анализ публикаций, выделены ключевые методы, описанные в источниках, определены тренды развития компьютерного моделирования. Текущий обзор предлагает рассмотреть вопросы о расширении возможностей и сферах применения методов компьютерного моделирования.

Ключевые слова: компьютерное моделирование, методы, искусственный интеллект, численные методы, междисциплинарность, алгоритмы.

1. Introduction

1.1 The relevance of the study

In recent decades, computational modeling methods have gained key importance in various fields of science and technology – from biotechnology and chemical industry to medicine, engineering and quantum computing. Modern manufacturing, scientific research and medical diagnostics increasingly rely on computer models to predict material properties, optimise technological processes, and analyse and visualise complex biological and physical systems [1, 2, 3]. Thanks to computer simulation, virtual experiments are possible, which can significantly reduce resource and time costs, as well as minimise the risks associated with real tests [1].

Thus, computer simulation provides powerful tools for the analysis, prediction and optimisation of various processes, helps to accelerate scientific discoveries, automate engineering processes and improve efficiency in various fields.

The relevance of this study stems from the growing complexity of modern science tasks that require accurate analysis and prediction.

1.2 The purpose of the study

The aim of the study is to identify the main tracks of development of computer modeling methods, as well as to determine the current trends, in-demand technologies and highlight promising areas of their application.

1.3 The analysis of previous research

Previously, domestic and foreign researchers have studied the classification of computer modeling methods, their efficiency and applicability. For example, the work of H. F. Aslanova, N. A. Zeynalov and D. B. Tagiyev presents a review of modern approaches to modeling chemical processes, highlights their advantages and disadvantages [1]. Scientists from Novosibirsk in 2025 consider the application of computer modeling in biotechnology [2], and other domestic researchers – in medical imaging and prosthetics [3]. In addition, there are systematic reviews of computer modeling applications in specific areas such as patient flow management in healthcare [4] and quantum computing modeling [5].

Despite the large number of publications, there is no unified classification of computer modeling methods, as well as a comparative analysis of their effectiveness in different industries. This determines the relevance and scientific novelty of this review paper.

2. Methods

2.1 Search strategy

The article presents a review of publications in English-language sources. The ScienceDirect, Dimensions and SemanticScholar databases were searched among the section ‘computer technologies’ by the presence of the keywords ‘computer modeling methods’ in the title or abstract (842 articles) (Figure). The ScienceDirect service produced 129 results at this stage of the search. In Dimensions database 373 publications were found, and the query in Semantic Scholar gave 340 results. After the screening the final sample totalled 19 articles.

The search strategy consisted of three stages of searching for suitable publications in three different databases.

ScienceDirect yielded 129 publications using the query “Computer” AND “modeling” AND “methods” in the title and abstract. Of these, only 14 publications were open access.

Dimensions service gave 373 results to the ‘Computer modeling methods’ search query in the publication title and abstract. Only 161 publications were open access. After applying a filter “Search only in the Information and Computer Technology category” to the search, 28 relevant publications remained. Of these, 2 were preprints, 2 were conference proceedings, and 24 were articles from peer-reviewed journals.

Semantic Scholar service retrieved 340 publications on the topic, with 134 results in the open access on the query ‘Computer modeling methods’ in the knowledge area ‘computer technologies’ since 2000. From these, 29 most cited publications were selected, among which 5 were conference proceedings and 24 were articles from peer-reviewed journals.

Thus, first, closed-access materials (537 articles) were excluded from the sample. Then another 238 articles that were not included in the ‘computer and information technology’ section, as well as publications with a low citation level, were excluded. At this stage, the sample amounted to 67 articles.

Further, 48 articles were excluded as a result of content analysis of abstracts and full texts of publications. The final sample totalled 19 publications, of which 17 were the articles from peer-reviewed journals, 1 was included in conference proceedings and 1 was a preprint.

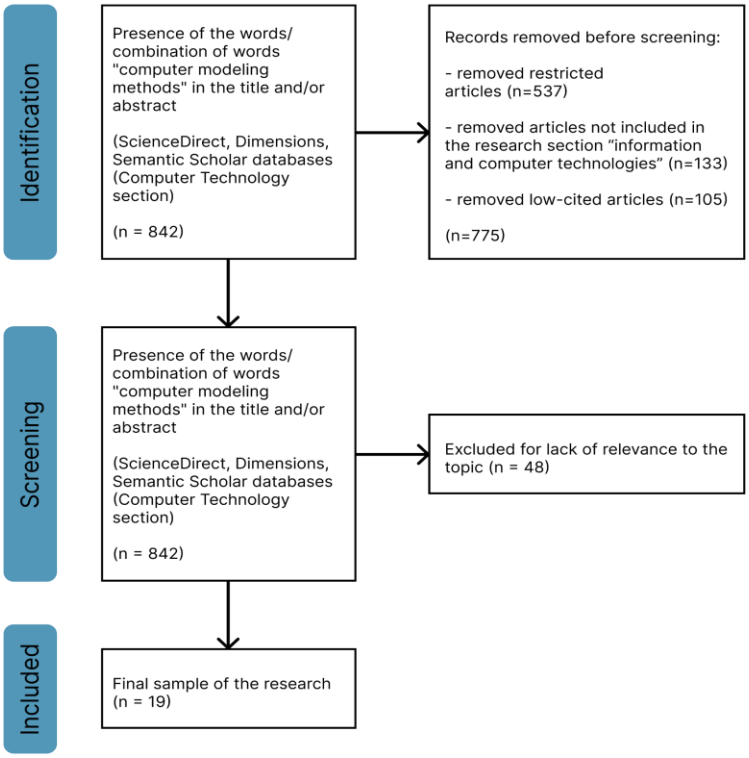


Figure. The process of forming the final sample of the study

2.2 Criteria for excluding sources

In the process of forming the final sample of sources at the stage of substantive analysis, those publications were excluded that did not specifically describe computer modeling methods or that were related to computer modeling but could not be used in this study.

2.3 Data extraction and processing methods

Modern digital tools were used to systematise, extract and analyse the scientific sources in this study.

All the sources that made up the final sample were downloaded and collated in one collection in the Zotero bibliographic data management application. This tool allows primary analyses of publications, such as sorting the collected sources by year, viewing the type of publication, and opening the full text of the publication directly in the application.

The Perplexity intelligent search engine was used to automate searches, pre-analyse article content and refine information. This tool effectively identified key themes, methods and results presented in the sources, and provided quick summaries and comparisons across publications [6].

Together, Zotero and Perplexity provided a convenient organisation of the bibliography and facilitated the source selection process.

3. Results

3.1 Classification of selected sources

The final sample most often includes publications in interdisciplinary journals and specialised publications in engineering, computer science and applied sciences.

The review covers two categories of applicants: lead authors are both individual researchers and teams of scientific institutes (Table 1).

Table 1 – Authors and Publications

№	Authors	Country/City	Organization	Publication
1	Aslanova H. F., Zeynalov N. A., Tagiyev D. B.	Republic of Azerbaijan	M. Nagiyev Institute of Catalysis and Inorganic Chemistry, Ministry of Science and Education of the Republic of Azerbaijan	AZERBAIJAN CHEMICAL JOURNAL
2	Kazantsev F. V., Trofimova M. F., Khlebodarova T. M., Matushkin Yu. G. & Lashin, S. A.	Novosibirsk, Russia	Kurchatov Genomic Center of ICG SB RAS, Institute of Cytology and Genetics of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk State University	Vavilov Journal of Genetics and Breeding
3	Samokhina A. O., Shemyakov S. E., Ratiev A. P., Egiazaryan K. A.	Moscow, Russia	Pirogov Russian National Research Medical University	Traumatology and Orthopedics of Russia

4	Syed Mohiuddin, John Busby, Jelena Savović, Alison Richards, Kate Northstone, William Hollingworth, Jenny L Donovan, Christos Vasilakis	Bristol, UK Belfast, UK Bath, UK	NIHR CLAHRC West, University Hospitals Bristol NHS Foundation Trust, School of Social and Community Medicine, University of Bristol, School of Medicine, Queen's University Belfast, Centre for Healthcare Innovation & Improvement (CHI2), School of Management, University of Bath	BMJ Open
5	Potapov V., Gushansky S.	Novosibirsk, Russia	Siberian State University of Telecommunications and Informatics	The Herald of the Siberian State University of Telecommunications and Informatics
6	Luo, J.-C., Friedman, M.B.	New York, USA	Columbia University	Computer Methods in Applied Mechanics and Engineering
7	Hiroyuki Ogata, Yutaka Akiyama, Minoru Kanehisa	Kyoto, Japan	Institute for Chemical Research Kyoto University	Preprint
8	William J. Allen, Robert C. Rizzo	USA	Stony Brook University	Biology
9	Taldaev A., Terekhov R., Nikitin I., Zhevlakova A., Selivanova I.	Moscow, Russia	Laboratory of Nanobiotechnology, Institute of Biomedical Chemistry, Sechenov First Moscow State Medical University,	International Journal of Molecular Sciences
10	Zongrui Pei	New York, USA	New York University	Cell Reports Physical Science
11	H. Haron, A. Rehman, D. I. S. Adi, S. P. Lim, T. Saba	Skudai, Johor Bahru, Malaysia Riyadh, Saudi Arabia	Universiti Teknologi Malaysia, Al-Imam Muhammad Bin Saud Islamic University	Mathematical Problems in Engineering
12	Kuzmichev A. A., Azarov V. N., Kuzmichev A. V.	Volgograd, Russia	Volgograd State Technical University	MATEC Web of Conferences
13	Aliya Askarova, Saltanat Bolegenova, Symbat Bolegenova, Meruyert Beketayeva, Valeriy Maximov, Aizhan Nugymanova, Pavel Šafařík	Almaty, Kazakhstan Prague, Czech Republic	al-Farabi Kazakh National University, Czech Technical University in Prague	Acta Polytechnica

14	Mika Letonsaari, Jukka Selin	Mikkeli, Finland	South-Eastern Finland University of Applied Sciences	Procedia Computer Science
15	Evan Baker, Peter Challenor, Matt Eames	UK	University of Exeter	Journal of Computational and Graphical Statistics
16	Yu Jianxi	China	Henan Institute of Economics and Trade	Measurement: Sensors
17	Rachael Y. Jablonski, Taran Malhotra, Daniel Shaw, Trevor J. Coward, Farag Shuweihdi, Chris Bojke, Sue H. Pavitt, Brian R. Nattress, Andrew J. Keeling	UK	University of Leeds, Aintree University Hospital, Chesterfield Royal Hospital Calow, King's College London	The Journal of Prosthetic Dentistry
18	Petropavlovskaya V. B., Novichenkova T. B., Buryanov A. F., Poleonova Y. Y.	Russia	Tver State Technical University, Institute of Civil Engineering and Architecture	Procedia Engineering
19	Ali Raza, Umbreen Fatima, Muhammad Rafiq, Nauman Ahmed, Ilyas Khan, Kottakkaran Sooppy Nisar, Zafar Iqbal	Lahore, Pakistan Viet Nam Alkharj, Saudi Arabia	National College of Business Administration and Economics, The University of Lahore, University of Central Punjab, Ton Duc Thang University, Prince Sattam Bin Abdulaziz University	Results in Physics

3.2 Computer modeling methods described in the sources

The selected sources discuss a wide range of different computer modeling techniques. For example, the work of Jenn-Ching Luo and Morton B. Friedman (1990) describes an innovative approach to parallelising the finite element method [7]. Also, the authors review methods such as genetic algorithms [8], docking and molecular dynamics [9, 10, 11], and parameterization [12]. The application of numerical methods is also described in detail, for example, researchers from Volgograd describe in their work the use of numerical methods for modeling the processes of pollutant transport and deposition on building facades [13], a team of scientists from Kazakhstan and the Czech Republic applies numerical methods to solve systems of equations with variable physical properties for three-dimensional modeling of heat and mass transfer processes [14], and researchers from Pakistan, Vietnam and Saudi Arabia in their joint work offer non-standard methods for simulating the processes of heat and mass transfer. In

addition, some authors describe the application of computer modeling techniques such as metabolic, structural and functional modeling [2].

In several papers, authors describe the benefits of combining computer modeling methods with other technologies. For example, Mika Letonsaari and Jukka Selin propose an innovative interdisciplinary approach that combines computer modeling algorithms and non-linear narrative design techniques from the game industry [15]. Besides, in 2019, researchers Evan Baker, Peter Challenor and Matt Eames described a methodology that effectively combines the advantages of deterministic and stochastic models to predict the output of complex systems [16]. A recent study by Yu Jianxi focuses on the development of a mathematical model for the analysis and optimisation of heterogeneous cellular networks using algorithms based on graph theory, auction theory and multi-criteria optimisation methods in multidimensional computer space [17]. In medicine, computer modeling is also actively integrated with other technologies, for example, a group of Russian researchers from Moscow compared and evaluated the anatomical features of the structure of the head of the human radial bone using computed tomography data and computer modeling methods [3]. Their work perfectly demonstrates that this approach provides high accuracy and informativeness, which is important for clinical practice, especially in traumatology and orthopaedics.

Furthermore, many authors compare different modeling methods in their papers. In 2025, researchers from England compared three methods of facial prosthesis design: the use of a 3D morphable model, traditional computer-aided design methods and classical manual modeling of a wax model. The article demonstrates that the use of 3D morphable models in facial prosthesis design provides high accuracy and reproducibility comparable to traditional methods, while reducing labour and skill requirements [18].

In addition to describing individual methods, some authors also conduct systematic reviews in the field of computer modeling. For example, in 2017, researchers from England in their article investigated existing approaches to computer modeling of patient flows in UK emergency departments, highlighting the potential of these methods to improve the organisation of medical care and the need to improve methodological rigour and practical implementation of the results [4].

The findings are summarized in Table 2.

Table 2 – Methods of computer modeling

№	Sources	Methods described
Individual methods		
1	Luo, J.-C., Friedman, M.B.	Finite element method
2	Hiroyuki Ogata, Yutaka Akiyama, Minoru Kanehisa	Genetic algorithms
3	William J. Allen, Robert C. Rizzo	Docking and molecular dynamics
4	Taldaev, A., Terekhov, R., Nikitin, I., Zhevlakova, A., Selivanova, I.	

5	Zongrui Pei	
6	H. Haron, A. Rehman, D. I. S. Adi, S. P. Lim, T. Saba	Parameterization
7	A. A. Kuzmichev, V. N. Azarov, A. V. Kuzmichev	Numerical methods
8	Aliya Askarova, Saltanat Bolegenova, Symbat Bolegenova, Meruyert Beketayeva, Valeriy Maximov, Aizhan Nugymanova, Pavel Šafařík	
9	Kazantsev, F. V., Trofimova, M. F., Khlebodarova, T. M., Matushkin, Yu. G. & Lashin, S. A.	Metabolic, structural and functional modeling
Combination of methods		
10	Mika Letonsaari, Jukka Selin	Non-linear narrative design techniques from the game industry
11	Evan Baker, Peter Challenor, Matt Eames	Deterministic and stochastic models
12	Yu Jianxi	Graph theory, auction theory and multi-criteria optimisation methods in multidimensional computer space
13	Anna O. Samokhina, Sergei E. Shemyakov, Andrei P. Ratiev, Karen A. Egiazaryan	Computed tomography
Comparison of methods		
14	Rachael Y. Jablonski, Taran Malhotra, Daniel Shaw, Trevor J. Coward, Farag Shuweihdi, Chris Bojke, Sue H. Pavitt, Brian R. Nattress, Andrew J. Keeling	The use of a 3D morphable model, Traditional computer-aided design methods and classical manual modeling of a wax model
Reviews		
15	Syed Mohiuddin, John Busby, Jelena Savović, Alison Richards, Kate Northstone, William Hollingworth, Jenny L Donovan, Christos Vasilakis	Patient flow within UK emergency departments: a systematic review of the use of computer simulation modeling methods

3.3 Areas of application of computer modeling

The analysed sources describe the application of computer modeling methods in various branches of science and industry. The authors develop new approaches to solving problems in mechanics and engineering [7, 12, 16, 17, 19]. For example, in 2012, researchers from Malaysia and Saudi Arabia proposed an innovative method that improves visualisation and construction of 2D and 3D models from scanned data, which is important for computer graphics, engineering simulation and geometric data processing [12]. In biotechnology [2, 8], chemical industry [1] and medicine [3, 4, 9] [10, 11, 18], computer modeling is also widely used. Japanese researchers back in 1993 presented an algorithmic approach to 3D modeling of RNA based on genetic algorithms [8], American scientists William J. Allen and Robert C. Rizzo in their work apply modern computer methods to the development of tools to combat HIV infection

[9], and an article by Zongrui Pei presents an overview of modern computer modeling methods in drug development [11]. Some authors investigate the application of computer modeling methods in architecture [13] and game industry [15], energy [14], quantum technologies and computer security [5, 20].

The results are outlined in Table 3.

Table 3 – Areas of application of computer modeling

№	Sources	Areas of application
1	Luo, J.-C., Friedman, M.B.	Mechanics and engineering
2	H. Haron, A. Rehman, D. I. S. Adi, S. P. Lim, T. Saba	
3	V. B. Petropavlovskaya, T. B. Novichenkova, A. F. Buryanov, Y. Y. Poleonova	
4	Evan Baker, Peter Challenor, Matt Eames	
5	Yu Jianxi	
6	Kazantsev, F. V., Trofimova, M. F., Khlebodarova, T. M., Matushkin, Yu. G. & Lashin, S. A.	Biotechnology
7	Hiroyuki Ogata, Yutaka Akiyama, Minoru Kanehisa	
8	H. F. Aslanova, N. A. Zeynalov, D. B. Tagiyev	Chemical industry
9	Anna O. Samokhina, Sergei E. Shemyakov, Andrei P. Ratiev, Karen A. Egiazaryan	Medicine
10	Syed Mohiuddin, John Busby, Jelena Savović, Alison Richards, Kate Northstone, William Hollingworth, Jenny L Donovan, Christos Vasilakis	
11	William J. Allen, Robert C. Rizzo	
12	Taldaev, A., Terekhov, R., Nikitin, I., Zhevlakova, A., Selivanova, I.	
13	Zongrui Pei	
14	Rachael Y. Jablonski, Taran Malhotra, Daniel Shaw, Trevor J. Coward, Farag Shuweihdi, Chris Bojke, Sue H. Pavitt, Brian R. Nattress, Andrew J. Keeling	
15	A. A. Kuzmichev, V. N. Azarov, A. V. Kuzmichev	Architecture
16	Mika Letonsaari, Jukka Selin	Game industry

17	Aliya Askarova, Saltanat Bolegenova, Symbat Bolegenova, Meruyert Beketayeva, Valeriy Maximov, Aizhan Nugymanova, Pavel Šafařík	Energy
18	Potapov, V., Gushansky, S.	Quantum technologies and computer security
19	Ali Raza, Umbreen Fatima, Muhammad Rafiq, Nauman Ahmed, Ilyas Khan, Kottakkaran Sooppy Nisar, Zafar Iqbal	

4. Discussion

4.1 Development of computer modeling methods

The analysis of sources shows that computer modeling methods develop gradually and are a stable tool for application in various fields. It is impossible to say unambiguously which methods have become obsolete and which ones have become more popular recently. For example, the application of molecular docking and molecular dynamics methods [9, 10] in medicine is described in papers 2012 and 2022 by different authors. A universal tool in computer modeling is classical numerical methods, which are the most frequently described by researchers. In 1990, Jenn-Ching Luo and Morton B. Friedman presented a new computational model for the finite element method [7], and in 2017 in the article 'The research of contamination regularities of historic buildings and architectural monuments by methods of computer modeling' the application of numerical methods for modeling the processes of contamination of building facades was described [13]. But despite the fact that numerical methods are the basic tool in computer modeling, some researchers not only use them in their works, but also modify and develop new approaches. For example, in 2021, a group of scientists proposed a non-standard numerical method to effectively account for delays in the time series of the model [20].

Despite their stability, computer modeling techniques continue to evolve. Recently, there has been an integration of computational modeling techniques with both other traditional approaches, such as graph theory algorithms, auctions and multi-criteria optimisation [17], and emerging technologies such as language models, machine learning techniques and quantum computing [11].

4.2 Main trends in the development of computer modeling

Most authors, when talking about the development of computer modeling, mention integration with other methods and approaches. In recent years, the absolute trend is interdisciplinarity and combination of computer modeling with other technologies from different fields. Modern scientific and applied problems increasingly go beyond the boundaries of one field of knowledge and require an integrated approach for effective solution. In many publications, authors emphasise that only the combination of knowledge from different disciplines, e.g. biology, mathematics, computer science, engineering and medicine, enables the creation of new software platforms, automation of analysis, personalisation of models and improved efficiency of production and clinical decisions. Interdisciplinary approaches allow models to be tailored to real-world conditions, take into account unique features of objects and processes, and enable faster innovation in industry and healthcare. Among the prospects of computer modeling, in their works authors note the development of integrated systems, expansion of models [13], integration with artificial intelligence systems [15]. Thus, it not only ensures the accuracy of analysis and increases the

efficiency of production, but also allows solving the most complex problems of modern science and industry, previously considered inaccessible to classical methods.

5. Conclusion

Computer modeling methods remain a fundamental and universal tool for solving a wide range of scientific and applied problems. Despite the stable popularity of traditional approaches, the field of computer modeling shows a gradual development due to the improvement of algorithms, introduction of new technologies and expansion of application areas.

In recent years, there has been a clear trend towards a combined approach, combining computer modeling methods with other technologies. Of particular importance is the personalisation of models, automation of analysis and development of software platforms, which promotes the introduction of computational modeling in medicine, biotechnology, energy, architecture and other industries. Comparative studies and systematic reviews show that combining different methods and technologies provides not only increased accuracy and reproducibility of results, but also reduced labour costs, increased speed of development and adaptation of solutions to specific tasks.

Thus, nowadays computer modeling continues to develop as an interdisciplinary field. The key trend is integration with other technologies and expansion of the areas of application, which is expected to open up new horizons for research and industry, ensuring a high level of innovation, efficiency and adaptability of modern solutions.

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DESIGNING WITH CONSIDERATION OF COGNITIVE DISTORTIONS AND PSYCHOLOGICAL EFFECTS

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Abstract. This article addresses the problem of user errors in interfaces caused by cognitive biases. The author systematizes six key biases and develops an original framework of design principles to mitigate them. Structured around four fundamental information processing problems, the framework provides practical solutions for issues like the halo effect and status quo bias. Its application is demonstrated through a typical e-commerce scenario analysis. The result is a structured tool for designers to enhance interface clarity, safety, and effectiveness at the conceptual design stage.

Keywords: user interface, cognitive biases, UX-design, design principles, human-computer interaction, decision making, usability.

ПРОЕКТИРОВАНИЕ С УЧЕТОМ КОГНИТИВНЫХ ИСКАЖЕНИЙ И ПСИХОЛОГИЧЕСКИХ ЭФФЕКТОВ

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Аннотация. Статья посвящена проблеме пользовательских ошибок в интерфейсах, вызванных когнитивными искажениями. Автор систематизирует шесть ключевых искажений и разрабатывает оригинальный фреймворк дизайн-принципов для их нивелирования. Структурированный вокруг четырех фундаментальных проблем обработки информации, фреймворк предлагает решения для таких проблем, как эффект ореола и консерватизм. Его применение продемонстрировано на анализе типового сценария электронной коммерции. Результатом является структурированный инструмент для повышения понятности и безопасности интерфейсов.

Ключевые слова: пользовательский интерфейс, когнитивные искажения, UX-дизайн, дизайн-принципы, человеко-компьютерное взаимодействие, принятие решений, юзабилити.

Modern users interact with numerous digital interfaces daily, requiring them to make constant decisions under conditions of limited time and attention. However, human thinking, evolutionarily tuned for survival in the physical world, is subject to

systematic errors – cognitive biases [1]. These biases, resulting from the operation of the fast "System 1" according to D. Kahneman [2], become a source of frequent errors, misunderstandings, and decreased trust in digital products. Despite the extensive theoretical base in cognitive psychology, there is a noticeable gap in its practical application to interface design. Many existing guidelines are fragmented and do not provide a systematic approach to addressing the root causes of user errors. The aim of the study is to develop such an approach – a structured framework of design principles aimed at mitigating the most critical cognitive biases at the conceptual design stage.

The theoretical basis of the work is the research of D. Kahneman and A. Tversky, who first described cognitive biases as systemic errors in judgment and decision-making. To structure the subject area, B. Benson's model was used, grouping biases around four fundamental problems: "Too much information" (gives rise to, for example, availability heuristic and negativity bias), "Not enough meaning" (leads to the halo effect), "Need to act fast" (causes the sunk cost fallacy and status quo bias), and "What should we remember?" (determines the peak-end rule) [3]. In the works of domestic researchers, such as Khadzhiev I. V. and Ananchenko I. V., the manifestation of specific biases (e. g., the halo effect) in interfaces is analyzed. Nevertheless, comprehensive works offering a universal toolkit for designers are currently insufficient [4]. A detailed analysis shows that while individual biases are well-studied, their collective impact on user experience and structured methods for their compensation in design remain underexplored.

The research was conducted in several stages. At the first stage, using the method of systematic analysis of scientific literature, cognitive biases having the most significant impact on user experience were identified and classified. The selection criteria included the frequency of a bias's manifestation in digital environments and its potential impact on the success of key user scenarios. At the second stage, using the synthesis method, design principles aimed at compensating for each category of biases were formulated. At the third stage, the developed framework was tested using the scenario analysis method: a typical user scenario ("Checkout process in an online store") was selected, analyzed for potential biases, and conceptually improved using the proposed principles [5].

The main result of the work is the framework presented in Table. It is a matrix linking the information processing problem, a specific cognitive bias, its negative impact on UX, and a compensating design principle.

Table – Framework of design principles for mitigating cognitive biases

Brain's Problem	**Cognitive Bias**	**Impact on UX (Risk)**	**Design Principle**
P1: Too much information: Information Filtering	Availability Heuristic	User cannot find a function if it is hidden behind a non-obvious icon.	Principle of Expected Placement: Placement of elements according to established mental models.

P1: Too much information: Salience of Negative Information	Negativity Bias	Users pay excessive attention to error messages or negative reviews, which can create an unjustified sense of distrust towards the entire system (Figure 1).	Principle of Balanced Feedback: Critical messages should be clear but not emotionally charged. Positive feedback and success confirmations should be equally prominent.
P2: Not enough meaning	Halo Effect	Attractive design masks poor usability (Figure 2).	Principle of Independent Usability: Functionality must be ensured even with the visual design “turned off”
P3: Need to act fast: Decision Inertia	Sunk Cost Fallacy	User is afraid to cancel a lengthy process, even if a mistake was made (Figure 3).	Principle of Easy Exit: Obvious “Cancel” button and progress visualization at any stage.
P3: Need to act fast: Resistance to Change	Status Quo Bias	User resists changing settings or adopting new features, even if they are beneficial, due to a preference for the familiar default state.	Principle of Smart Defaults & Guided Onboarding: Set the most beneficial and safe options as defaults. Use unobtrusive tutorials and highlight the benefits of new features to encourage exploration.
P4: What should we remember?	Peak-End Rule	Negative experience at the end of interaction overshadows all positive impressions (Figure 4).	Principle of Positive Completion: Key scenarios should end with clear positive feedback (confirmation, gratitude).

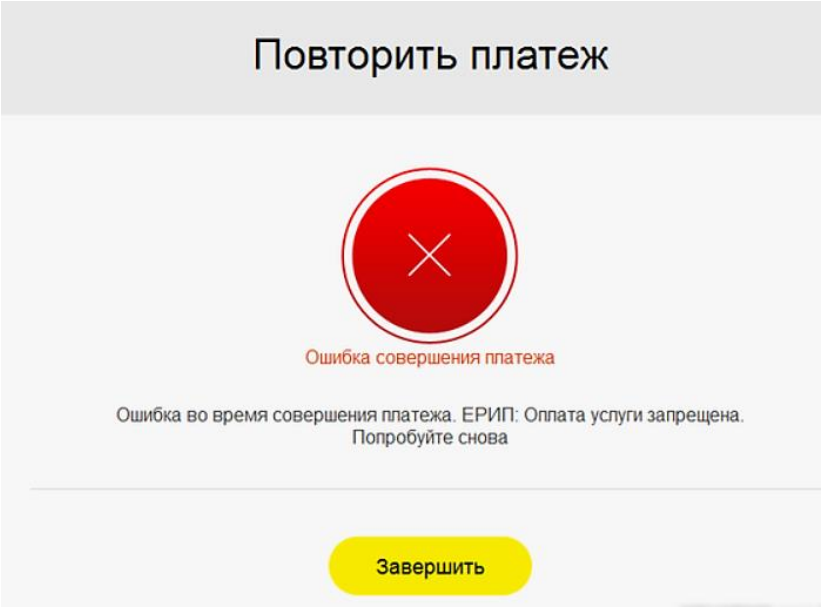


Figure 1. Unbalanced feedback

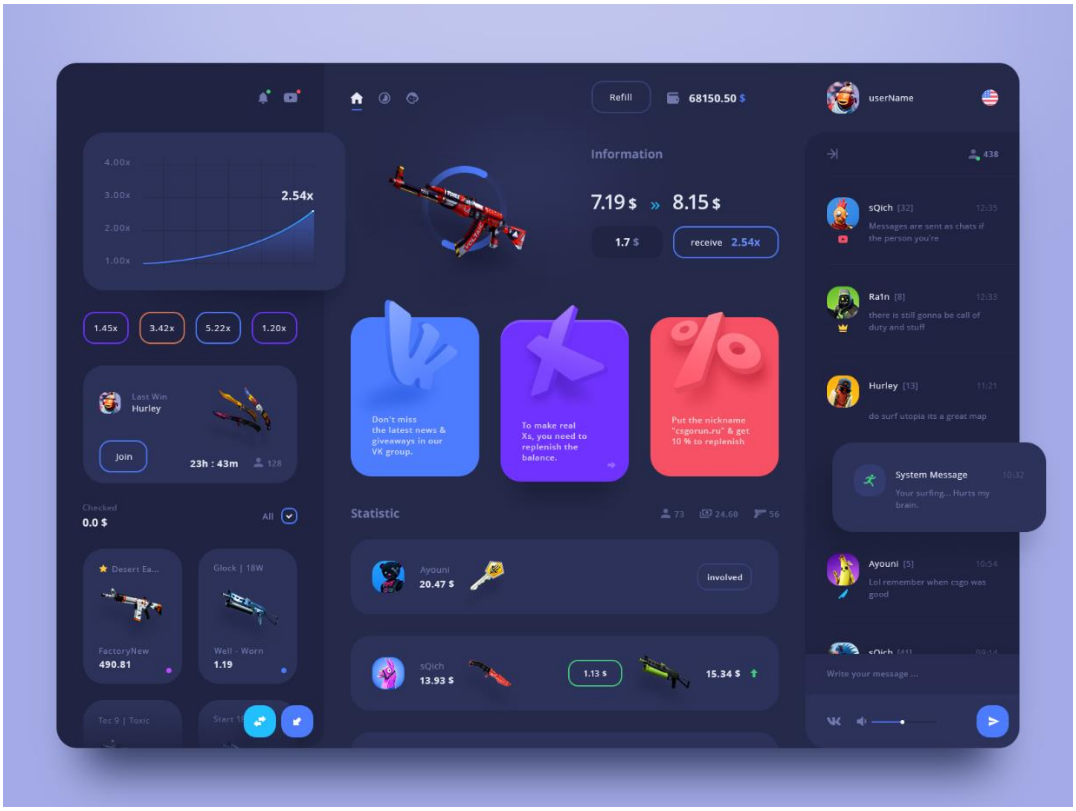


Figure 2. Attractive design masks poor usability



Figure 3. Not obvious “Cancel” button and progress visualization

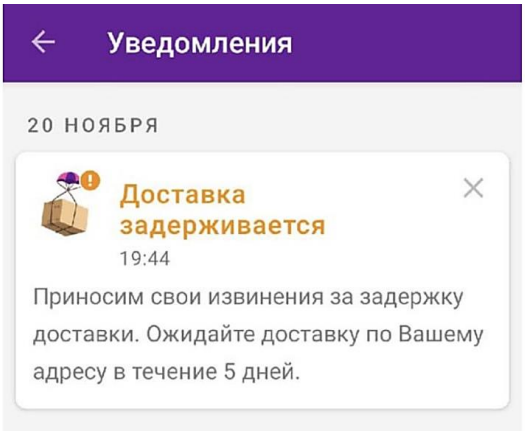


Figure 4. Negative experience at the end of interaction

The application of the proposed framework demonstrated its effectiveness using the checkout scenario as an example. The analysis showed that a typical order form is susceptible to risks associated with biases from “P3” (lack of an easy exit and resistance to optional beneficial steps due to Status Quo Bias) and “P2” (implicit data validation). Furthermore, a single error message (P1: Negativity Bias) could disproportionately affect the user's overall perception of the platform's reliability [6]. The mitigation of Status Quo Bias (P3: Need to act fast: Resistance to Change) is particularly crucial for onboarding and feature adoption. For example, a project management application introducing an automated reporting feature might face user reluctance. Applying the “Principle of Smart Defaults & Guided Onboarding” would involve pre-selecting the most common report parameters as defaults and displaying a concise, one-time tooltip highlighting the time-saving benefit: “This report is pre-configured to save you 15 minutes weekly. Click here to customize.” This approach reduces the cognitive effort required to try the new feature, leverages the user's tendency to stick with defaults, and clearly communicates the value proposition, thereby overcoming the initial resistance and encouraging exploration. For instance, a prominently displayed payment error, without balancing it with positive confirmation upon success, can make the user perceive the entire payment system as unreliable. Applying the corresponding

principles allowed for a conceptual improvement of the scenario: adding a progress bar, explicit navigation buttons, and real-time field validation. This framework is not a rigid template but serves as a tool for idea validation and identifying “blind spots” at early design stages. Its advantage lies in its systematic nature and focus on the root causes of user errors, not their external manifestations. A limitation of the framework is the need for its adaptation to a specific subject area and target audience [7].

In the course of the research, an original framework of design principles aimed at compensating for cognitive biases in user interfaces was developed and tested. The practical significance of the work lies in providing designers and developers with a structured tool for improving the clarity, safety, and effectiveness of digital products. The proposed approach shifts the focus from correcting user errors post-factum to preventing them at the design stage, thereby enhancing user trust and satisfaction. In the future, it is planned to further detail the framework and conduct usability testing to quantitatively assess the effectiveness of the proposed principles.

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USE OF MODERN THERMAL INSULATION MATERIALS TO INCREASE THE EFFICIENCY OF INDUCTION FIRES

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Abstract. The article analyzes modern materials and insulation technologies used to increase the efficiency of industrial induction furnaces. It examines the properties of ceramic and heat-resistant alloys, as well as nanomaterials, under high-temperature and electromagnetic conditions. The article also discusses the methods of applying insulation coatings and their impact on reducing heat losses. The results obtained demonstrate the potential for improving the energy efficiency of industrial equipment.

Keywords: induction furnaces, thermal insulation, energy efficiency, modern materials, heat losses.

ИСПОЛЬЗОВАНИЕ СОВРЕМЕННЫХ ТЕПЛОИЗОЛЯЦИОННЫХ МАТЕРИАЛОВ ДЛЯ ПОВЫШЕНИЯ КПД ИНДУКЦИОННЫХ ПЕЧЕЙ

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Аннотация. В статье проанализированы современные материалы и технологии теплоизоляции, используемые для повышения коэффициента полезного действия промышленных индукционных печей. Проведен анализ свойств керамических и термостойких сплавов, а также наноматериалов в условиях высоких температур и электромагнитных воздействий. Рассмотрены методы нанесения теплоизоляционных покрытий и их влияние на снижение тепловых потерь. Полученные результаты демонстрируют перспективы повышения энергоэффективности оборудования в промышленном применении.

Ключевые слова: индукционные печи, теплоизоляция, энергоэффективность, современные материалы, тепловые потери.

Induction furnaces are widely utilized across multiple industrial sectors due to their high energy efficiency, precise temperature control, and ability to maintain a

stable thermal regime. Their primary applications include foundry and metallurgical operations, where they are employed for melting ferrous and non-ferrous metals, alloy production, and scrap metal recycling.

Modern thermal insulation materials and systems play a decisive role in enhancing the energy efficiency of induction furnaces – among the most energy-intensive pieces of equipment in metallurgical production. Analysis reveals that a substantial portion of the input electrical energy – up to 10-25 % – is lost through the furnace shell, hearth, and lid via conduction, convection, and thermal radiation. These losses directly reduce the coefficient of performance and increase the unit production cost. In the context of growing demands for energy conservation and sustainable industrial development, optimizing thermal insulation has evolved from a technical consideration into a strategic imperative for equipment modernization. The application of advanced refractory and insulating materials enables substantial reductions in heat losses, increases furnace efficiency, shortens heating cycles, extends refractory lining life, and reduces cooling system load. Particularly critical is the development of multi-layered insulation systems, wherein each layer performs a distinct function: the working layer resists molten metal and slag erosion, intermediate layers minimize conductive heat transfer, and reflective barriers suppress radiative losses [1].

In the construction of an induction steel-melting furnace, insulation materials are fundamental to ensuring durability, energy efficiency, and operational safety. Between the inductor – the water-cooled coil through which alternating current flows – and the crucible, a high-performance thermal and electrical insulation system is always installed to prevent heat dissipation and eliminate inter-turn electrical breakdowns. Modern furnaces employ composite insulating materials such as fiberglass-reinforced laminates and specialized high-temperature insulating tapes, which exhibit excellent dielectric strength, low thermal conductivity, and resistance to vibration and thermal cycling (Fig. 1).



Figure 1. Lining of the induction furnace

For large-scale furnaces, thin coatings of aluminum oxide (Al_2O_3) or zirconium oxide (ZrO_2) are applied via plasma or thermal spray techniques to protect coil windings from atmospheric oxidation and thermal stress. A supplementary layer of high-temperature ceramic lacquer is often applied over these oxide coatings to further enhance chemical resistance and surface integrity.

The furnace shell is surrounded by a layer of thermal insulation, typically composed of ceramic fiber or other modern low-conductivity materials, enabling effective retention of ultra-high temperatures (>1600 °C) within the crucible. The crucible itself functions as a critical thermal barrier – it is lined with a specialized refractory mixture resistant not only to thermal shock but also to chemical corrosion and erosive wear from molten metal and slag. Additionally, the hearth plate and refractory coating protect the structural components from direct contact with aggressive charge materials, significantly extending the furnace's service life. Enhanced insulation between the shell and the crucible not only conserves electrical energy but also ensures uniform temperature distribution throughout the working volume [2]. Thus, diverse insulation materials and application techniques collectively form an integrated system essential for the efficient, safe, and economical operation of industrial induction furnaces.

Each insulation material possesses distinct advantages and limitations, and the optimal system is designed as a balanced compromise between cost, durability, thermal performance, and installation feasibility. For instance, ceramic fiber – despite its widespread use due to flexibility and low density – is susceptible to fiber erosion under mechanical vibration and requires protective cladding or mesh reinforcement. Microporous silica plates offer exceptional thermal resistance, but are sensitive to moisture ingress and require hermetic sealing during installation. vacuum insulation panels, while offering record-low thermal conductivity, have limited service life and cannot withstand mechanical damage or high surface temperatures.

The data presented enable preliminary material selection based on operational temperature zones. For high-temperature zones (>1400 °C), such as the inner surface of the crucible, mullite-silica blocks or quartz-based refractory mixes are preferred despite their higher thermal conductivity, due to their structural integrity and slag resistance. For intermediate insulation layers operating at lower temperatures, microporous plates or ceramic fiber mats are optimal for maximizing thermal resistance.

Table – Comparative analysis of the physical and technical characteristics of thermal insulation materials for induction furnaces

Material	**Operating temperature, °C**	**Thermal conductivity, W/(m·K)**	**Density, kg/m³**	**Advantages**	**Disadvantages**
Ceramic Fiber	Up to 1400	0.08-0.12	96-160	Flexibility, light weight, low thermal conductivity	Brittleness, potential erosion under vibration
Microporous Silica Plate	Up to 1000	0.02-0.04	200-300	Extremely low thermal conductivity, dimensional stability	High cost, moisture sensitivity
Vacuum Insulation Panel	Up to 650	0.004-0.008	150-250	Record-low thermal conductivity	Limited service life, sensitivity to damage
Mullite-Silica Block	Up to 1600	0.2-0.3	800-1000	High strength, resistance to thermal cycling	Relatively high thermal conductivity

Vacuum insulation panels may be applied in outer shell layers where temperatures remain below 600 °C, enabling record-low heat losses. Outdated materials such as asbestos board must be strictly excluded from new designs due to their carcinogenic nature and regulatory prohibitions. It is critical to emphasize that material selection must be based not only on physico-technical properties but also on specific operational parameters: type of metal being melted, frequency of thermal cycles, slag chemistry, and budget constraints. For instance, mullite-silica blocks remain the preferred choice for steel and high-alloy melting above 1400 °C, despite their moderate thermal conductivity. In contrast, for medium-temperature processes (<1000 °C), microporous silica plates deliver superior energy efficiency. Economic studies indicate that replacing traditional single-layer linings with multi-layer systems using modern insulators can reduce specific energy consumption by 8-15 %, extend refractory lining life by 20-40 %, and shorten preheat times by 15-25 % [3]. These metrics are especially critical for enterprises adopting digital energy management systems, where precise energy metering and process optimization are now industry standards.



a



b



c



d

Figure 2. Modern thermal insulation materials:
a – ceramic fiber; b – vacuum insulation panel; c – mullite-silica block;
d – microporous silica plate

Ceramic fibers and microporous silica boards are the most widely used materials in industrial induction furnaces. Ceramic fiber is available in the form of mats, slabs, bundles, and packing materials. Its primary advantage is its ability to adhere tightly to complex surfaces, eliminating the formation of air pockets. The material is easy to cut and install, reducing labor costs during furnace repair [4]. However, with prolonged use and exposure to vibration from the inductor, the fiber can compact or partially blow out, reducing its efficiency (Fig. 2a). To prevent this, mesh reinforcement or protective coatings are used. Vacuum powder insulation panels are an advanced material that achieve record-low thermal conductivity values – from 0.004 to 0.008 W/(m K), which is 10-15 times lower than traditional thermal insulators. The panel design includes a porous filler, typically consisting of silica or microporous glass fiber, hermetically sealed within a multilayer metallized shell from which air has been removed. Creating a vacuum inside the panel virtually eliminates heat transfer by convection and conduction of the gas, leaving only a minimal contribution from thermal radiation and the solid phase of the filler (Fig. 2b). Mullite-siliceous block is a high-temperature

refractory material widely used as a working lining layer in induction furnaces, particularly in areas subject to extreme thermal and mechanical loads.

The main advantages of mullite-siliceous block include high mechanical strength, low thermal expansion, good corrosion resistance to slags and molten non-ferrous and ferrous metals, and a long service life compared to other refractories (Fig. 2c). Microporous boards are rigid panels with extremely low density and thermal conductivity. They are fiber-free, making them safe for health and highly resistant to deformation. Their drawback is their fragility and the need for careful installation without gaps. A special ceramic-based adhesive is often used to seal joints [5]. In recent years, combined solutions have become increasingly popular, where a layer of ceramic fiber is laid over a microporous board, which combines flexibility and ultra-low thermal conductivity (Fig. 2d).

In Russia, the widespread adoption of advanced thermal insulation solutions faces several barriers: the high cost of imported materials, a shortage of domestic alternatives, a lack of a clear regulatory framework, and a shortage of specialists experienced in new technologies. Many companies continue to use outdated solutions, such as asbestos board or simple fireclay blocks, despite their low efficiency and environmental risks. However, with a long-term approach, investments in energy efficiency pay off through energy savings, reduced downtime for repairs, and lower cooling costs. Another promising area is adapting technologies developed for heat storage systems to furnace thermal management. For example, the use of materials with variable thermal conductivity or phase change can enable the creation of “smart” insulation shells capable of regulating heat flow depending on the operating mode. Therefore, further development of thermal insulation for induction furnaces should focus not only on improving materials but also on integrating them into smart energy systems that meet the requirements of the “green” industry of the future.

Increasing the efficiency of induction furnaces by optimizing thermal insulation is one of the most effective energy-saving measures in metallurgical production. Analysis of modern materials and design solutions shows that switching from single-layer to multilayer systems using ceramic fibers, microporous boards, and reflective screens significantly reduces heat loss, reduces energy consumption, and extends equipment service life. The key to success is not simply choosing the most efficient material, but carefully designing the entire multilayer structure, taking into account temperature conditions, mechanical loads, and operating conditions. Implementing such solutions requires a comprehensive approach, including technical expertise, economic assessment, and personnel training. Despite existing barriers in Russian industry, the advantages of modern thermal insulation systems are clear and economically justified. The future development of this field lies in the development of domestic high-tech materials, the development of unified standards, and the integration of thermal insulation into the overall energy management and digitalization strategy of industrial enterprises. Only such a systematic approach will enable Russian manufacturers to reach a new level of energy efficiency and competitiveness in the global economy.

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WAYS TO RECYCLE PLASTIC WASTE FOR REUSE

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Abstract. The article presents the current state of plastic recycling in Russia and in the the world. It discusses the main stages of plastic processing, the processing of plastic into flakes and granules, and the necessary equipment for plastic recycling. The article also provides a comparison of plastic recycling equipment produced in different countries.

Keywords: PET recycling, flakes, equipment, plastic waste, recycling, equipment, plastic.

ПУТИ ПЕРЕРАБОТКИ ПЛАСТИКОВЫХ ОТХОДОВ ДЛЯ ВТОРИЧНОГО ИСПОЛЬЗОВАНИЯ

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Аннотация. В статье представлено современное состояние переработки пластика в России и в мире. Рассматриваются основные этапы его переработки, переработки пластика в хлопья и гранулы, а также необходимое оборудование для его переработки. Даны результаты сравнения оборудования по переработке пластика, произведенного в разных странах.

Ключевые слова: переработка ПЭТ, хлопья, оборудование, пластиковые отходы, вторичная переработка, оборудование, пластик.

Plastic is not just a material, but a symbol of modernity. It surrounds us everywhere, making our lives easier, more accessible and more comfortable. From food packaging and appliances to clothing and automobiles, plastic has become a part of our daily lives. However, these obvious advantages of plastic are fraught with a hidden threat [1].

Uncontrolled use of plastic leads to its accumulation in landfills, environmental pollution, pollution of the oceans and even a threat to species diversity.

The solution to this problem lies in plastic recycling – turning waste into a resource. Plastic recycling is not just recycling, it is an opportunity to create a closed loop, where waste becomes raw materials for new products.

Russia, like many other countries, is facing a growing amount of plastic waste. Recycling plastic into flakes is one of the key stages of this process, which allows you to obtain secondary raw materials for the production of new products.

The article will consider: the current state of plastic processing in Russia, comparison of Russian lines for the production of plastic flakes with foreign analogues and identification of their strengths and weaknesses.

The first steps towards recycling plastic waste were made at the beginning of the 20th century, first in Europe, and then in the United States. The world's first plastic recycling plant was built there in 1972. This facility has become a model for all plastic waste recycling plants in the world. However, this trend reached Russia only at the beginning of the 21st century. Until that time, plastic waste was not recycled in any way, but only taken to landfills or burned [2, p. 189].

At the moment, Russia lags far behind the world leaders in the field of waste recycling and plastic, in particular. But despite the significant lag in this industry, the plastic recycling sector in Russia has become of interest to various areas of entrepreneurial activity. In particular, this is noted in the active development of the production of domestic equipment for plastic processing (Fig. 1). To date, there are about 500 plastic waste processing enterprises in many large cities of Russia.

The result of the plastic recycling process is plastic flakes or granules, which are raw materials that are convenient for further production of products.

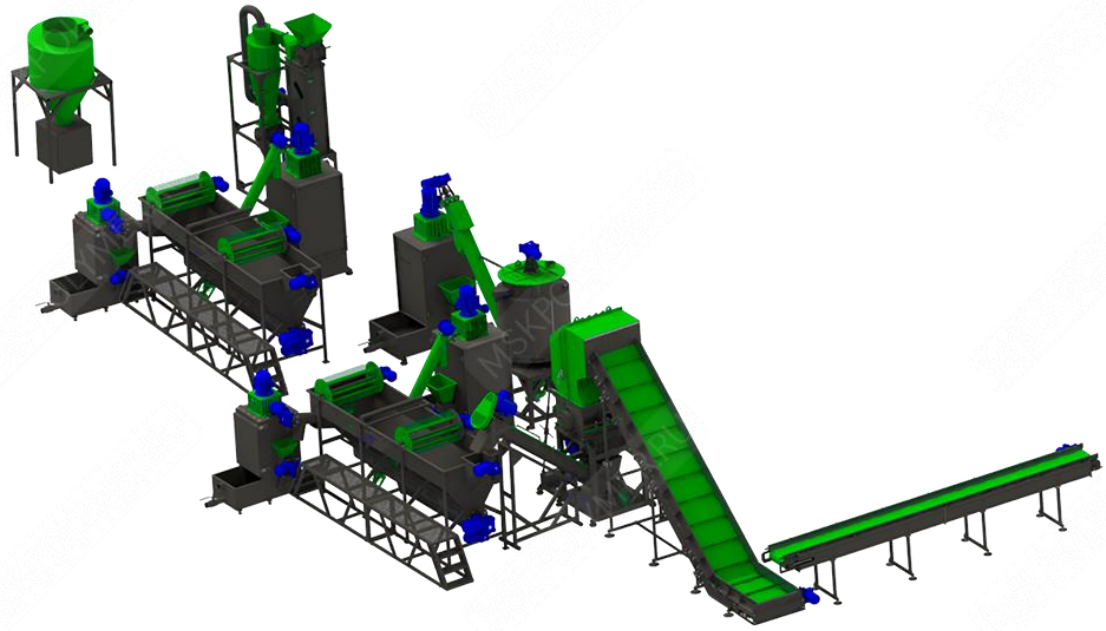


Figure 1. PET bottle recycling line

Recycling plastic into granules is a multi-stage process that turns used plastic products into valuable raw materials. Plastic waste is first collected from a variety of sources, such as separate collection containers, factories, and industrial waste. It is then sorted by type of plastic (polyethylene, polypropylene, PVC, and others), color, and quality. After sorting, the plastic is shredded into small pieces using special crushers. The size of the fragments depends on the type of plastic and its further use.

The next stage is washing and cleaning. Crushed plastic is washed with water to remove dirt, sand, food residues and other contaminants. Magnets and air separators are used to remove residual material. After that, the wet plastic is dried to remove moisture that can interfere with the extrusion process. Drying is carried out using thermal chambers or other methods. Cleaned and dried plastic flakes are fed into an extruder – a special device that heats and melts plastic [3]. Under pressure, the molten plastic passes through the die, forming granules of a certain shape and size. The shape of the granules can be different: cylindrical, disc-shaped, spherical, etc. Chilled pellets are packed in bags or containers for further use.

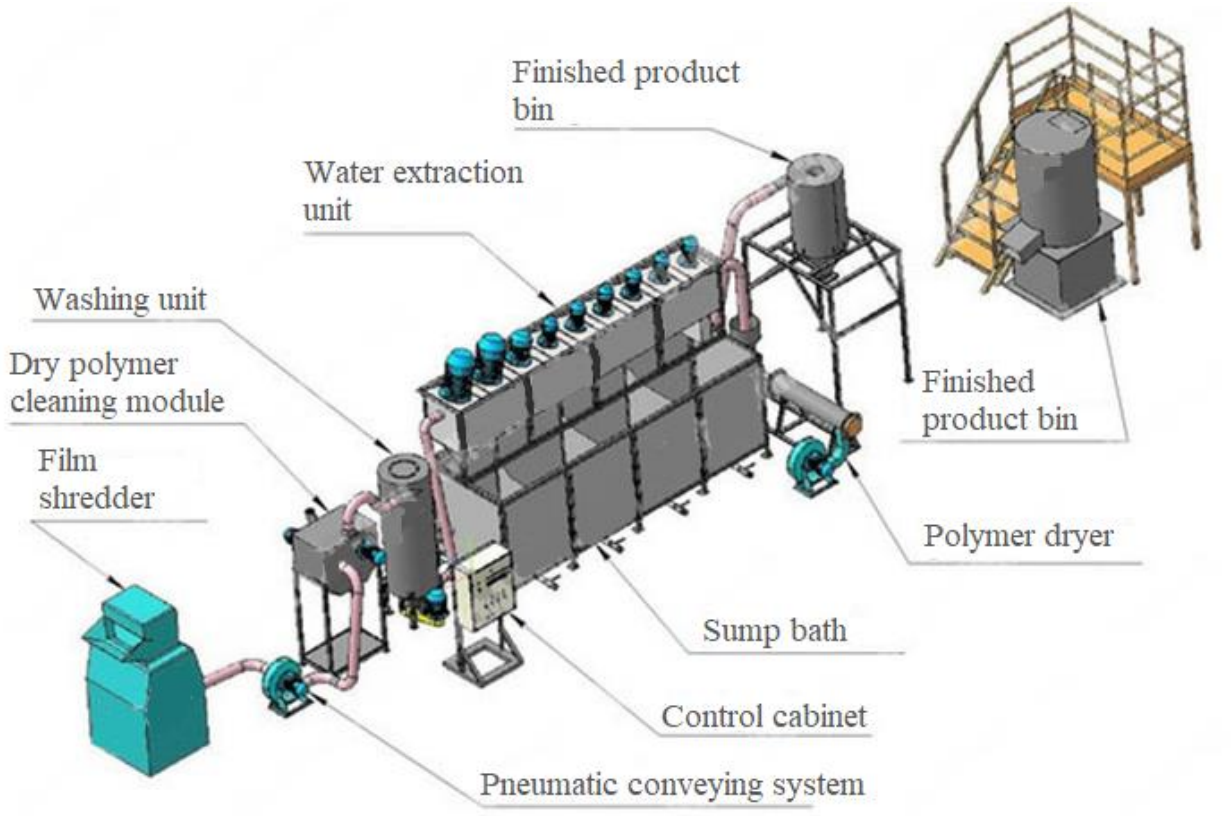


Figure 2. Plastic washing and cleaning line

Types of plastic for granulation: PET (polyethylene terephthalate): beverage bottles, food containers; **HDPE (high-density polyethylene):** detergent bottles, canisters, bags; **LDPE (low-density polyethylene):** bags, film, packaging; **PP (polypropylene):** drawers, containers, lids; **PVC (polyvinyl chloride):** pipes, windows, linoleum.

Plastic recycling lines are a complex chain of equipment connected in series, each of which has an important role in the process, however, the combinations of equipment can be different [4, p. 45].

First, the plastic goes to the sorting, where conveyor belts move it, magnetic separators remove metal objects, air separators separate light materials such as paper and film. Manual sorting or optical sorters complete the process by separating the plastic by type, color, and quality.

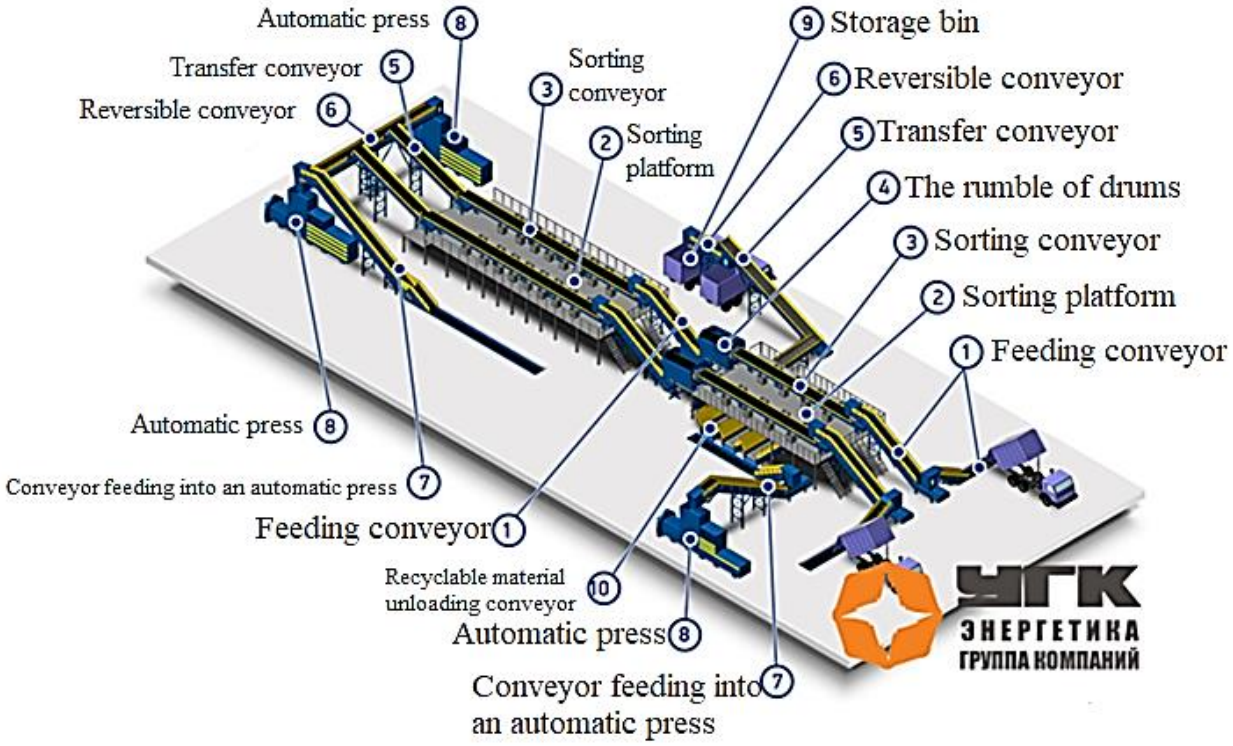


Figure 3. Plastic sorting line

Next, the plastic enters the shredding equipment, where crushers, cutters or shredders grind it into small fragments.

The next stage is cleaning. Water washers remove dirt, sand and other contaminants; Flotation cells separate light contaminants, filters are cleaned of fine particles, and centrifuges remove excess moisture.

Then the wet plastic is dried. Dryers, hot air dryers or infrared dryers remove residual moisture.

The cleaned and dried plastic enters the extruder, where it is melted and formed into granules. The spinneret gives the granules a certain shape and size. The pellet cooler completes the process by cooling and solidifying the pellets.

At the end of the process, the pellets are transported by conveyor belts and packed in bags or containers.



Figure 4. Main stages of plastic recycling

Monitoring systems with sensors and control systems automate and optimize the process by monitoring temperature, pressure, material level and other parameters [5].

China, as a world leader in the production and processing of polymers, offers a wide range of processing equipment, from simple lines to high-tech complexes. High competition in the market leads to more affordable prices for equipment, as well as the availability of spare parts and repair services. The introduction of innovative technologies ensures the emergence of more efficient equipment.

Russian manufacturers also offer equipment for recycling plastic waste. Their advantage lies in the proximity of production, which can be important for customers in terms of logistics and maintenance. Some Russian manufacturers offer high-quality equipment that is not inferior to foreign analogues.

Table – Comparison of technical parameters of equipment for processing PET into flakes produced in different countries

Characteristic	**PET 1000 Line**	**STANKO-1000**	**KGD-1000**	**BXPET-1000**
Country of origin	Russia	Belarus	Turkey	China
Performance кг/ч	1000	1000	1000	1000
Consumed power, kW	260	265	1100	210-260
The amount consumed water	No data	No data	25-35	3-5
Required Labor costs, people	2-8	2-3	1	4-5
Required area for placement,	No data	300	No data	425
Cost, million rubles	20	45	No data	9

From an economic point of view, lines from China often offer more attractive prices, which can be a decisive factor for customers with limited budgets. Modern Chinese equipment is highly efficient, providing increased productivity and reduced processing costs.

Analysis of the table comparing the technical parameters of equipment for processing PET into flakes produced in different countries shows that, despite the same declared capacity (1000 kg/h), the lines differ significantly in a number of other parameters.

The KGD-1000 line, made in Turkey, has a high consumption of electricity (1100 kW) and water (25-35 m^3/h) compared to other lines. At the same time, it requires the smallest number of personnel (1 person). The BXPET-1000 line, made in China, has the widest range of power consumption (210-260 kW) and the lowest water consumption (3-5 m^3/h), as well as the lowest cost (9 million rubles). The STANKO-1000 line, produced in Belarus, requires the largest area (300 m^2), the largest number of personnel (2-8 people) and has the highest cost (45 million rubles). The PET 1000 line, manufactured in Russia, has a power consumption in the range of 260 kW. However, there is no data on water consumption and accommodation area.

Thus, the choice of optimal equipment for processing PET flakes depends on priorities: saving energy and water, minimizing labor costs, minimizing space, low cost. In the case of prioritizing resource saving and low cost, the BXPET-1000 line made in China may be the most suitable option. If minimizing labor costs is preferred, then the KGD-1000 line made in Turkey may be more attractive. However, the lack of data on water consumption and footprint for PET 1000 and STANKO-1000 lines makes it difficult to make a final choice.

It is important to note that the recycling of plastic waste is allowed no more than 3 times, while the same capacity of the lines does not guarantee the same quality of the finished product. For the final choice, it is recommended to conduct an additional analysis, taking into account the quality of the flakes produced, the availability of service and support, and the reputation of the manufacturer.

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APPLICATION OF DISTRIBUTED ENERGY TO REDUCE ENERGY LOSSES IN HEATING NETWORKS

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Abstract. The article is devoted to an overview of distributed energy as a promising model of energy generation, in which sources are located near consumers, which significantly reduces losses during heat and electricity transmission. The key advantages of this system are considered, including high energy efficiency through the use of cogeneration plants and renewable energy sources, as well as its role in shaping a sustainable and environmentally friendly energy infrastructure of the future**.**

Keywords: distributed generation, energy supply, small generation, electric energy, thermal energy, efficiency, heating network, energy losses.

ПРИМЕНЕНИЕ РАСПРЕДЕЛЕННОЙ ЭНЕРГЕТИКИ ДЛЯ СНИЖЕНИЯ ПОТЕРЬ ЭНЕРГИИ В ТЕПЛОВЫХ СЕТЯХ

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Аннотация. Статья посвящена обзору распределенной энергетики как перспективной модели генерации энергии, при которой источники располагаются вблизи потребителей, что позволяет значительно сократить потери при передаче тепла и электроэнергии. Рассматриваются ключевые преимущества данной системы, включая высокую энергоэффективность за счет использования когенерационных установок и возобновляемых источников энергии, а также ее роль в формировании устойчивой и экологичной энергетической инфраструктуры будущего.

Ключевые слова: распределенная генерация, энергоснабжение, малая генерация, электрическая энергия, тепловая энергия, КПД, тепловая сеть, энергопотери.

Distributed energy is a model of energy generation in which sources are located in close proximity to consumers, integrating into local networks or operating independently. Unlike centralized systems, where energy is generated by large power

plants and transported over long distances, distributed energy minimizes losses by reducing energy transmission routes.

The key components of such a system are cogeneration plants such as micro-thermal power plants and gas piston units that produce both heat and electricity using the combined cycle principle. Their efficiency reaches 85-90 % due to the heat recovery of exhaust gases and coolants.

In addition, renewable energy sources are actively used in the distributed energy sector, including solar collectors, heat pumps and biogas plants. For example, solar panels combined with thermal accumulators can provide heating and hot water for low-rise buildings, reducing dependence on main networks. Energy storage systems such as buffer tanks for heat and electric accumulators play an important role, which help to balance peak loads and increase the stability of the system.

The advantages of distributed energy include a significant reduction in transport losses: when heat is transferred over distances of more than 2-3 km, losses in centralized systems reach 15-25 %, while local systems reduce them to 3-5 %. In addition, distributed energy is characterized by increased sustainability, as it is able to operate offline in case of accidents in the backbone networks, and environmental friendliness, since the use of renewable energy sources and highly efficient generators reduces co_2 emissions, contributing to the transition to a “green” economy [1, 2]. An example of the possible location of sources and consumers in a distributed energy system is shown in Figure 1.

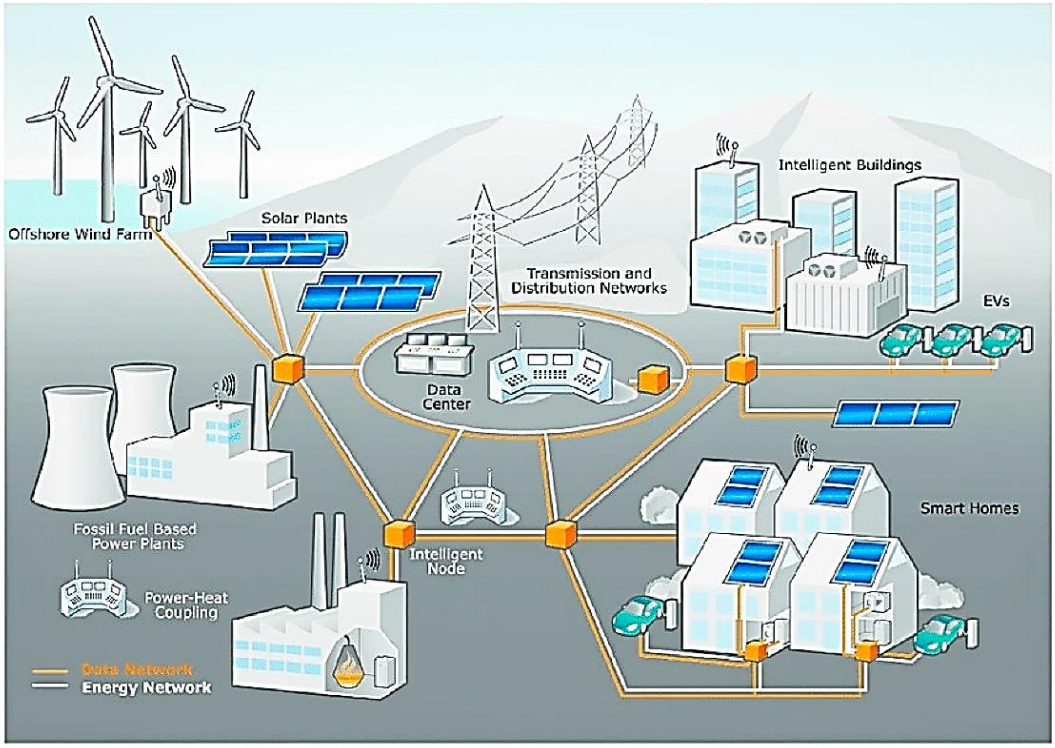


Figure 1. Energy distribution scheme

Losses in district heating systems remain a critical problem, especially in regions with worn-out infrastructure. In Russia, average losses in heating networks amount to

20-30% of the energy produced, and in some cases, for example, in cities with outdated communications, this figure reaches 40-50 %.

The main causes of such losses are thermal leaks caused by physical wear of pipelines, including corrosion and joint depressurization, which is typical for 70 % of networks in the Russian Federation that require urgent replacement. Inefficient insulation, for example, the use of mineral wool instead of modern materials such as polyurethane foam, exacerbates the situation. Hydraulic losses occur due to pumping of the coolant under excessive pressure, which leads to overspending of electricity by pumping stations, as well as load imbalance caused by uneven heat distribution between consumers in the absence of automated regulation [2].

Operational factors, such as outdated control circuits with manual temperature and pressure control, and a low diagnostic level due to the lack of real-time monitoring systems, further increase losses. For example, in a typical boiler house serving an area with a population of 50,000 people, annual heat losses can reach 5-7 Gcal per 1 km of network. This highlights the need to move towards more efficient heat supply models, including the introduction of distributed energy.

Distributed energy offers a set of mechanisms to minimize losses in heating networks based on generation localization, management optimization, and the introduction of innovative technologies. Localization of energy sources, such as micro-thermal power plants shown in Figure 2, or solar thermal power plants, reduces the distance of heat transportation to consumers, which directly reduces heat losses.



Figure 2. Micro-combined heat and power

For example, the installation of gas piston units in residential complexes or industrial zones provides heat and electricity supply directly to the facility, eliminating the need for transmission through long highways, where losses can reach 20-30 %. Combined cycle cogeneration plants simultaneously produce heat and electricity, increasing the overall efficiency of the system to 85-90 %. The heat that is often discharged into the environment in traditional CHP plants is recycled here for hot water, heating or technological processes, which additionally reduces energy consumption. Intelligent control, including IoT sensors and automatic control systems, allows load balancing in real time, adapting the operation of generators to the current demand.

For example, temperature and pressure sensors installed at network nodes transmit data to a central server, which optimizes the operating modes of the equipment, preventing overheating or underheating of the coolant. This is especially important to eliminate the imbalance in heat distribution between consumers, which often occurs in centralized systems due to manual control. Another mechanism is the integration of thermal energy storage devices, such as buffer tanks, which accumulate excess heat during periods of low demand and release it during peak hours, reducing the load on generators and the grid. The introduction of digital counterparts of thermal networks that simulate the operation of the system in a virtual environment allows you to predict accidents, test modernization scenarios and optimize the network topology without physical intervention [3, 4].

The use of distributed energy in heating networks demonstrates a significant reduction in energy consumption and a sustainable economic effect. Switching to local generation reduces the costs associated with heat transportation by minimizing the length of networks and eliminating intermediate links in the energy supply chain. Cogeneration plants, such as micro-CHP plants, provide simultaneous generation of heat and electricity with an efficiency of up to 90 %, which reduces unit costs per unit of energy produced. Savings are achieved not only by reducing transmission losses, but also by optimizing equipment operating modes, automated load management, and recycling of excess heat. Energy storage systems, including buffer tanks and thermal accumulators, balance supply and demand, reducing peak loads on generators and grid infrastructure. The introduction of intelligent monitoring and control systems, such as IoT sensors and digital twins, increases the accuracy of consumption forecasting, prevents accidents and reduces operating costs. The economic effect is manifested in reducing the payback period of projects to 3-5 years, due to reduced dependence on centralized networks, reduced connection fees and optimized fuel costs. For industrial enterprises, distributed energy means direct savings on energy resources and increased product competitiveness, while in the residential sector it helps to reduce tariffs for end users. The environmental aspect also contributes to the economy: reducing emissions of co_2 and other harmful substances allows avoiding fines and taking advantage of government subsidies for “green” projects.

The introduction of distributed energy into heating networks requires consideration of regulatory and technical conditions. The legislative framework governing small-scale generation in Russia includes Federal Law No. 35-FZ “On Electric Power Industry” (as amended on October 25, 2024) and government resolutions defining the procedure for connecting to the grid and tariffs for energy transmission. A key aspect is the simplified connection of generation facilities with a capacity of up to 15 kW, which encourages households to install solar panels or micro-thermal power plants. However, for projects with a capacity of more than 1 MW, there are strict requirements for coordination with system operators, including the provision of feasibility studies and expert examinations. The technical aspects of integration include the compatibility of distributed energy equipment with the existing infrastructure of thermal networks. For example, the connection of gas piston units to main pipelines requires the modernization of tie-in units and the installation of automatic pressure control systems.

The future of distributed energy in heat supply is associated with technological transformation and a change in the paradigm of energy system management. One of the key trends will be the growing share of renewable sources in local generation, including hybrid systems combining solar collectors, heat pumps and biogas plants. This will reduce dependence on fossil fuels and minimize the carbon footprint. The development of "virtual thermal power plants" – distributed generators integrated into a single network – will create conditions for the formation of decentralized energy clusters capable of flexibly redistributing resources between consumers [4].

Innovations in the field of heat storage, such as phase-shifting materials or thermochemical batteries, will solve the problem of seasonal imbalance of supply and demand, ensuring year-round stability of supply. Digitalization of heating networks through the introduction of digital twins and blockchain platforms for energy accounting will increase transparency and reduce transaction costs. In the medium term, microgrids are expected to grow – autonomous power systems that combine generation, storage and consumption of heat within individual neighborhoods or industrial zones. This will require the development of new business models, such as energy cooperatives or generator rental services. Government support through subsidies, green tariffs, and tax incentives will be a catalyst for the mass adoption of distributed solutions.

By 2030, the share of distributed energy in heat supply may reach 30 %, which will fundamentally change the structure of the energy market, making it more sustainable, flexible and end-user oriented.

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TO THE QUESTION OF MINIMIZING HEAT LOSS OF A LOW-STOREY BUILDING

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Abstract. The article discusses approaches to the design of an energy-efficient low-storey building. Special attention is paid to the use of heat pumps and heat recovery systems, which allow to significantly reduce energy consumption and provide a high level of living comfort. The data on the influence of the shape and orientation of the building on its energy characteristics, requirements for the enclosing structures are given.

Keywords: energy efficiency, low-storey building, heat pump, heat recovery, enclosing structures.

К ВОПРОСУ О МИНИМИЗАЦИИ ТЕПЛОПОТЕРЬ МАЛОЭТАЖНОГО ЗДАНИЯ

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Аннотация. В статье рассмотрены подходы к проектированию энергоэффективного малоэтажного здания. Особое внимание уделено применению тепловых насосов и систем рекуперации тепла, которые позволяют значительно снизить энергопотребление и обеспечить высокий уровень комфорта проживания. Приведены данные о влиянии формы и ориентации здания на его энергетические характеристики, требования к ограждающим конструкциям.

Ключевые слова: энергоэффективность, малоэтажное здание, тепловой насос, рекуперация тепла, ограждающие конструкции.

In the context of the global climate crisis, the accelerating depletion of fossil resources, and rising energy prices, issues of energy efficiency and conservation have become not only urgent but strategically essential across all areas of human activity. This problem is particularly acute in the construction industry, which, according to the International Energy Agency, accounts for nearly 37 % of global CO_2 emissions and

consumes approximately 36 % of the world's final energy. In Russia, the situation is equally strained: the country's housing stock is characterised by a high level of energy consumption, averaging 200-300 kWh/m² per year, which is 2-3 times higher than the figures for Northern European countries. One of the key steps towards sustainable development has been the adoption of Federal Law No. 261-FZ "On Energy Conservation and Enhancing Energy Efficiency", which established the legal framework for the implementation of energy-efficient standards. However, despite these legislative initiatives, there remains a lack of targeted government support in the country, limited funding for pilot projects, and a low level of public awareness regarding the potential of energy-saving technologies.

In these conditions, a particularly promising direction is the design and construction of energy-efficient low-rise buildings, where a comprehensive approach can be applied from the stage of architectural conception to the implementation of modern engineering systems. Low-rise construction offers a number of advantages: lower inertia, flexibility in choosing volumetric-planning solutions, the possibility of using local renewable energy sources, and high adaptability to climatic conditions. It is important to emphasise that the energy efficiency of a building is established not at the stage of installing expensive equipment, but at the initial stages of design. One of the fundamental principles is passive solar design, which allows for the use of natural processes for heating, lighting, and ventilation without active energy consumption. Research [1, 2] shows that rational orientation of the building and its shape can reduce the demand for thermal energy by up to 36 %. In this respect, building shapes with a minimal ratio of external surface area to volume – such as squares, rectangles, or circles – prove to be the most advantageous from an energy perspective, as they experience less heat loss through a smaller surface area of the enclosing structures (Fig. 1). However, when choosing a shape, one cannot ignore architectural, functional, and technological aspects, as energy efficiency must be combined with aesthetics, ease of use, and construction costs.

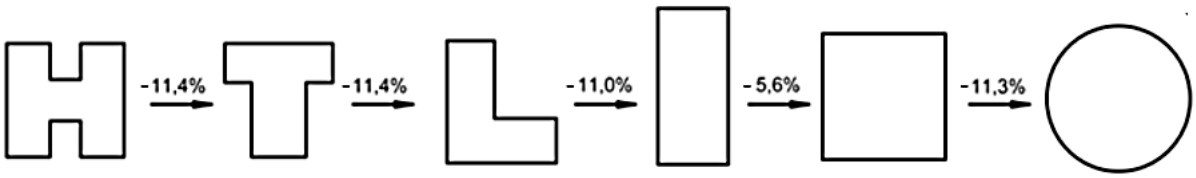


Figure 1. The impact of building shape on its energy consumption

The orientation of a building in relation to cardinal directions plays a crucial role. In temperate and northern latitudes, the optimal arrangement for the long facades of a rectangular house is along the east-west axis, allowing the southern facade to receive maximum solar radiation during the winter months. Sunlight penetrating through transparent structures warms the internal massive surfaces with high thermal inertia – such as concrete floors or brick partitions – which then slowly release heat into the interior throughout the night. For square buildings, the most advantageous orientation angles are 0°, 90°, and their multiples, as this also minimizes heating loads and evenly distributes solar radiation (Fig. 2) [3]. This approach helps reduce dependence on

external energy sources and ensures a comfortable microclimate even during the harsh Russian winter.

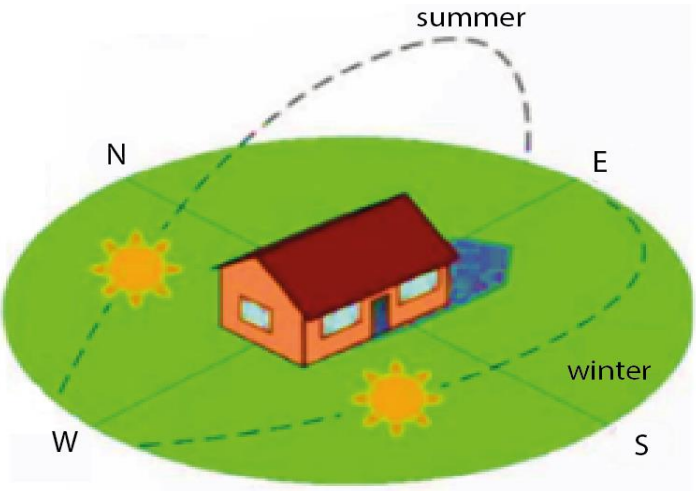


Figure 2. Preferred orientation of the building according to cardinal directions

However, even the most favorable shape and orientation cannot compensate for shortcomings in the construction of enclosing elements. Up to 70 % of the heat from a building can escape through its walls, windows, roof, and the ceilings above the basement or ground. Therefore, modern energy-efficient homes must have enclosing structures with extremely low thermal conductivity, high airtightness, good vapor permeability, and the absence of so-called thermal bridges. Thermal bridges are localized areas where, due to design features or breaches in insulation integrity, heat is transferred externally at an intensified rate. They can account for up to 30 % of a building's total heat loss and often lead to the formation of condensation, mold, and premature material degradation. To eliminate them, special connection nodes, additional insulation for corners, window frame perimeters, and balcony slabs, as well as monolithic construction technologies with subsequent external insulation, are employed.

Reducing heat loss through enclosing structures significantly decreases heating loads, which opens up opportunities for using low-temperature heating systems based on renewable energy sources. One of the most promising technologies in this area is heat pumps. According to forecasts from the International Energy Agency, by 2030, heat pumps will meet up to 22 % of global demand for heating in buildings, while in the European Union, their share already exceeds 40 % in new residential buildings. In Russia, despite a growing interest in this technology, the share of heat pumps remains at only 3-5 %, attributed to high initial costs and a lack of specialists. Nevertheless, the efficiency of heat pumps is supported by numerous studies: their coefficient of performance averages between 3 and 5, meaning they produce 3-5 kilowatts of thermal energy for every kilowatt of electricity consumed. The working principle of a heat pump is based on a cycle of compressing and expanding a refrigerant, which sequentially passes through an evaporator, compressor, condenser, and expansion valve, transferring heat from a low-potential source (air, water, ground) to the building’s heating system (Fig. 3).

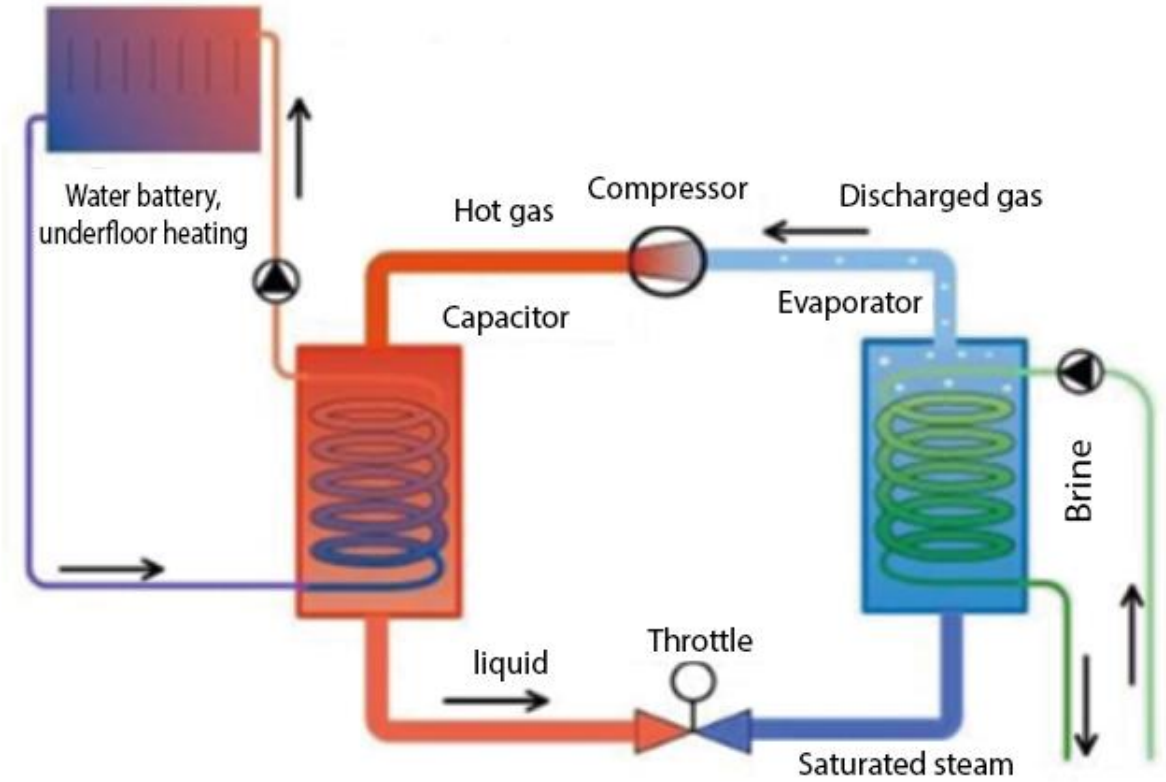
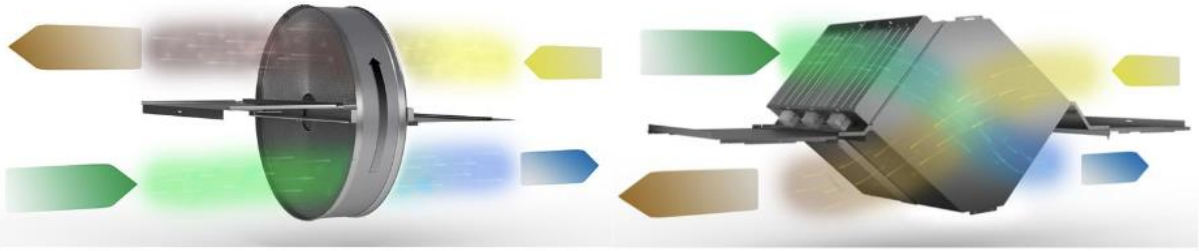


Figure 3. Operation principle of the heat pump

There are two main types of heat pumps: air-source and geothermal (GSHP). Air-source pumps are easier to install and cheaper to set up; however, their efficiency decreases at temperatures below -15 °C, which limits their use in northern regions of Russia. Geothermal pumps, which utilize the stable ground temperature at a depth of 1.5 to 2 meters (averaging +5…+10 °C year-round), operate significantly more reliably and can provide not only heating in winter but also passive cooling in summer. Despite the high capital costs of drilling or laying a horizontal collector, GSHPs can pay for themselves within 7 to 12 years if used year-round. It is important to note that for maximum efficiency, heat pumps should work in conjunction with low-temperature heating systems (30-50 °C). The most suitable solution in this case is a water-based underfloor heating system, which evenly distributes heat throughout the room and creates ideal conditions for comfort with minimal energy consumption.

In addition to heating, a significant portion of energy in a building is used for ventilation. In airtight energy-efficient homes, natural air infiltration is virtually eliminated, making mechanical supply and exhaust ventilation necessary. Without heat recovery technologies, up to 50% of total energy consumption can be spent on preheating the incoming air. A heat recovery system addresses this issue, using a heat exchanger—a device that transfers heat from warm exhaust air to cold incoming air. To date, there are two main types of heat recovery ventilators used in residential buildings: rotary and plate exchangers. A rotary heat exchanger consists of a rotating wheel with numerous microchannels made of special material with high thermal capacity (Fig. 4a). Its efficiency reaches 75-80 %, but it requires a small amount of

electrical energy for rotation and may allow slight mixing of air streams. In contrast, plate heat exchangers completely separate incoming and exhaust air and can achieve efficiencies of up to 93 %. They do not consume electricity during the heat exchange process and are considered the most reliable and hygienic (Fig. 4b).



a b

Figure 4. Heat exchangers:
a – rotary type; b – plate type

In advanced projects, heat recovery systems are integrated with heat pumps: the heat pump is used for further cooling or heating of the air after the heat recovery unit, especially in transitional seasons. To prevent unpleasant odors caused by dust heating on the surfaces of the air heater, the maximum temperature of incoming air is limited to 54 °C. In energy-efficient homes with low heating loads (no more than 10-15 W/m²), even such a limit is sufficient to ensure complete heating through an air heating system [4]. This synergistic approach allows for the creation of nearly zero-energy buildings that meet European standards and are gradually being implemented in Russian practice.

It is also worth mentioning that energy efficiency is not just a technology but a mindset. In countries with developed “green” architecture, such as Germany, Sweden, or Finland, over 70 % of new low-rise homes are built according to the Passivhaus standard, which allows for an annual energy consumption for heating of no more than 15 kWh/m². In comparison, in a typical Russian home, this figure is 120-180 kWh/m². Meanwhile, the cost of building an energy-efficient home is, on average, only 10-15 % higher, but this difference pays off in 5-10 years due to savings on utility bills [5]. As the cost of 1 Gcal of thermal energy in Russia continues to rise (in 2024, the average price ranged from 2,400 to 3,200 rubles depending on the region), the economic benefits of energy-efficient construction are becoming increasingly clear.

In conclusion, creating an energy-efficient low-rise building is the result of a synthesis of architectural thought, advanced building materials, and innovative engineering solutions. This approach not only reduces operating costs and enhances living comfort but also makes a real contribution to combating climate change and achieving national sustainable development goals. For the widespread adoption of such solutions in Russia, systemic measures are necessary: government subsidies, preferential loans, specialist training, and an information campaign among the population. Only through a comprehensive approach can energy-efficient construction move from a niche to mainstream practice and become the new standard for future generations.

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COMPARATIVE ANALYSIS OF METHODS FOR CALCULATING THE UNIVERSAL INDEX OF INFORMATION SYSTEMS RESILIENCE

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Abstract. This paper analyzes various methods for calculating an integrated resilience index for an information system, which allows for assessing of the relationship between key system performance indicators and external influences in a format suitable for further processing by automated security systems. The article discusses various index formation methods, their advantages and disadvantages, and possible index composition, as well as a comparison with existing alternatives.

Keywords: resilience, information system, external shocks, integral index, up-time, reliability.

СРАВНИТЕЛЬНЫЙ АНАЛИЗ МЕТОДОВ РАСЧЕТА УНИВЕРСАЛЬНОГО ИНДЕКСА РЕЗИЛЬЕНТНОСТИ ИНФОРМАЦИОННЫХ СИСТЕМ

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Аннотация. В рамках данной работы проведен анализ различных способов расчета интегрального индекса резильентности информационной системы, который позволяет оценить взаимосвязь между ключевыми показателями функционирования системы и внешними воздействиями в формате, пригодном для дальнейшей обработки автоматизированными системами безопасности. В статье рассматриваются способы формирования индекса, их преимущества и недостатки, возможный состав индекса, проводится сравнение с существующими аналогами.

Ключевые слова: резильентность, информационная система, внешние шоки, интегральный индекс, отказоустойчивость, надежность.

Introduction. Under conditions of unprecedented digitalization speed and growing complexity of cyber threats, the resilience of information systems (IS) has become a critically important aspect that determines their ability to successfully withstand external impacts and failures. The use of automated information security systems is becoming the norm. Such systems make it possible to minimize the human factor and transfer knowledge from information security provider companies to organizations in other industries. These systems allow outsourcing part of the risk, reducing the number of qualified personnel required – an extremely relevant task in the modern Russian economy, which is experiencing an acute labor shortage.

However, the use of automated security systems imposes several constraints on the data they operate with. Dashboards and multidimensional graphs used by human operators are excessive for such systems in their graphical representation. At the same time, human operators working with IS require a visual indicator that characterizes the general state of a system.

Information system resilience is the ability of an IS to respond effectively to negative environmental manifestations, minimizing damage and rapidly restoring its functions while maintaining the operability of core services. A resilience indicator must be visually interpretable for IS operators and strictly formalized in numerical form for processing by automated security systems.

The purpose of this study is to form an integral index for assessing the resilience of an information system to negative external shocks.

Related work. An information system is understood as a set of information contained in databases, as well as technical means, processes, and methods of searching, collecting, storing, processing, providing, and distributing such information, as well as methods of implementing such processes and methods [1].

It is also necessary to clarify the semantic space implied by the term “resilience”. This term is primarily used in psychology and economics, but the authors consider its potential field of application to be much wider.

Thus, the resilience of an information system is its ability not simply to avoid failures, but to adapt to them, continuing to perform critically important functions even when part of the system has failed. Unlike the classical term “fault tolerance”, which focuses on the ability of a system to continue operation under a physical component failure (for example, through redundancy or duplication), resilience encompasses a broader context. It includes the ability of a system to overcome an adverse external environment. For instance, such a system can withstand cyberattacks, internal configuration errors, or failures in interactions between modules.

The term “resilience” is chosen because concepts such as “reliability” have ambiguous interpretations. On the one hand, reliability is often translated from English as up-time, meaning one of the generally accepted performance indicators calculated as the probability of failure-free system operation over a given time. Obviously, like fault tolerance, this is a narrower concept.

On the other hand, reliability can be defined more broadly, as some authors do, describing it as a composite indicator including such characteristics as failure-free performance, durability, maintainability, and operability [2]. Naturally, an

automatically calculated indicator – such as resilience – is not capable of incorporating the notion of "maintainability".

There also exists an intermediate use of this term, where reliability is interpreted as an abstract characteristic measured by indicators such as Mean Time Between Failures (MTBF) and Mean Time to Recovery (MTTR).

Nevertheless, even if reliability is defined as failure-free performance – the ability of an IS to maintain operability for a predetermined time [2] – it remains incomplete. One can say that a reliable system aims not to fail, a fault-tolerant one – to continue operating even after failure, while a resilient one – to change so as to independently restore its state prior to the shock and prevent degradation of the entire system as a result.

Therefore, the purpose of this work is not to replace already existing and established concepts such as reliability, security, integrity, availability, or performance, nor key indicators such as up-time. The resilience index is a high-level tool that generalizes these concepts.

Turning to methods of high-level IS characterization, many existing approaches can be noted. One may investigate the quality of the code forming the basis of an IS [3], or conduct an extensive analysis of IS quality that takes into account not only reliability, performance, and security but also usability, maintainability, and portability [4]. It is also possible to evaluate the interconnection of IS components in the context of their corresponding potential cyber resilience threats [5, 6].

All these methods may be useful. Code quality assessment can be useful when improving a system upon emergence of new threats or adding new modules. Comprehensive IS quality assessment is necessary at the stage of putting it into operation, and cyber resilience analysis – which includes an extended list of cybersecurity components – can improve the quality of predictive analytics.

However, it becomes clear that there is little research on forming an indicator that characterizes an IS not probabilistically, at a planning level, but at the operational level at a given moment in time, demonstrating the current system state considering environmental influence. Moreover, such an indicator should be universal or at least easily adaptable to various business and government spheres. In addition, the indicator should be both understandable to humans and formalized for subsequent processing within automated security systems.

Conceptually, the closest to these requirements are the "Functional Resilience Metric" (FRM) and the "Security Efficiency Index" (SEI) [7].

The first of these metrics is declared as a tool that makes it possible to numerically assess "the degree of system resilience to incidents and technical failures" [7], which is highly consonant with the idea of a resilience index. The authors state that FRM "makes it possible to assess how well an organization can cope with unexpected situations, minimizing their impact on its processes" [7], and provide the following formula:

$$\mathrm{FRM}=\alpha \times \frac{\mathrm{UF}/\mathrm{UF}_{\max}\times \mathrm{PAL}\times \mathrm{SRC}}{1+\ln(1+\mathrm{ADT}/\mathrm{ADT}_{\max})},$$

where α is a coefficient, ADT is the average downtime, ADT_{max} is the maximum downtime, UF is the system update frequency, UF_{max} is the maximum update frequency, PAL is the share of automated processes, and SRC is the employee readiness index.

The formula for calculating the integral security efficiency indicator is not provided here, but it also includes a number of expert-defined coefficients, natural logarithm computation, and exponentiation. The essence of this indicator is the combination of three metrics: DEM – the effectiveness of security measures, TAM – threat assessment, and FRM. In turn, DEM and TAM also involve calculating natural logarithms and exponentiation.

These indicators and alternatives are compared below.

Methodological Foundations. Let us denote several aspects essential for forming a resilience index. An IS resilient to negative environmental manifestations can reasonably be understood as having weak sensitivity of its critical indicators (e.g., response time, availability) to external impacts. That is, for a resilient system, negative external shocks will exert minimal influence [8].

Accordingly, two indices are introduced: the external shock index (negative environmental manifestations) – showing external negative influence, and the system stability index – showing values of IS operability metrics. Both indices are measured at the same moments in time so that subsequent comparison is possible.

The composition of indices may change but must correspond to their names. Possible components of the system stability index may include the above-mentioned MTBF, MTTR, up-time, as well as the share of free CPU/GPU/RAM, response time, and other metrics corresponding, in the opinion of the IS operator, to the field of system use. For example, when using the resilience index as part of an AI agent that ensures cybersecurity, the stability index may include such indicators as interrupt frequencies, micro-stutters of the cache subsystem, system call delays [9].

Components of the external shock index may be: the number of vulnerabilities with CVSS ≥ 9 relevant to the given IS; the number of activations of Intrusion Detection Systems (IDS); the volume of traffic coming from outside to network devices. The list of metrics can also be expanded and may represent, as in the case of IDS activations, the results of automated cybersecurity subsystems, including AI-based ones.

The next step was to carry out a correct comparison of the two indices in order to obtain resilience index values. At the same time, the mathematical meaning of the resulting index should be such that a value close to 1 would mean a higher degree of IS resilience, and a value close to 0 – non-resilience.

The difficulty in carrying out this analysis lies in the fact that intuitive methods such as time series analysis and correlation coefficients cannot be used in this case. The reason for this is the need for real-time resilience assessment – correlation analysis assumes comparing two data arrays to obtain a single numerical value. In this case, however, it is necessary to compare only two values at each moment in time (time series analysis is impossible for the same reason). In addition, as the number of observations grows, the correlation coefficient will change less and less.

Mathematically, possible methods for forming the final index include addition of the two indices, their difference, quotient, and product, as well as the use of a more complex function, such as a logarithm of one index with the other as basis, or exponentiation.

1. Sum of indices

Let the integral resilience index be calculated as:

$$R_1 = \alpha \times Y + \beta \times (1 - X), \alpha + \beta = 1,$$

where X is the external shock index, Y is the system stability index, α and β are some weights indicating the significance of stability and external shocks, respectively, for a particular IS.

Higher values of R_1 indicate a more resilient IS. The advantages of this approach are clarity and computational simplicity, interpretability, and a small number of expert-defined parameters. The condition $R_1 \in [0,1]$ is also met.

At the same time, the model assumes a linear relationship between shocks, stability, and resilience, which may conceal complex interactions. For example, a slight drop in stability under the influence of a highly aggressive environment may be more critical than the index value suggests. There is also a risk of one index dominating the other if coefficients are poorly selected.

It can be concluded that R_1 is suitable for IS where metric interpretability is crucial and shocks and stability can be considered linearly dependent with resilience.

2. Difference of indices

Let the integral resilience index be calculated as:

$$R_2 = (Y - X + 1)/2.$$

Higher values of R_2 indicate a more resilient IS. Advantages of this approach include the absence of expert-defined parameters, interpretability, and computational simplicity. The condition $R_2 \in [0,1]$ is also met.

However, it should be noted that the absence of expert parameters may reduce index flexibility, leaving the only possibility for adjustment to changing component metrics of indices X and Y. Also, as in the case of R_1, shocks and stability must be considered linearly dependent with resilience.

This index will be useful for IS where parameter assessment is difficult or impossible, and for systems where frequent revision of key performance indicators is undesirable. If necessary, coefficients may be introduced for X and Y, but in that case R_2 becomes simply a version of R_1.

An alternative approach is the geometric interpretation of R_2, allowing a transition to resilience index calculation using Euclidean distance.

In this case, data obtained across different years are plotted in a Cartesian coordinate system, where the X-axis shows external shocks and the Y-axis shows system stability.

Placement of a point in the upper-left quadrant (Quadrant II) indicates low shocks and high stability – the most desirable state corresponding to the highest index values; in the upper-right quadrant (Quadrant I) – high stability with high external shocks – a somewhat less desirable option, as countering shocks depletes system resources; in the lower-left quadrant (Quadrant III) – low values of both shocks and

stability, indicating a risk of internal failures; the lower-right quadrant (Quadrant IV) indicates that the system is unable to cope with external shocks and is in a critical state.

The formula of the integral resilience index in this case will be:

$$R_2 = \sqrt{(X-1)^2+(Y-0)^2}/\sqrt{2} = \sqrt{(1-X)^2+(Y)^2}/\sqrt{2}.$$

Thus, the transition is made to the distance from a point to, for example, (1, 0) – the point of maximum stability and absence of shocks. Selection of a point later allows changing the target level of system resilience.

3. Quotient of indices

Let the integral resilience index be calculated as:

$$R_3 = \frac{Y/(X+\epsilon)}{1+Y/(X+\epsilon)},$$

where ε is a small constant.

Higher values of R_3 indicate a more resilient IS. Advantages of this approach include the ability to demonstrate a nonlinear relationship between resilience, environment, and IS stability, absence of expert-defined parameters, interpretability, and computational simplicity. The condition $R_3 \in [0,1]$ is also met.

A weakness of this approach is the inability to capture linear relationships, as well as the inability for fine adjustment via coefficients, although this can be resolved by introducing them, as in the previous methods.

This index will be useful for IS with nonlinear relationships, characterized by existence at extreme resilience index values.

4. Product of indices

Let the integral resilience index be calculated as:

$$R_4 = Y \times (1-X).$$

Higher values of R_4 indicate a more resilient IS. Advantages of this approach include the absence of expert-defined parameters (which can be introduced if needed), interpretability, and computational simplicity. The condition $R_4 \in [0,1]$ is also met.

At the same time, unlike the difference-based calculation method, the rate of change of the index does not vary based on both components of the final index simultaneously. For example,

$$\Delta R_4 = 0{,}9 \times (1-0{,}5) - 0{,}9 \times (1-0{,}51) \approx 0{,}009 \approx 0{,}9 \times (1-0{,}9) - 0{,}9 \times (1-0{,}91),$$

while

$$\Delta R_3 = \frac{0{,}9/(0{,}5+\epsilon)}{1+0{,}9/(0{,}5+\epsilon)} - \frac{0{,}9/(0{,}51+\epsilon)}{1+0{,}9/(0{,}51+\epsilon)} \approx 0{,}005 \neq 0{,}003 \approx \frac{0{,}9/(0{,}9+\epsilon)}{1+0{,}9/(0{,}9+\epsilon)} - \frac{0{,}9/(0{,}91+\epsilon)}{1+0{,}9/(0{,}91+\epsilon)}.$$

This index may be useful for highly sensitive IS in which the influence of the external environment and stability are highly significant not only in critical states but throughout the entire operational period.

5. Logarithm of indices

Let the integral resilience index be calculated as:

$$R_5 = \frac{\log_{1+X+\alpha}(1+Y)}{\log_{1+\alpha}(2)},$$

here, the denominator is a normalizer of the index over the range [0,1], and α is a coefficient that makes it possible to compute the index when X = 0 and to scale the index. This coefficient is not necessarily small and is defined by expert judgment.

In addition to requiring α to be set, R_5 poses interpretational difficulties. For example, $R_5(1, 1, \alpha = 0.1) \approx 0.1285$ – it is difficult to assign a clear meaning to this

value; a value of ~0.5, which has an intuitively understandable borderline meaning for R_5, is achieved, for example, at X = 0.094 and Y = 0.906.

One may say that this index is suitable for high-risk systems whose probability of losing resilience increases under external influence even when system stability is high (a situation of fragile stability).

6. Power function of indices

Let the integral resilience index be calculated as:

$$R_6 = Y^{1-X}.$$

Exponentiation is an example of a poorly chosen function. In this work it is considered as an example of a broad set of functions that will not reflect the logic of resilience index formation. For instance, when Y or X equals 1, R_6 will always equal 1, which is entirely incorrect (this means, for example, that the maximum level of shocks produces maximum resilience at any system stability).

Results. As many authors have noted, there is no single integral metric that would demonstrate system sustainability, reliability, or resilience. The functions listed above can be used independently or combined to form more complex indices. Such combined indices were not the primary focus of this work, since index complexity does not necessarily lead to greater universality, and the patterns found in data that justify a certain combination may change, creating difficulties in operational IS maintenance.

The indices R_1–R_5 presented above are based on a small set of functions, allow capturing linear and nonlinear dependencies, many of them are interpretable, and can be modified when necessary by adding coefficients.

Compared to existing metrics such as FRM and SEI described above, it can be noted that R1–R5 are significantly more universal and clearer.

The use of ln(1+x) for $x \in [0,1]$ in (1) appears to be excessive complication due to the similarity of this function to a linear one over the given interval. In addition, specific metrics are indicated, some of which cannot be easily evaluated (for example, SRC—the employee readiness coefficient) or may bias the final index toward the number of measures rather than their quality (number of updates without considering quality in UF). The structure of the final SEI index is also extremely complex and its maintenance in real-world conditions appears extremely challenging. Finally, it should be noted that FRM relies on historical values, whereas the resilience indices proposed in this work can be used immediately, based on operational data.

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INFLUENCE OF NANOTECHNOLOGIES ON THE STRENGTH CHARACTERISTICS OF CARDBOARD FOR TRANSPORT PACKAGING

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Abstract. This work investigates the influence of nanotechnologies on the mechanical properties of corrugated board used in transportation packaging. Experiments were conducted to study changes in tensile strength, moisture resistance, and deformation resistance when modifying the cardboard with nano-adhesives, nanocellulose, and polymer nanoparticles. It was demonstrated that the use of nanomaterials significantly improves the mechanical properties of the cardboard. The most effective material turned out to be a nano-adhesive, which provided an increase in strength by 25–30 %. The results confirm the promising application of nanotechnologies in the packaging industry for creating materials with enhanced performance characteristics.

Keywords: nanotechnologies, cardboard strength properties, nanomodification, transport packaging, nano-adhesive, nanocellulose, moisture resistance.

ВЛИЯНИЕ НАНОТЕХНОЛОГИЙ НА ПРОЧНОСТНЫЕ ХАРАКТЕРИСТИКИ КАРТОНА ДЛЯ ТРАНСПОРТНОЙ ТАРЫ

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Аннотация. В данной работе исследуется влияние нанотехнологий на прочностные характеристики картона для транспортной тары. В ходе экспериментов изучались изменения разрывной нагрузки, влагостойкости и стойкости к деформации при модификации картона наноклеем, наноцеллюлозой и полимерными наночастицами. Показано, что использование наноматериалов значительно улучшает механические свойства картона. Наиболее эффективным оказался наноклей, обеспечивший повышение прочности на 25–30 %. Результаты подтверждают перспективность применения нанотехнологий в упаковочной индустрии для создания материалов с улучшенными эксплуатационными характеристиками.

Ключевые слова: нанотехнологии, прочностные характеристики картона, наномодификация, транспортная тара, наноклей, наноцеллюлоза, влагостойкость.

Current trends in the packaging industry impose increased demands on the functional properties of materials used in the production of transport packaging. One of the key factors determining the efficiency of corrugated board as the primary material for packaging is its strength. Strength characteristics directly affect the ability of packaging to protect products from mechanical damage, maintain integrity during transportation and storage, and ensure ease of use [1].

However, traditional types of cardboard, such as corrugated board or solid board, often cannot cope with increasing loads, especially under external influences like high humidity, temperature fluctuations, and prolonged storage. This leads to reduced reliability of packaging and increased economic losses associated with product damage.

In recent years, nanotechnology has been actively implemented in various industries, including the production of packaging materials. The use of nanomaterials offers new possibilities for modifying cardboard, enabling significant improvement of its physical-mechanical properties. Nanoparticles such as nanoclay, nanocellulose, or polymeric additives can strengthen the structure of the material, enhance its barrier properties, and increase resistance to external influences [2].

The study of the impact of nanotechnologies on the strength characteristics of cardboard represents an important step in the development of modern packaging solutions. It not only enhances the quality of transport packaging but also provides a foundation for developing new environmentally safe and economically efficient materials.

Research into the application of nanotechnologies for modifying packaging materials has been actively developing over the past decades. Particular attention is paid to cardboard, which is one of the most common materials for transport packaging due to its availability, environmental friendliness, and relatively low cost.

However, its main drawbacks – low strength under high humidity conditions and limited resistance to mechanical stresses – require finding new solutions. Among the nanomaterials used for cardboard modification are nanoglasses, such as montmorillonite, which have a layered structure allowing them to create barrier coatings that reduce the permeability of the material to water and gases. Studies show that adding nanoglass to cardboard increases tear strength by up to 40 and significantly improves moisture resistance.

Nanocellulose, obtained from plant fibers, is used as a filler or coating and enhances the mechanical properties of cardboard by forming a dense network-like structure. In several studies, it has been noted that using nanocellulose increases the stiffness of cardboard by 30–50 % [3]. Polymer nanoparticles are used to create protective coatings that improve the material's resistance to external influences; for example, polymer additives can reduce cardboard water absorption by 60 %.

Scientific literature describes various methods of incorporating nanomaterials into the structure of cardboard. Surface coating involves applying nanomaterials onto the surface of cardboard using spraying or dipping techniques, which is commonly used to enhance moisture resistance and barrier properties of the material. Impregnation refers to treating cardboard with solutions containing nanoparticles, allowing for uniform distribution throughout the material's structure. Incorporation into

composition entails introducing nanomaterials directly into the pulp during cardboard manufacturing, providing deeper modification of its properties.

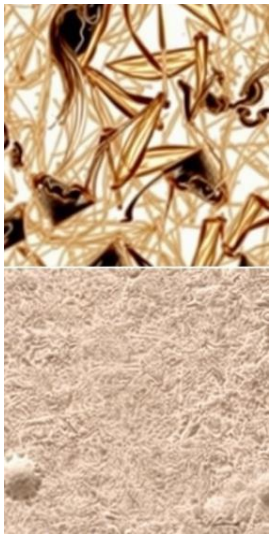


Figure. Microstructure of Cardboard Before and After Modification with Nanomaterials

The use of nanotechnologies in cardboard production offers several advantages, such as improved strength and durability of the material, enhanced barrier properties protecting against moisture, oxygen, and other factors, as well as the potential to develop eco-friendly materials. However, there are limitations, including the high cost of nanomaterials, technological challenges in implementing these technologies on a large scale, and the need for additional safety research regarding the use of such materials [4].

Table 1 – Comparison of Properties of Cardboard Modified with Different Nanomaterials

Type of Cardboard	**Tensile Strength, N/m**	**Moisture Absorption, %**	**Deformation Resistance, %**
Regular Cardboard	500	25	10
Cardboard with Nanoclay	700	15	15
Cardboard with Nanocellulose	650	18	12

The study aimed to investigate the effect of nanotechnologies on the strength characteristics of cardboard used in transport packaging. For this purpose, samples of smooth and corrugated cardboard were selected and modified using different types of nanomaterials. As basic nanomaterials, nano-adhesive, nanocellulose, and polymer nanoparticles were applied. Each of these materials was integrated into the cardboard by one of three methods: surface coating, impregnation, or direct addition of nanoparticles into the cardboard composition during its manufacture.

To evaluate the effectiveness of the modifications, tests were carried out measuring tensile strength, moisture resistance, and deformation resistance. Tensile strength was measured using a tensile testing machine, which recorded the force required to break the sample. Moisture resistance was determined by immersing the samples in water for a specified period and then measuring their mass before and after testing, calculating the level of water absorption. Deformation resistance was assessed using a climate chamber where the samples underwent cyclical changes in temperature and humidity. Additionally, bending tests were performed to assess the rigidity of the material.

All experiments were conducted under laboratory conditions using state-of-the-art equipment. To measure tensile strength, a universal testing machine Shimadzu AGS-X was employed, ensuring high measurement accuracy. Moisture resistance was studied using an AquaTest Pro series water absorption analyzer. The climatic chamber ESPEC SH-241 allowed simulating various external conditions, which was crucial for evaluating the behavior of materials in real operational situations.

To ensure the reliability of the results, each test was repeated no less than five times for each type of sample. The data obtained were processed using mathematical statistical methods. This made it possible to identify significant differences between the characteristics of conventional and nanomodified cardboard. Special attention was given to the dependence of the material's properties on the type and concentration of nanoparticles. For instance, the effects of nano-adhesive and nanocellulose on the barrier properties of cardboard were investigated, while the influence of polymer nanoparticles on its mechanical strength was examined.

Therefore, the methodology of the study was aimed at comprehensively assessing the changes in the physico-mechanical properties of cardboard under the influence of nanotechnologies. This approach enabled not only comparing the characteristics of modified and unmodified samples but also identifying the most promising directions for further technology development.

During the experiments, quantitative data demonstrating the influence of different types of nanomaterials on the strength characteristics of cardboard were obtained. All results are presented in tables for easy analysis.

Table 2 – Tensile Strength of Cardboard, N/m

Type of Cardboard	**Regular Cardboard**	**Nanoadhesive**	**Nanocellulose**	**Polymeric Nanoparticles**
Smooth Cardboard	200	250	240	230
Corrugated Cardboard	180	230	220	210

Adding nanomaterials significantly increases the tensile strength of cardboard. The most effective proved to be the nano-adhesive, which increased the strength of smooth cardboard by 25 % and corrugated cardboard by 27 %. Nanocellulose also showed good results, achieving a strength increase of 20–22 %. Polymeric

nanoparticles were less effective but still managed to raise the tensile strength by 15 % [5].

Table 3 – Water Absorption of Cardboard, %

Type of Cardboard	Regular Cardboard	Nanoadhesive	Nanocellulose	Polymeric Nanoparticles
Smooth Cardboard	85	51	59	72
Corrugated Cardboard	92	55	64	78

Modification of cardboard with nanomaterials significantly reduces its water absorption. The nano-adhesive proved to be the most effective, reducing this indicator by 40 %. Nanocellulose decreased water absorption by 30 %, which is also a substantial improvement. Polymeric nanoparticles had a lesser effect, decreasing water absorption by only 15 % [6].

Table 4 – Deformation Resistance of Cardboard, %

Type of Cardboard	Regular Cardboard	Nanoadhesive	Nanocellulose	Polymeric Nanoparticles
Smooth Cardboard	100	135	130	115
Corrugated Cardboard	100	130	125	110

Using nanomaterials significantly increases the deformation resistance of cardboard. The nano-adhesive provided the greatest improvement: the resistance of smooth cardboard increased by 35 %, and corrugated cardboard by 30 %. Nanocellulose also yielded good results, increasing resistance by 25–30 %. Polymeric nanoparticles were least effective, raising this parameter by only 10–15 %.

Data analysis shows that the most effective nanomaterial is nano-adhesive, which ensures significant improvements in all tested characteristics: tensile strength, water absorption, and deformation resistance. Nanocellulose also demonstrates good results, particularly in terms of ecological sustainability and barrier properties. Although polymeric nanoparticles lag behind in effectiveness, they may be beneficial in cases where a combination of mechanical strength and flexibility is needed.

The obtained data confirms that nanomaterials significantly improve the physicomechanical properties of cardboard. This is explained by their ability to fill microscopic pores and form additional bonds within the material's structure. For example, nano-adhesive forms barrier layers that reduce water absorption, while nanocellulose enhances mechanical strength due to its high specific surface area.

However, the implementation of such technologies faces certain limitations. The main barriers include the high production costs and the necessity of specialized equipment. Furthermore, long-term environmental and toxicological effects of using nanomaterials require additional research.

Despite these challenges, the prospects for using nanomodified cardboard in transport packaging are evident. Improved strength and moisture resistance allow for broader applications, especially in environments with high humidity or mechanical stress.

As a result of the conducted research, it was established that the application of nanotechnologies significantly improves the physicomechanical properties of cardboard for transport packaging. Nano-adhesive, nanocellulose, and polymeric nanoparticles demonstrate varying levels of effectiveness, yet all contribute to increasing tensile strength, reducing water absorption, and improving deformation resistance. The most promising material proved to be nano-adhesive, which ensured maximum enhancement of all studied characteristics.

The practical significance of the study lies in the possibility of using nanomodified cardboard for producing transport packaging capable of withstanding increased mechanical loads and exposure to external factors such as humidity. This opens up new opportunities for the packaging industry, enabling better product quality and lower losses during transportation.

For future research, it is recommended to study the long-term effects of using nanomaterials, their environmental safety, and the economic feasibility of implementing them in mass production. Developing hybrid modification methods combining multiple types of nanomaterials to achieve optimal properties is also of interest.

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ENERGY MANAGEMENT IN THE CONTEXT OF TRANSITION TO A LOW-CARBON ECONOMY

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Abstract. The paper examines the management challenges faced by heat supply organizations in Saint Petersburg in the context of the global transition to a low-carbon economy. It analyzes the regulatory framework, the current state of the city's heat supply system, and the key barriers to decarbonization – financial, technological, human resources, and organizational. Special attention is given to the role of energy management as a tool for adapting to new environmental and regulatory requirements. Based on a review of practices implemented by leading industry players, the paper proposes management solutions aimed at integrating ESG principles, improving energy efficiency and reducing the carbon footprint.

Keywords: low-carbon economy, energy management, heat supply, decarbonization, ESG, energy efficiency, carbon footprint, combined heat and power plant.

ЭНЕРГЕТИЧЕСКИЙ МЕНЕДЖМЕНТ В УСЛОВИЯХ ПЕРЕХОДА К НИЗКОУГЛЕРОДНОЙ ЭКОНОМИКЕ

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Аннотация. В работе рассматриваются управленческие проблемы, с которыми сталкиваются теплоснабжающие организации Санкт-Петербурга в контексте глобального перехода к низкоуглеродной экономике. Анализируется нормативно-правовая база, текущее состояние системы теплоснабжения города и основные барьеры на пути декарбонизации – финансовые, технологические, кадровые и организационные. Особое внимание уделено роли энергетического менеджмента как инструмента адаптации к новым экологическим и регуляторным требованиям. На основе обзора практик ведущих игроков отрасли предлагаются управленческие решения, направленные на интеграцию ESG-принципов, повышение энергоэффективности и снижение углеродного следа.

Ключевые слова: низкоуглеродная экономика, энергетический менеджмент, теплоснабжение, декарбонизация, ESG, энергоэффективность, углеродный след, ТЭЦ.

The transition to a low-carbon economy is becoming a global trend that defines strategic development priorities for energy systems worldwide. Against the backdrop of increasing climate risks, stricter international environmental standards, and growing demands for sustainable development, Russia's energy sector – and heat power generation in particular – is at the centre of transformative changes. In this context, special attention is paid to cities with populations exceeding one million, where high energy consumption and infrastructure load require both technological and managerial adaptation.

Saint Petersburg is one of the largest consumers of thermal energy in the Russian Federation. The city's district heating system covers more than 90 % of its housing stock and primarily relies on fossil fuel combustion at large combined heat and power plants and boiler houses. This results in a significant carbon footprint for the city's heat power sector, making it a key target for decarbonization. At the same time, Saint Petersburg's specific characteristics – harsh climate, dense urban development, high level of wear and tear on heat networks, and a complex organizational structure of the industry – pose unique challenges for the adoption of green management practices (Fig. 1).

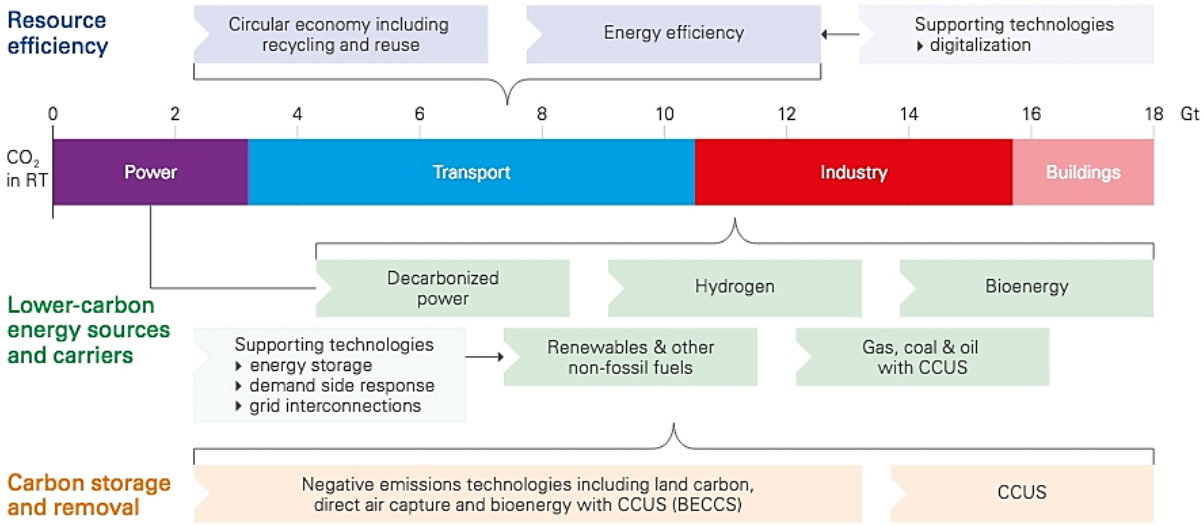


Figure 1. Improvements for further substantial reductions in CO2 emission

In recent years, both federal and regional authorities have adopted strategic documents aimed at reducing greenhouse gas emissions and improving energy efficiency. However, the practical implementation of these initiatives in the heat power sector faces several barriers: insufficient funding for modernization, inertia of management models, lack of clear market signals, and a shortage of expertise in sustainable energy management [1].

The transition to a low-carbon economy in the Russian Federation is being shaped within the framework of a comprehensive state policy aimed at reducing

anthropogenic pressure on the climate system and ensuring sustainable development. At the federal level, the key instrument is the Strategy for the Development of a Low-Carbon Economy of the Russian Federation until 2050, approved in 2022. The document sets targets for limiting the growth of greenhouse gas emissions, including a reduction in the specific carbon intensity of GDP and the phased decarbonization of key economic sectors, including energy.

An important tool for implementing this strategy is the national project Ecology, which includes measures to modernize heat power facilities, reduce pollutant emissions, and introduce best available technologies. Furthermore, in 2024 Russia launched the pilot phase of a national greenhouse gas accounting and reporting system. This creates the groundwork for the future introduction of a carbon regulation mechanism, including the potential application of a carbon tax or an emissions trading scheme.

At the regional level, Saint Petersburg is actively engaging in this process. In 2021, the city approved a Comprehensive Plan for Reducing Greenhouse Gas Emissions, which sets a target to cut specific emissions per unit of GRP by 20 % by 2030 compared to the 2017 level. Special attention is given to heat power generation as one of the largest sources of urban emissions. The plan envisages phased modernization of CHP plants and boiler houses through the introduction of best available technologies, promotion of energy saving in residential and municipal sectors, and development of district heating systems with potential integration of alternative sources [2].

Saint Petersburg's Energy Strategy until 2035 lays the foundation for transforming the city's energy system, focusing on digitalization, improving reliability and environmental performance, and creating conditions to attract private investment into green projects. However, the implementation of these initiatives directly depends on tariff policy, government support mechanisms, and the willingness of energy companies to revise their management approaches.

Saint Petersburg operates one of the largest and most complex district heating systems in the Russian Federation. Over 90 % of the city's housing stock is connected to the centralized heating system, making it a key element of life support for a metropolis with a population exceeding 5.6 million. This high degree of centralization, on one hand, ensures stable heat supply even during the most severe winters, and on the other, creates significant dependence on the condition of generating facilities and heat networks.

The backbone of heat generation in the city consists of large combined heat and power plants owned by PJSC TGK-1, as well as by SUE TEC SPb, which operates dozens of district boiler houses. According to 2024 data, CHP plants account for about 70 % of heat energy production, with the remainder coming from boiler houses and independent sources. The vast majority of facilities use natural gas as the primary fuel, making the system relatively "clean" compared to coal-dependent regions, yet still carbon-intensive.

According to estimates by the Russian Ministry of Energy and industry analysts, Saint Petersburg's heat power sector generates over 10 million tons of CO_2 equivalent annually, constituting a significant portion of the city's greenhouse gas emissions. At the same time, the efficiency of fuel and energy resource use remains suboptimal: on

average, heat losses in networks reach 12–15 %, exceeding indicators of modern European counterparts. High loss levels are primarily due to physical deterioration of heat networks – according to the Saint Petersburg Energy Committee, pipeline wear in some districts exceeds 60–70 %.

Despite the scale and relative gasification of the system, Saint Petersburg's heat power sector faces several structural challenges hindering its transition to a more sustainable and low-carbon model. One of the main issues remains the high degree of physical and obsolescence of equipment: a significant portion of boiler houses and heat networks have been in operation since Soviet times, which not only reduces the overall system efficiency but also increases accident rates. Combined with insufficient automation and weak digitalization, this complicates real-time monitoring of heat supply quality and efficiency. Moreover, the rigid hierarchical management structure limits flexibility and virtually excludes the possibility of integrating alternative heat sources such as heat pumps, geothermal energy, or secondary energy recovery. Although natural gas remains the primary fuel and keeps emissions comparatively lower than in coal-dependent regions, complete reliance on fossil fuels and the absence of commercial projects involving renewable or low-carbon technologies maintain the sector's high carbon intensity. Collectively, these factors render the heat supply system inertial and poorly adapted to the challenges of low-carbon transformation [3].

At the same time, positive shifts have been observed in recent years. PJSC TGK-1 is implementing a technological modernization program that includes turbine reconstruction, introduction of automatic control systems, and digital monitoring platforms. SUE TEC SPb is actively replacing sections of heat networks under the Safe City program and introducing heat metering systems at the building level. However, these measures are mainly technical in nature and are insufficiently accompanied by transformation of management approaches focused on reducing the carbon footprint and achieving ESG goals.

Thus, despite a relatively high level of gasification and the presence of large modern CHP plants, Saint Petersburg's heat power sector remains carbon-intensive and inertial. Its adaptation to the requirements of a low-carbon economy will require not only infrastructure investments but also systemic transformation of energy management.

The transition of Saint Petersburg's heat power sector to a low-carbon model requires not so much technological change as a fundamental transformation of management approaches. In practice, heat supply organizations face a complex of interrelated challenges spanning financial, technological, human resources, organizational, and regulatory aspects of their operations.

Financial barriers remain among the most significant. Modernizing CHP plants, replacing heat networks, implementing CO_2 capture and utilization systems, and integrating low-carbon heat sources all require enormous capital investments. At the same time, tariff regulation in the heat supply sector is tightly constrained by social considerations: a substantial increase in tariffs for households and budget-funded institutions is politically unacceptable. As a result, companies must independently balance investment commitments with the need to maintain profitability, often leading to the postponement of green projects or their implementation only as pilot initiatives [4].

Technological uncertainty also creates management difficulties. The absence of commercially proven solutions adapted to Russian conditions, the high cost of pilot projects, and a lack of technical regulations complicate strategic decision-making. Moreover, even when technologies are available, their large-scale deployment is hindered by the low flexibility of existing infrastructure, which was not originally designed for hybrid or distributed generation models.

Human resources shortages represent another serious challenge. Modern energy management under ESG transformation requires specialists who combine engineering expertise with skills in sustainable development, carbon footprint analysis, emission reduction project management, and non-financial reporting. However, most managers and engineers at Saint Petersburg's heat power enterprises received their education in an era when environmental aspects were not a priority, and management decisions were based solely on technical and economic indicators. This creates a gap between strategic decarbonization goals and operational realities on the ground [5].

From an organizational perspective, many heat supply companies still operate within traditional management models focused on stability, reliability, and minimizing downtime – not on innovation and sustainable development. ESG principles are rarely integrated into top management's key performance indicators, and strategic planning is weakly aligned with emission reduction targets. As a result, green initiatives are often perceived as an additional burden rather than an element of long-term competitiveness.

Finally, the regulatory and market environment remains incompletely formed. Despite the existence of strategic documents, Russia still lacks an operational carbon pricing mechanism – neither a carbon tax nor an emissions trading scheme. This deprives companies of economic motivation to reduce emissions, as green investments do not yield direct financial returns. Additionally, the instability of green policies, frequent changes in regulations, and the absence of long-term incentives increase investment risks and reduce management confidence in the viability of low-carbon projects [6].

Thus, management challenges in Saint Petersburg's heat power sector are systemic in nature. Overcoming these barriers requires not piecemeal solutions but a comprehensive approach: restructuring corporate culture, revising goals and KPIs, actively engaging with regulators, and developing new competencies at all levels of management.

In recent years, Saint Petersburg has seen initial but meaningful shifts toward integrating sustainability principles into heat supply organizations's operations. These changes are still fragmented, yet they already reveal management approaches that could form the basis for systemic transformation of the sector. The most notable initiatives come from major players – PJSC TGK-1 and SUE TEC SPb – whose actions, due to their scale, influence the entire city's energy system.

PJSC TGK-1, which controls the city's main CHP plants, has in recent years consistently embedded the ESG agenda into its corporate strategy. The company was among the first in the sector to publish non-financial reports, disclosing data not only on financial results but also on emission volumes, water consumption, energy efficiency levels, and social initiatives. At CHP-15, one of the key plants in the southern part of the city, an experimental project was launched to co-fire natural gas and wood pellets. Although modest in scale – the biomass share does not yet exceed

5 % – this step holds important symbolic and practical significance: it demonstrates the technical feasibility of partial decarbonization without fully replacing boiler equipment.

Simultaneously, the company is actively investing in digitalization: AI systems have been implemented at several CHP plants to forecast heat loads and optimize turbine operation modes. This enables a 2–4 % reduction in specific fuel consumption, which at the enterprise scale is equivalent to cutting tens of thousands of tons of CO_2 annually. Importantly, such projects are no longer perceived as an "ecological nod to fashion" but are evaluated in terms of return on investment and enhanced operational resilience.

However, for such solutions to become the norm rather than the exception, a change in management logic itself is required: from reactive responses to regulatory requirements toward proactive inclusion of carbon risks and opportunities in strategic planning.

SUE TEC SPb, which is responsible for heat distribution and the operation of hundreds of boiler houses and thousands of kilometers of heat networks, focuses on improving efficiency at the operational level. The program to replace outdated heat pipelines, implemented within the framework of the city's Safe City project, is one of the largest infrastructure initiatives in the housing and utilities sector. The use of modern pre-insulated pipes equipped with remote condition monitoring systems not only reduces heat losses but also enables rapid detection of accidents, minimizing their consequences.

In 2024, in certain districts such as Krasnogvardeisky and Frunzensky average heat losses were reduced to 9–10 %, approaching European standards. The company is also actively developing a system for apartment-level heat metering, which fundamentally changes end-user behavior: residents become more engaged in improving thermal insulation of their apartments and using resources rationally. While such measures do not reduce direct emissions at generation sources, they lower the overall load on the system which, under strict tariff constraints, represents one of the most cost-effective ways to enhance resilience (Fig. 2).



Figure 2. Reconstruction of heating mains in St. Petersburg

Beyond large companies, more innovative initiatives are emerging. For example, in new residential areas on the city's outskirts, such as the South-West district, hybrid heat supply systems are being designed, where centralized heat delivery is supplemented by local heat pumps utilizing ground or wastewater heat. Such solutions are especially promising in areas with low building density, where laying main pipelines is economically unfeasible.

Another potential resource is the recovery of low-grade heat from industrial facilities. For instance, the Pules oil refinery or the Sever waste-to-energy plant release significant amounts of secondary heat that are currently not used for urban needs. Integrating this heat into Saint Petersburg's overall thermal network will require not only technical integration but also new management and legal mechanisms, in particular, the creation of special tariff rates for "secondary heat" and the development of quality standards for such heat.

All this underscores that a successful transition to a low-carbon model is impossible without transforming energy management itself. Leaders of heat supply organizations must learn to think not only in terms of reliability and cost but also in terms of carbon footprint, asset lifecycle, ESG risks, and sustainable value. This requires both internal changes – revising key performance indicators, retraining staff, implementing energy management systems in line with clear and predictable regulatory policies, mechanisms for green financing, and the development of a low-carbon technology market.

Only with such a comprehensive approach can Saint Petersburg transform its heat power sector from a source of environmental risks into an element of urban resilience, demonstrating an example of how traditional infrastructure can adapt to the challenges of the 21st century.

The transition to a low-carbon economy is no longer a distant prospect but has become an urgent management task for all energy sectors, including heat power. In Saint Petersburg's context, this task is particularly complex. Yet this very complexity makes the city's experience especially valuable: if a sustainable, reliable, and simultaneously low-carbon heat supply model can be achieved under such conditions, it will serve as a replicable example for many Russian regions and countries with similar climates.

An analysis of the regulatory framework, current industry state, and management barriers shows that technological solutions, even the most advanced ones, cannot ensure decarbonization on their own. The key success factor is the transformation of energy management: shifting from maximum reliability at minimum cost to sustainable efficiency through innovation, responsibility, and flexibility. This means that reducing the carbon footprint must become not an external obligation but an internal imperative of strategic planning, operational control, and leadership performance evaluation.

In the long term, the success of decarbonizing Saint Petersburg's heat power sector will be determined not so much by the availability of technologies as by the maturity of the management ecosystem – one capable of making complex decisions under uncertainty, balancing social, economic, and environmental goals, and integrating sustainable development into the very DNA of corporate culture. Only such an approach can turn the challenges of the low-carbon transition from a burden into a source of innovation, competitive advantage, and sustainable urban development.

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MODERN TECHNOLOGIES OF PULP AND PAPER INDUSTRY WASTE TREATMENT AND DISPOSAL

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Abstract. The article considers the main types of waste from the pulp and paper industry, their characteristics and polluting components. Wastewater treatment methods, including physico-chemical, biological, and modern membrane technologies, as well as solid waste disposal methods with an emphasis on sludge and ash processing, are described. Special attention is paid to innovative approaches in recycling, such as biotechnology and thermal methods (pyrolysis, gasification), which make it possible to obtain recycled materials for use in construction, energy and agriculture. The analysis of environmental efficiency and economic feasibility of introducing new technologies into production is carried out. It is concluded that further research and development is necessary to increase the sustainability and competitiveness of the industry in the face of modern environmental challenges.

Keywords: pulp and paper industry waste, wastewater treatment, solid waste disposal, coagulation, flocculation, biological methods.

СОВРЕМЕННЫЕ ТЕХНОЛОГИИ ПЕРЕРАБОТКИ И УТИЛИЗАЦИИ ОТХОДОВ ЦЕЛЛЮЛОЗНО-БУМАЖНОЙ ПРОМЫШЛЕННОСТИ

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Аннотация. В статье рассматриваются основные виды отходов целлюлозно-бумажной промышленности, их характеристики и загрязняющие компоненты. Описаны методы очистки сточных вод, включая физико-химические, биологические и современные мембранные технологии, а также методы утилизации твердых отходов с акцентом на переработку шламов и золы. Особое внимание уделено инновационным подходам в переработке отходов, таким как биотехнологии и термические методы (пиролиз, газификация), позволяющие получать вторичные материалы для использования в

строительстве, энергетике и сельском хозяйстве. Проведен анализ экологической эффективности и экономической целесообразности внедрения новых технологий в производство. Сделан вывод о необходимости дальнейших исследований и разработок для повышения устойчивости и конкурентоспособности отрасли в условиях современных экологических вызовов.

Ключевые слова: отходы целлюлозно-бумажной промышленности, очистка сточных вод, утилизация твердых отходов, коагуляция, флокуляция, биологические методы.

The pulp and paper industry is one of the largest and most resource-intensive industries in the world, with an annual production of over 400 million tons of products. At the same time, production processes are accompanied by the formation of a significant amount of waste – sewage sludge, sludge, ash and other residues that require effective environmental management. For example, about 11 million tons of pulp and paper industry waste are generated annually in Europe, and this figure continues to increase. The main volumes of waste are associated with the processes of decontamination, purification and processing of products, which creates a serious environmental burden, including problems of burial, pollution of water resources and greenhouse gas emissions.

In this regard, it is important to develop and implement effective methods of wastewater treatment and industrial waste disposal aimed at improving environmental safety and sustainable use of resources. Modern technologies strive to ensure not only the reduction of harmful effects on the environment, but also the most efficient use of recycled materials, for example, the processing of ash and sludge into new reagents for water purification. Such approaches contribute to closed production cycles and waste minimization, which is one of the key challenges and prospects for the development of the pulp and paper industry in the context of increasing environmental requirements and regulations.

Thus, the development and improvement of physico-chemical purification methods using new composite coagulants and sorbents from recycled materials is an important area of scientific research and industrial technological solutions. This will improve the efficiency of wastewater treatment and waste disposal, reduce the burden on natural ecosystems and increase the overall environmental sustainability of the industry [1].

The pulp and paper industry is one of the significant industries producing large amounts of waste that have an impact on the environment and require effective management. The main types of waste from this industry include:

The largest category of waste in terms of volume is wastewater generated at all stages of pulp and paper production. These effluents contain significant concentrations of lignin, cellulose, various chemicals, dyes, bleaches, as well as heavy metals and other pollutants. The high organic matter content in wastewater puts a strain on aquatic ecosystems, leading to an increase in biochemical oxygen consumption and a decrease in water quality.

During wastewater treatment and bleaching, sludge and sediments containing concentrated organic and inorganic components, chemical residues and microparticles

of wood raw materials are formed. These solid wastes are difficult to dispose of and require special methods of recycling or safe burial.

Ash residues are formed during the incineration of sediments and wood waste. The ash contains oxides of aluminum, silicon, iron, calcium, etc., which have properties that allow them to be recycled, for example, as coagulants for water purification. This contributes to a closed cycle of waste recycling and reduces the burden on the environment.

The organic components of the waste are mainly represented by lignin, cellulose, hemicellulose and their derivatives, as well as synthetic chemicals used in the processing of raw materials. Inorganic components include metal-containing impurities, minerals, and chemicals accumulated in sediments and ashes [2].

Pollutants in pulp and paper industry waste have high chemical activity, causing significant impacts on aquatic and terrestrial ecosystems. Organic pollutants contribute to an increase in BOD, while toxic substances and heavy metals lead to bioaccumulation and toxic effects. Integrated management and innovative cleaning technologies are necessary to minimize the negative impact and rational use of resources.

Wastewater treatment in pulp and paper production is an integrated process aimed at removing mechanical, chemical and biological pollutants to reduce negative environmental impacts and comply with regulatory requirements. Modern cleaning systems are based on various methods, which can be roughly divided into physico-chemical, biological and membrane methods.

The key methods of primary and secondary purification are coagulation, flocculation and flotation. Coagulation is based on the addition of reagents (for example, aluminum-containing coagulants) that neutralize the charges of colloidal particles and promote their aggregation. During flocculation, the coagulants formed combine into larger floccules, which are easier to separate from the water. Flotation is used to remove suspended and colloidal contaminants by floating particles to the surface using gas bubbles, which contributes to the effective separation of pollutants. These methods can reduce turbidity, color, and organic matter content [2, 3].

Aerobic and anaerobic technologies are widely used to destroy organic substances. Aerobic purification is carried out with the help of microorganisms living in the presence of oxygen, which decompose organic matter and contribute to the formation of activated sludge. Anaerobic purification is characterized by a lack of oxygen and a high yield of biogas, a valuable energy component. A number of enterprises use bioreactors with granular sludge, which increases efficiency processing. Biological methods are the basis for deep purification and reduction of biochemically consumed oxygen (BOD).

The sludge formed during wastewater treatment is a mixture of organic and inorganic substances with a high content of lignin, cellulose and mineral additives. They can be biotechnologically processed using white rot fungi and vermiculture, which is a complex application of fungi and earthworms, which makes it possible to destroy organic matter and convert waste into vermicompost suitable for use as a biofertilizer. Solid-phase cultivation and subsequent vermiculture contribute to reducing toxicity and increasing the fertility of the substrate. The combustion and heat

treatment of ash provides the production of mineral components that can be used as raw materials for the production of coagulants and building materials.

Waste from the pulp and paper industry is widely used in construction: ash and sludge are used as additives in concrete, brick and other building mixes, improving their mechanical characteristics and reducing cost. In the energy industry, ash residues serve as fuel or raw materials for the production of energy-efficient materials. In agriculture, biotechnologically processed waste is used as organic fertilizers and plant growth stimulants, which contributes to soil reclamation and increases the sustainability of agroecosystems.

Modern approaches to solid waste disposal include integrated technologies combining biotechnology, heat treatment and the recycling of materials, which makes it possible to close production cycles and reduce the amount of waste generated. This not only solves environmental problems, but also creates additional economic benefits for pulp and paper industry enterprises.

In modern conditions of increasing environmental requirements, the industry faces the task of not only minimizing the amount of waste, but also turning it into a valuable secondary resource. Innovative approaches in the disposal of CBP solid waste are aimed at developing technologies for processing and integrated use of the materials obtained [4].

One of the promising areas is the biotechnological processing of sludge using white rot fungi and vermiculture, which makes it possible to effectively degrade lignin and organic matter, turning waste into vermicompost – fertilizer for agriculture and soils for the reclamation of disturbed lands. Technologies have also been developed for converting fiber-mineral waste into building materials and additives to concrete, providing improved product characteristics while reducing cost.

Pyrolysis and gasification of solid waste make it possible to extract energy and valuable chemical compounds from lignin-containing materials while minimizing the formation of toxic emissions. Pyrolysis promotes the decomposition of organic matter in conditions of oxygen deficiency to produce gaseous and liquid products that can be used in the energy and chemical industries. Gasification converts waste into synthesis gas with a high potential for subsequent conversion into fuels and chemicals. These methods open up new possibilities for a closed production cycle and reducing the environmental burden.

A number of pulp and paper industry enterprises in Russia and abroad use integrated recycling systems using biotechnologies and heat treatment to create added value from waste. For example, technologies for biotechnological processing of solid waste to produce vermicompost have been introduced at pilot plants of the Baikal Pulp and Paper Mill, which contributes to land reclamation and waste toxicity reductionA number of pulp and paper industry enterprises in Russia and abroad use integrated recycling systems using biotechnologies and heat treatment to create added value from waste. For example, technologies for biotechnological processing of solid waste to produce vermicompost have been introduced at pilot plants of the Baikal Pulp and Paper Mill, which contributes to land reclamation and waste toxicity reduction. Thermal recycling projects with the production of coagulaThermal recycling projects with the production of coagulants and materials for the construction industry are also

being developed, which improves the economic efficiency and environmental safety of production [5].

Thus, the integration of innovative approaches into the disposal of pulp and paper industry waste ensures the sustainable development of the industry, promotes energy efficiency and reduces the environmental burden, while providing economic and social benefits

Assessment of the environmental efficiency of wastewater treatment methods is a key criterion when choosing technological solutions in the pulp and paper industry. Modern methods, such as two-stage biological purification using activated sludge, aerobic and anaerobic reactors (MBBR, FBBR, IFAS), demonstrate high resistance to toxic substances, stability of operation with fluctuations in parameters and a significant reduction in organic pollutants (BOD, COD) [6].The use of a combination of ozone oxidation and biofilter makes it possible to further improve the quality of purification, reducing the use of chemicals and energy consumption. It has been practically proven that two-stage biological systems provide effective and sustainable purification, which positively affects the state of aquatic ecosystems and reduces anthropogenic stress.

In general, a balanced approach to the selection and implementation oIn general, a balanced approach to the selection and implementation of cleaning technologies, taking into account both environmental safety and economic feasibility, is the key to the sustainable development of pulp and paper industry enterprises. This approach contributes not only to compliance with the requirements of environmental legislation, but also to increasing competitiveness by optimizing production processes and rational use of resources [7].

Technologies for cleaning and recycling waste from the pulp and paper industry are rapidly developing, reflecting modern requirements for environmental safety and sustainable production. The main trends include the integration of biotechnological methods with physico-chemical processes, as well as the active introduction of modern membrane technologies and thermal processing, which significantly improves the efficiency of purification and processing. The use of innovative biotechnologies and waste heat treatment contributes to the creation of closed production cycles, minimizing environmental impacts and obtaining valuable recycled materials.

The development prospects are aimed at expanding the use of waste as raw materials for the production of building materials, fertilizers and energy resources, which opens up new opportunities for a closed-loop economy and reduces the induelopment prospects are aimed at expanding the use of waste as raw materials for the production of building materials, fertilizers and energy resources, which opens up new opportunities for a closed-loop economy and reduces the industry's dependence on non-renewable resources. The introduction of such technologies requires an integrated approach, taking into account economic feasibility and adaptation to regional conditions.

Taking into account modern challenges relTaking into account modern challenges related to environmental requirements and growing volumes of waste, further research is needed to improve cleaning and disposal methods, explore new biotechnological and heat treatment processes, as well as develop.

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LOCAL ADAPTIVE LOGIC IN ENGINEERING SYSTEMS OF LOW-RISE RESIDENTIAL BUILDINGS DURING EXTERNAL UTILITY INTERRUPTIONS

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Abstract. The article discusses the integration of embedded local adaptive logic into engineering systems of low-rise residential buildings to ensure continuity of basic life-support functions during external utility disruptions. Primary focus is placed on a decentralized control architecture based on industrial I/O modules, SCADA software, and fail-safe actuation systems. Special attention is paid to the use of domestic interface modules (OWEN), signal converters (MOXA), pressure sensors (Danfoss), and electromagnetic contactors (PML series), all compliant with GOST R 51522 and VSN 60-89 standards. A prototype is described in which local logic autonomously maintains hydraulic parameters in water supply circuits after simulated power interruption-without any involvement of a central operator. Economic and reliability benefits of such architecture are analyzed, including reduced response time, increased fault tolerance, and compatibility with existing infrastructure.

Keywords: local adaptive logic, decentralized control, SCADA, engineering systems, fault-tolerant automation, OWEN, MOXA, Danfoss, PML contactor.

ЛОКАЛЬНАЯ АДАПТИВНАЯ ЛОГИКА В ИНЖЕНЕРНЫХ СЕТЯХ МАЛОЭТАЖНЫХ ЖИЛЫХ ЗДАНИЙ ПРИ НАРУШЕНИИ ВНЕШНЕГО ЭНЕРГОСНАБЖЕНИЯ

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Аннотация. В статье рассматривается интеграция встраиваемой локальной адаптивной логики в инженерные сети малоэтажных жилых зданий для обеспечения непрерывности базовых функций жизнеобеспечения при внешних коммунальных сбоях. Основное внимание уделено децентрализованной архитектуре управления на базе промышленных модулей ввода-вывода, SCADA-программного обеспечения и отказоустойчивых

исполнительных систем, а также применению отечественных интерфейсных модулей (ОВЕН), конвертеров сигналов (MOXA), датчиков давления (Danfoss) и электромагнитных пускателей (серии ПМЛ), соответствующих требованиям ГОСТ Р 51522 и ВСН 60-89. Описан прототип, в котором локальная логика автономно поддерживает гидравлические параметры в контурах водоснабжения после имитации отключения питания – без участия центрального оператора. Проанализированы экономические и надежностные преимущества такой архитектуры, включая сокращение времени реакции, повышение отказоустойчивости и совместимость с существующей инфраструктурой.

Ключевые слова: локальная адаптивная логика, децентрализованное управление, SCADA, инженерные сети, отказоустойчивая автоматизация, ОВЕН, MOXA, Danfoss, пускатель ПМЛ.

Modern low-rise residential complexes, despite the apparent simplicity of their engineering systems, increasingly face challenges stemming from external instability of utility networks. Unlike high-rise construction, where centralized monitoring systems are easier to justify due to scale, the low-rise sector demands solutions that combine compactness, autonomy, and minimal dependence on external operator intervention. This issue becomes particularly acute during short-term power outages, hydraulic shocks in water supply networks, or pressure drops in hot water supply (HWS) mains – situations that do not require major repairs but may cause discomfort, flooding, or even pipe freezing in cold weather if response is delayed. One promising approach to enhancing the resilience of such facilities is the implementation of local adaptive logic-embedded algorithms capable of making control decisions directly within control cabinets, bypassing the central dispatch point.

The technical implementation of such logic relies on proven industrial components widely used in utility automation. As the core hardware platform, OWEN-brand I/O modules (MK110 and MV110 series) are employed Russian designed DIN-rail-mounted devices supporting standard Modbus RTU/ASCII and DCON protocols. For instance, the MK110-8DN.4R module features 8 discrete inputs (24 V level, compatible with p-n-p/n-p-n transistor switches), up to 1 kHz polling rate, and 4 relay outputs (up to 4 A at 250 V AC), enabling not only sensor signal acquisition but also direct actuator control, such as pump contactors [1]. Importantly, the module provides galvanic isolation between power, interface, and measurement circuits and complies with GOST R 51522 (Class A electromagnetic compatibility for industrial equipment), which is critical for stable operation in high-noise environments typical of utility control cabinets.

For measurement of key parameters in engineering systems, highly reliable sensors verified in real-world operation are used. In particular, compact Danfoss MBS 1200-2611-C2GB04 pressure transducers, made of stainless steel, with operating temperature range up to +125 °C and 4–20 mA or 0–10 V output signals, are employed to monitor pressure in water and heat supply hydraulic systems. These sensors are certified for resistance to vibration and radio interference (up to 100 V/m), as confirmed in the manufacturer's technical documentation, and are widely deployed in individual heat substations (IHS) and pumping stations across Russia. For temperature

monitoring on pipelines-especially in HWS circuits-Siemens QAD22 surface-mounted sensors are used, based on Ni 1000 sensing elements, with range −30…+130 °C and IP42 protection grade-allowing their installation without additional enclosures in both dry and humid indoor environments. Both sensor types connect to analog inputs of the MV110-224.8AC modules, which provide galvanic isolation up to 3000 V between measurement and power circuits [1].

A key component enabling physical execution of control commands is the PML-2120M-U3-V series electromagnetic contactor. This is a non-reversing starter station with "Start" and "Stop" pushbuttons, IP54 protection rating, and 220 V coil control voltage-supporting both manual operation and integration into automated systems where startup is triggered by an external discrete signal from the OWEN module. Notably, the contactor design permits brief startup attempts even at reduced supply voltage-increasing the probability of successful emergency pump restart after transient grid disturbances (e. g., upon automatic transfer switch (ATS) activation or backup source engagement). Such devices are widely used in plumbing rooms and comply with VSN 60-89 requirements for equipment installation in high-humidity areas [2].

To integrate local nodes into a unified information system-supporting both centralized monitoring and autonomous control-protocol gateways are used, notably the MOXA MGate MB3180, supporting up to 16 TCP masters and 31 RTU slaves over Modbus TCP/RTU/ASCII. This gateway enables conversion between Ethernet and serial interfaces (RS-485/RS-232), allowing OWEN modules to be integrated into a SCADA system while retaining local bus functionality even if server communication is lost. As per MOXA's documentation, the auto-calibrating timeout feature allows the gateway to adapt to changing cable lengths and electromagnetic interference-particularly valuable during retrofitting of existing facilities with non-standard wiring. The architecture follows the principle of "centralized data collection + decentralized execution": the dispatcher accesses full system status, but critical operations (e. g., pump restart upon pressure drop below threshold) are executed locally-eliminating delays due to command transmission and processing.

The software implementation of local adaptive logic is carried out in the SCADA+ SP-DEV-1 environment-a Russian-developed SCADA platform for automation projects supporting distributed execution. The primary tool for control algorithm development is the FBD (Functional Block Diagram) editor-one of the standard IEC 61131-3 controller programming languages. Unlike centralized solutions where logic executes on a server, here the algorithm resides in the SCADA+ SP-RTM-50 execution module, installed directly in the dispatch cabinet alongside OWEN modules. This ensures autonomous logic operation even during server disconnection or network loss [2]. An example of such logic is the "adaptive pump station restart" algorithm, comprising the following steps:

1. Upon receiving a "Pump Station Control Fault" signal from the control panel (dry contact, normally open),
2. The system checks for voltage presence at the contactor output (indirectly-via discrete input status),
3. If voltage is absent, a 30-second delay timer is activated (to avoid false triggers during brief dips),

4. After timer expiry, a pulse is sent to discrete output DO1 of the MK110 module, energizing the PML-2120M-U3-V contactor coil,

5. If pressure does not recover to the setpoint (e. g., 0.4 MPa) within 10 seconds after startup, a second attempt is made after a 2-minute pause,

6. After two failed attempts, further restarts are blocked, and an “Unrecoverable Fault” alarm is generated-forwarded to the SCADA server once communication is restored.

This logic operates without continuous operator involvement and resolves 60–70 % of typical transient faults, e. g., frequency inverter shutdowns due to overheating or momentary phase loss. To ensure resilience against power failures, an uninterruptible power supply (UPS) with 24 V output-capable of sustaining OWEN modules and relay outputs for up to 6 hours at ≤50 W load (e. g., OWEN ABB-20.4), is installed in the dispatch cabinet [1]. This is critical: even if 220 V AC supply is fully lost, the local node retains the ability to control contactors, since relays in the MK110-8DN.4R module are driven by 24 V DC, and PML contactors support brief actuation at reduced voltage. The UPS also powers essential communication interfaces (e. g., RS-485 or Ethernet gateways), preserving SCADA connectivity and enabling remote diagnostics during outages. Furthermore, the system includes automatic reinitialisation routines that re-engage critical processes once main power is restored – without requiring manual reset – thereby minimizing downtime and supporting unattended operation over extended periods.

As part of a pilot project, a laboratory, scale model simulating a water supply pumping station under transient failure conditions was assembled. The test stand included:

- Grundfos UPA 15-90 pump (0.12 kW),
- 8 L expansion tank,
- Danfoss MBS 1200 pressure sensor (0–1.6 MPa, 4–20 mA),
- OWEN MK110-8DN.4R module,
- PML-2120M-U3-V contactor,
- 24 V / 4 Ah UPS,
- PC with SCADA+ software.

The test scenario involved simulated power interruptions (0.5–5 s) and forced pump shutdown via external relay. In all cases, local logic restored system pressure within 45–75 seconds, whereas in “non-adaptive” mode (centralized monitoring only), restoration required manual intervention, averaging 4.2 minutes. This confirms that decentralized architecture significantly reduces downtime and enhances life support reliability.

To summarize the contribution of various technologies to engineering system resilience, Table is provided.

Table – Contribution of Technologies to Fault Tolerance of Engineering Systems in Low-Rise Buildings.

Technology	**Application in system**	**Contribution to resilience**
OWEN MK110/MV110 modules	Local signal acquisition & control output	Enable autonomous logic execution during server loss
MOXA MB3180 gateways	Modbus TCP ↔ RTU conversion	Maintain RS-485 local bus functionality during Ethernet failure
Danfoss MBS 1200 sensors	Hydraulic pressure monitoring	Detect pre-failure deviations (e. g., gradual pressure drop)
PML-2120M-U3-V contactors	Physical pump activation	Support manual and remote emergency startup, even at reduced voltage
SCADA+ (SP-RTM-50 executor)	Local FBD logic execution	Enable adaptive control independent of central server

Analysis shows that resilience stems not from a single “miracle device”, but from a coordinated architecture, where each component contributes to overall reliability. Especially critical is the synergy of hardware fault tolerance (galvanic isolation, backup power) and software flexibility (configurable FBD logic), allowing system adaptation to specific operating conditions.

For visualization of parameter dynamics and evaluation of local adaptation efficacy, standard SCADA tools-trend lines-are used (Fig.). Such graphs capture pressure variations in supply and return pipelines of the primary heating circuit over time, enabling detection of both abrupt failures (e. g., hydraulic shock spikes) and slow trends (e. g., gradual pressure decline due to leaks). Importantly, trend data is archived in a MySQL relational database, ensuring reproducibility and enabling retrospective analysis [2].

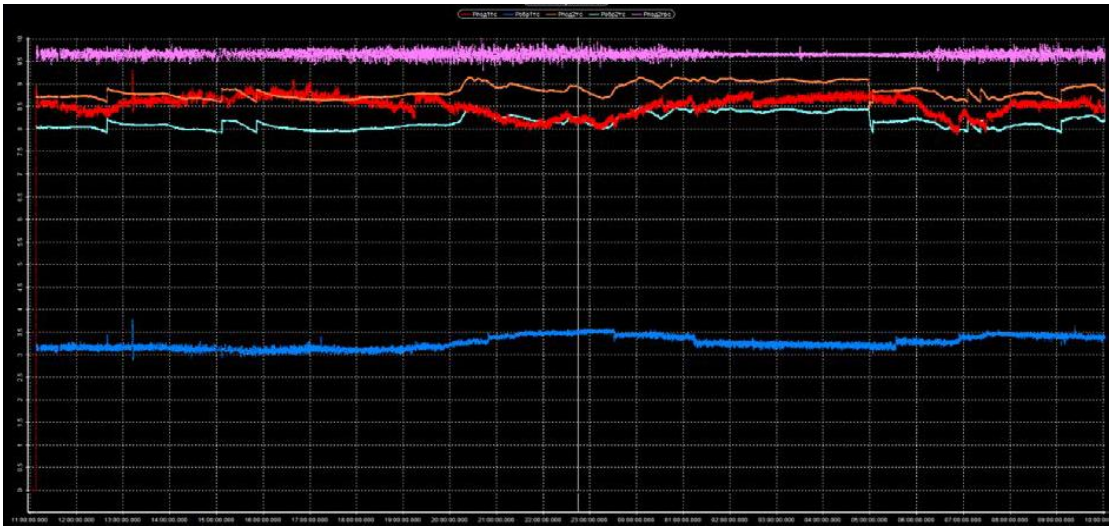


Figure. Pressure trend lines in a decentralized IHS during simulated external power failure

The graph shows that, upon simulated brief power loss (t = 12:05), supply pressure drops from 0.52 MPa to 0.18 MPa within 25 seconds. However, within 65 seconds (t = 12:06:10), pressure recovers to 0.48 MPa thanks to local adaptive logic and automatic pump restart. The operator receives an alert, but by the time it is reviewed, the system has already stabilized. Without local logic, pressure would remain at ~0.2 MPa until manual intervention, potentially leading to system freezing and severe damage in winter. Thus, trend lines not only record incidents but also demonstrate the effectiveness of adaptive control.

From an economic perspective, implementing local adaptive logic is justified even with moderate budgets. The cost of a kit for one pumping station (OWEN MK110-8DN.4R – ₽8,900; OWEN ABB-20.4 UPS – ₽14,200; 50 m KIPEVng cable – ~₽2,500; installation & commissioning – ~₽25,000) totals ~₽50,000–55,000 as of 2025 [3]. Even conservative estimates of impact-reduced downtime-yield significant returns: according to St. Petersburg State Housing Inspection, average basement flood remediation cost in low-rise buildings is ₽280,000–450,000, with 2–3 pump-related failures per station annually. A 50 % risk reduction via automatic restart yields payback in under one year. Additionally, dispatch personnel workload is reduced: analysis of utility company service requests shows up to 35 % of calls concern "false alarms" – functional equipment requiring only manual reset. Automating such events reduces technician dispatches and reallocates labor toward preventive maintenance.

The environmental benefit, though indirect, is also significant. Upon emergency shutdown of a circulation pump in an HWS system, water temperature in risers can drop below 45 °C within 5–7 minutes-violating SanPiN 2.1.4.2496-09 (minimum 50 °C at draw-off points) and enabling Legionella pneumophila proliferation. To restore parameters, operators often flush 15–20 m³ of cooled water per incident. At 2 incidents/year, this adds 30–40 m³ of excess water consumption-and corresponding load on sewerage and treatment plants. Automatic recovery within 60–90 seconds virtually eliminates such waste, aligning with Russia's Water Policy Strategy until 2030 principles of water conservation [4].

Moreover, stable pressure and temperature in hydraulic circuits reduce equipment wear-including seals, gaskets, and heat exchangers. Per VolgGTU data, each pressure surge (water hammer) reduces pipeline component lifespan by 3–5 % [5]. Local logic incorporating soft start (via timed relay output) minimizes peak loads-particularly important in systems with Danfoss FC 51/FC 202 frequency inverters, where abrupt starts may trigger overload protection [3]. Thus, adaptive control contributes not only to resilience but also to infrastructure longevity.

Compared to fully centralized systems (e.g., high-end PLCs like Siemens S7-1500 or Schneider Quantum), the local approach holds advantages in three key aspects:

– Cost: OWEN modules are 8–12× cheaper than industrial PLCs;

– Integration simplicity: No redesign of existing cabinets-DIN-rail installation in additional compartment suffices;

– Response speed: Local FBD execution in SP-RTM-50 takes ≤20 ms, versus 300–800 ms for centralized cycles (sensor → gateway → server → command → contactor) [6].

This latency difference is critical for transient faults: a pump retaining inertial rotation for 1–2 seconds post-power-loss can be restarted in-flight-avoiding full stop and subsequent hydraulic shock. In centralized systems, command arrival occurs after inertia is lost, forcing a “cold start” with higher motor and grid stress.

Nevertheless, local adaptive logic is not a replacement, but a complement to centralized SCADA. As emphasized in the Ministry of Construction’s Methodological Guidelines on Digitalization of Housing & Utilities, optimal architecture integrates three control levels:

- Level 0–1 (sensors, actuators, local controllers) – for basic safety and resilience;
- Level 2 (SCADA server, dispatcher) – for monitoring and operational intervention;
- Level 3 (analytics, predictive maintenance) – for strategic planning.

Local logic firmly occupies Level 0–1, ensuring a “safe minimum” even during full system disconnection.

Implementation of local adaptive logic in engineering systems of low-rise residential buildings is a technologically sound, economically justified, and environmentally beneficial solution. It requires no revolutionary changes, relies on proven components (OWEN, MOXA, Danfoss, PML), complies with current standards (VSN 60-89, GOST R 51522), and contributes directly to a key target of Russia’s national project “Housing and Urban Environment” – enhancing utility infrastructure reliability. Future developments include integration with backup power systems (small-scale PV, wind turbines) and edge computing for predictive diagnostics (e.g., detecting pump performance degradation via current and vibration trends) – making the low-rise sector not just comfortable, but truly resilient.

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SECTION 3. HUMANITARIAN ASPECTS OF SOCIETY DEVELOPMENT

УДК 372.881.111.1

BEYOUND TEA AND THE QUEEN: BREATHING LIFE INTO BRITISH CULTURE TO CULTIVATE INTERCULTURAL MINDS IN RUSSIAN EFL CLASSROOMS

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Abstract. This article explores how authentic British cultural content – such as BBC documentaries, TV series, music, and social media – can develop Intercultural Communicative Competence (ICC) among Russian secondary students. A 12-week intervention with 60 seventh-graders in Chekhov replaced textbook stereotypes (tea, the Queen) with real-world topics like Brexit, identity, and multiculturalism. Results showed a significant shift: while 87 % initially saw British culture as uniform, 74 % later recognized its diversity and complexity. Critical tasks and the "Post-Brexit Identity" project fostered reflection on both British society and students' own cultural assumptions. The study offers practical, ethical strategies for using authentic materials without reinforcing native-speaker bias.

Keywords: intercultural communicative competence, British culture, EFL teaching, cultural stereotypes, critical cultural awareness, post-Brexit identity.

ВЫХОДЯ ЗА РАМКИ ЧАЯ И КОРОЛЕВЫ: ВДОХНОВЛЯЯ ЖИЗНЬ В БРИТАНСКУЮ КУЛЬТУРУ ДЛЯ ВОСПИТАНИЯ МЕЖКУЛЬТУРНОГО МЫШЛЕНИЯ В РОССИЙСКИХ КЛАССАХ АНГЛИЙСКОГО ЯЗЫКА КАК ИНОСТРАННОГО

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Аннотация. В статье описывается, как аутентичные материалы британской культуры – документальные фильмы BBC, сериалы, музыка и соцсети – могут развивать межкультурную коммуникативную компетенцию у российских школьников. В 12-недельном эксперименте с 60 семиклассниками в Чехове стереотипы (чай, королева) заменили реальными темами: брексит, идентичность, мультикультурализм. Результаты показали значительный сдвиг: если изначально 87 % учащихся видели британскую культуру как единое целое, то после – 74 % стали воспринимать ее как разнообразную и изменчивую. Задания и проект

«Пост-брекситская идентичность» способствовали рефлексии не только о Британии, но и о собственной культуре. В статье предложены практические и этичные методы работы с аутентичными материалами без идеализации носителей языка.

Ключевые слова: межкультурная коммуникативная компетенция, британская культура, обучение английскому языку, культурные стереотипы, критическое культурное осмысление, пост-брекситская идентичность.

1. Introduction: Dethroning the Cliché – Why Russian Classrooms Need Real Britain

Let's be honest: for decades, British culture in Russian English classrooms has been stuck in a time capsule – complete with a cup of Earl Grey, a stiff upper lip, and a waving monarch. While charming, this postcard version of Britain does little to prepare our students for real intercultural encounters in a world where English is less about Buckingham Palace and more about navigating TikTok debates, climate protests, and the messy, vibrant plurality of identities in Birmingham or Glasgow.

Intercultural Communicative Competence (ICC) – that delicate blend of knowledge, empathy, critical awareness, and communicative agility – is no longer a luxury in EFL education; it's a necessity [1, p. 50]. Yet in many Russian schools, ICC remains an abstract ideal, buried under grammar drills and recycled textbook dialogues featuring "Mr. Smith from London" who inexplicably drinks tea at 4 p. m. every day.

This article emerges from my own classroom frustrations – and hopes. Over years of teaching, I've watched bright, curious teenagers parrot outdated clichés about Britain while remaining utterly unaware of the cultural currents shaping real British lives today. My central conviction? Authentic, contemporary British cultural content – when used critically and creatively – can awaken Russian learners to the complexity of "the other", and, in doing so, help them better understand themselves.

The study I describe here tested this conviction with 120 seventh- and eighth-graders in Chekhov. Through a blend of BBC documentaries, gritty TV dramas, protest music, and opinion journalism, we dared to ask: What if British culture in our classrooms looked less like a museum exhibit and more like a living, breathing, sometimes contradictory conversation?

2. Theoretical Compass: ICC as Critical Dialogue, Not Cultural Postcards

At the heart of this work lies a simple but powerful idea: intercultural learning isn't about collecting facts about "them" – it's about learning to think, question, and connect across difference. Michael Byram's model of Intercultural Communicative Competence (ICC) has long guided my teaching, not as a rigid formula, but as a framework for ethical, reflective engagement [1, p. 53]. His five "savoirs" (knowing, being, understanding, discovering, and critically engaging) together form a dynamic set of capacities that go far beyond language accuracy.

Most crucial for today's classrooms is savoir s'engager – the ability to critically examine cultural practices, values, and power structures, both in other societies and in

one's own. In a time of rising nationalism and online echo chambers, this critical stance is not optional; it's essential [1, p. 58].

The Council of Europe's Common European Framework of Reference for Languages (CEFR) supports this view, describing advanced language users as "mediators" who bridge cultures, interpret meanings, and navigate ambiguity – not as passive imitators of native-speaker norms [2, p. 112].

Yet theory only comes alive in practice – and here's where many well-intentioned efforts stumble. Simply showing students, a BBC clip or a British pop song doesn't automatically build ICC. As Gilmore argues, authenticity isn't about the origin of a text; it's about how learners use it [3, p. 102]. A news report becomes "authentic" for learning only when students are invited to analyze its perspective, compare it with local media, or question whose voices are included – or silenced.

This is especially important in Russia, where images of Britain have long been shaped by historical narratives: from Soviet-era portrayals of the UK as a capitalist adversary to post-Soviet idealizations of British "refinement" and order [4, p. 82]. These simplified lenses – whether hostile or admiring – flatten a rich, diverse, and often contradictory society into a single story.

That's why I don't see my role as "bringing British culture into the classroom". Instead, I aim to create a space where students and I interrogate cultural representations together – asking not just "What is Britain like?" but "Whose Britain? According to whom? And how does this reflect or challenge what we believe about our own society?" In this way, culture becomes a site of dialogue, not a postcard to be memorized.

3. From Theory to Practice: A 12-Week Classroom Experiment

To test whether authentic British cultural content could genuinely shift students' intercultural awareness, we designed a structured 12-week intervention with two parallel groups of 30 students each (ages 13–14, Grade 7) across two classes of Checkov secondary school MBOU gymnasium 7. Both groups followed the same national English curriculum and had comparable English proficiency levels (A2–B1 CEFR). The only difference? The materials and tasks.

The Control Group used the standard textbook (Spotlight 7 & 8, Prosveshcheniye, 2023–2025), which includes short cultural inserts on landmarks, the monarchy, and "British traditions". Lessons focused on vocabulary drills, grammar practice, and comprehension questions based on simplified texts.

The Experimental Group engaged with a curated set of authentic British materials, carefully selected for relevance, accessibility, and cultural depth. These included:

Video:

- 3 episodes of Derry Girls (Channel 4, 2018–2019), focusing on scenes depicting everyday life during The Troubles
- BBC News segments: "Why are food banks rising in the UK?" (2022), "Youth mental health crisis" (2023)
- Stormzy's Glastonbury 2019 performance (BBC)

- Short documentaries from BBC Three: “What does it mean to be British today?”

Text:

- Opinion articles from The Guardian (e. g., “The myth of the ‘polite Brit’ ”, “Why regional identity matters more than ever”)
- Lyrics and interviews with British artists (Stormzy, Arlo Parks, Sam Fender)
- Social media posts from UK-based youth activists (e. g., climate strikes, anti-racism campaigns)

Audio:

- BBC Radio 1 interviews with young Britons on identity, class, and belonging
- Podcast clips from The Daily (UK edition) on NHS challenges

Each week, students completed critical cultural tasks designed around three principles:

- Compare (e. g., “How do British and Russian teens talk about mental health?”)
- Question (e. g., “Whose voices are missing in this news report?”)
- Create (e. g., “Design a poster that shows a ‘real’ Britain you discovered”)

The culminating project was a digital zine titled “Britain Beyond the Brochure”. Students worked in small groups to produce multimedia pages combining images, quotes, short analyses, and personal reflections. One group contrasted royal wedding coverage with footage from the 2020 Black Lives Matter protest in London. Another mapped regional accents using audio clips and interviewed two British exchange students (via Zoom) about their sense of identity as “Scots” vs. “British”.

I facilitated discussions using open-ended prompts and encouraged respectful disagreement. No “right answers” were expected – only thoughtful engagement.

The contrast between groups became evident within weeks. While the control group could recall textbook facts (“British people drink tea”, “London has red buses”), the experimental group began using language like “working-class communities in Manchester”, “multicultural London”, or “the tension between tradition and change”. More importantly, their questions shifted from “What do they do?” to “Why do they see it that way?” – a clear sign of emerging intercultural sensitivity.

4. What Changed – and How: From Stereotypes to Critical Thinking

Before the experiment began, we gave all 60 students a short survey to understand their ideas about British culture. The results were telling:

- 87 % described Britain using the same three ideas: tea, the Queen, and politeness.
- Only 3 % (2 out of 60) in the experimental group could name a British city outside London.
- Zero students mentioned Scotland, Wales, or Northern Ireland as distinct nations with their own governments.
- One student wrote: “British people are always calm, never argue, and love the royal family.”

In other words, “British culture” existed in their minds as a single, frozen image – polite, orderly, and strangely uniform.

But after 10 weeks of working with real, contemporary British content, something shifted. Students started noticing contradictions. They saw that Britain isn’t one story – it’s many stories, often in tension with each other.

A key turning point was the "Post-Brexit Identity" project. This wasn't about politics in the abstract. Instead, we asked students to explore a simple but powerful question: "Who belongs in Britain today – and who gets to decide?"
To answer it, they worked in small groups using real sources:

- News clips about Brexit's impact on EU citizens living in the UK
- Opinion pieces by British-Pakistani writers on national identity
- Social media posts from young Scots arguing for independence
- Interviews with Londoners of Nigerian or Polish descent talking about "feeling British

Through this, students discovered that "Post-Brexit British identity" isn't a fixed personality – it's a contested, evolving idea. It includes:

- People who feel more Scottish or Welsh than British
- Immigrants who call Britain home but face discrimination
- Young activists who reject old symbols (like the Union Jack) but create new ones
- Communities rethinking what "belonging" means after years of political division

One group made a short video titled "Three Britains", showing three fictional teens: a Scottish girl who doesn't recognize the Queen as her head of state, a London boy with Ghanaian roots who raps about his dual identity, and a farmer in Yorkshire who voted for Brexit to "protect tradition". The point wasn't to pick a "right" version – but to show that British identity today is layered, emotional, and deeply personal.

And this sparked reflection at home. After watching a BBC report on youth mental health support in UK schools, a usually quiet student said:
"In Russia, we don't talk about this. But maybe we should."

That moment captured the heart of intercultural learning: it's not just about understanding others – it's about using that understanding to question, compare, and sometimes reimagine your own world [5, p. 15].
What Actually Worked? Three Simple but Powerful Strategies

– Critical Juxtaposition

Instead of watching Line of Duty just for vocabulary, we compared a scene where police are questioned by the media with a similar scene from a Russian TV series (Sled). Students discussed: Who has power? Who is trusted? Why? This led to honest conversations about transparency and public institutions in both countries.

– Culture as Controversy

We skipped the usual list of "British holidays". Instead, we looked at real debates:
Should schools celebrate Empire Day?
Should statues of slave traders be removed or kept?
Students didn't just learn facts – they practiced taking a stance, listening to others, and revising their views.

– Student-Led Inquiry

The "Post-Brexit Identity" project gave students choice and voice. They picked their angle, found sources, and presented in formats they liked: posters, podcasts, short

films, or digital zines. Because the topic felt real – and connected to bigger questions about belonging, migration, and pride – it resonated far beyond the English classroom.

By the end of the experiment, 68 % of students in the experimental group could name at least two distinct cultural or national identities within the UK (e. g., Scottish, Northern Irish, Black British). More importantly, 74 % said they now saw culture as "something people argue about and change", not "something fixed from the past". That's the shift we were hoping for – not just knowledge, but critical curiosity.

5. Final Thoughts: Teaching Culture Without Colonizing Minds

Let me be clear: this isn't about replacing one stereotype with another, or turning our classrooms into uncritical fan clubs for British media. As Adrian Holliday warns, "native-speakerism" and cultural essentialism can easily creep in when we treat any culture as superior or static [6, p. 81].

The goal isn't to make our students "more British". It's to help them become intercultural citizens – thoughtful, reflexive, and unafraid of complexity. That means:

- Curating, not consuming: Selecting materials that show Britain in all its contradictions – progressive and regressive, inclusive and exclusionary.
- Centering student voice: Letting learners draw their own comparisons, challenge assumptions, and connect global issues to their local realities.
- Decentering English: Reminding students that British culture is just one node in a vast, multilingual network of Englishes [7, p. 94].

Looking ahead, I dream of telecollaborative projects linking Russian and British teens in joint media literacy initiatives, or rural schools using podcasts to explore cultural narratives beyond the capital. The digital age offers unprecedented access – but only if we guide our students to use it critically.

So yes, let's keep the tea. But let's also serve up protest songs, parliamentary debates, street art, and the voices of British-Pakistani poets and Welsh language activists. Because real intercultural competence begins not when we admire a culture from afar, but when we dare to step into its tensions – and find, surprisingly, pieces of ourselves reflected there.

Appendix: Sample Task Templates Used in the Experiment

(Available for adaptation by other educators)

Template 1: Critical Viewing Guide

What is this video showing? What is it not showing?
Whose perspective is centered? Whose is missing?
How might a Russian teen react differently to this than a British teen? Why?

Template 2: Comparative Reflection Journal

This week I learned about _____ in Britain. In Russia, we _____. One similarity is _____. One big difference is _____. This made me think about _____.

Template 3: Zine Page Planner

Title of your page: _____
Main image or quote: _____
Key fact or insight: _____
Personal reaction or question: _____

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УДК 371

DEVELOPMENT OF THE SYSTEM OF ADDITIONAL EDUCATION FOR CHILDREN IN THE RUSSIAN FEDERATION

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Abstract. The author analyzes the current state and development trends of the system of additional education for children in the Russian Federation. Based on official statistical data for 2023-2024, issues of staffing, material and technical base, salaries of teaching staff and the introduction of personalized financing are being considered. The study shows the positive dynamics of the industry's development in the context of the implementation of the Concept of developing additional education for children until 2030.

Keywords: education system, additional education for children, development, modernization of education, intensive development.

РАЗВИТИЕ СИСТЕМЫ ДОПОЛНИТЕЛЬНОГО ОБРАЗОВАНИЯ ДЕТЕЙ В РОССИЙСКОЙ ФЕДЕРАЦИИ

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Аннотация. Автор анализирует современное состояние и тенденции развития системы дополнительного образования детей в Российской Федерации. На основе официальных статистических данных за 2023-2024 годы рассматриваются вопросы кадрового обеспечения, материально-технической базы, заработной платы педагогических работников и внедрения персонифицированного финансирования. Исследование показывает положительную динамику развития отрасли в контексте реализации Концепции развития дополнительного образования детей до 2030 года.

Ключевые слова: система образования, дополнительное образование детей, развитие, модернизация образования, интенсивное развитие.

In the education system, additional education occupies a certain area of educational and educational activity that is outside the general education state standard. In 2019, the national Education project was launched, which was successfully completed in 2024, and therefore the system of additional education for children has been intensively developing. Centers for children and adolescents were opened all over Russia, with special attention being paid to small towns and remote regions. Additional

education for both children and adults is focused on meeting human needs and on the comprehensive development and acquisition of additional competencies necessary for them. Additional education for children is one of the leisure components of basic education, and this is one of the distinctive features. We also note that one of the distinctive features of additional education for children is that it helps to develop the child's personal interests and abilities, positively influences motivation to receive basic education, developing self-development and self-education, helps to reveal their own talents and interests. The result is the expansion of the child's horizons, the development of his ideas about himself, the world as a whole, and the people around him. The program for the development of additional education for children has been developed until 2030 and approved by the Government. At the same time, its two–stage implementation is expected: from 2022 to 2024, and then from 2025 to 2030. The enrollment of children in additional education is increasing every year, as shown in Figure.

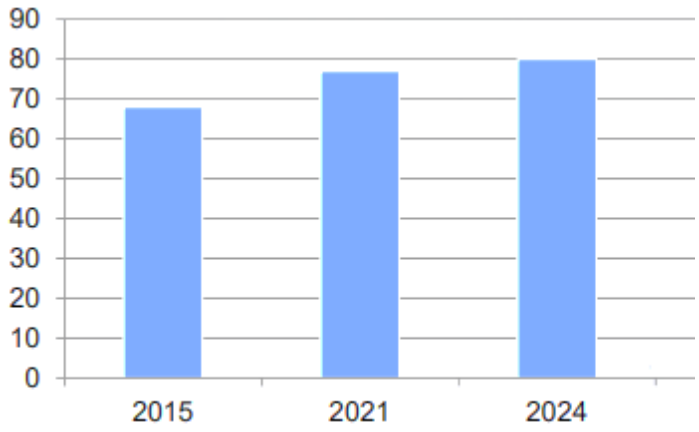


Figure. Additional education coverage for children

Among the main problems existing in the development of additional education for children and requiring solutions are the following: insufficient staffing for additional education organizations; limited accessibility of additional education infrastructure for various categories of children; isolation of additional education for children from general and vocational education, and many others [1].

In recent years, the field of additional education for children has been experiencing a systemic and substantial crisis, as existing interdepartmental barriers do not contribute to its effective development and reduce the effectiveness of the activities of institutions of additional education.

The requirements for improving the quality of additional education are primarily imposed by children and parents, as well as the professional community. The system of additional education for children in the Russian Federation is undergoing a period of intensive development due to the implementation of strategic documents at the federal level and large-scale investments in national projects. Federal Law No. 273-FZ dated December 29, 2012 “On Education in the Russian Federation” established the legal basis for the functioning of additional education as an independent type of education [2], and the Concept for the Development of additional Education for

children until 2030, approved by Decree of the Government of the Russian Federation dated 03/31/2022 No. 1726-r, defined strategic guidelines for the modernization of the industry [3]. The key results of the National Education Project for 2019-2024 demonstrate fundamental changes in the infrastructure of additional education. During this period, 19,965 “Point of Growth” education centers have been established and are operating, which provide access to modern additional education for students in rural areas and small towns. The creation of 464 children's technoparks “Kvantorium”, including 329 technoparks based on educational institutions, has significantly expanded the possibilities of technical creativity for children and adolescents [4].

The large-scale development of the additional education infrastructure has led to the creation of more than 1.4 million new places of additional education in educational institutions of various types. The digitalization of the educational process is ensured by the functioning of 329 IT-cube digital education centers, 30 key centers for additional education for children and 85 mobile technoparks “Kvantorium”.

The achievement by the Russian Federation of the 85 % additional education target for children by 2025 raises the question of the qualitative characteristics of this achievement. The aggregated federal indicators conceal a significant regional differentiation, the analysis of which is necessary for the formation of a sound public policy for the period up to 2030. The purpose of the study is to identify typological groups of regions according to the level of development of additional education systems and to substantiate the directions for improving public policy, taking into account regional specifics.

The analysis of regional data allows us to identify four typological groups of regions. The first group consists of the leading regions with coverage rates above 85 %: the Republic of Tatarstan (over 85 %), Nizhny Novgorod Region (92.6 %), St. Petersburg (84.02 %) [4]. The second group consists of regions with an average level of development, providing coverage at the level of 75-85 %. The third group is represented by regions with critical infrastructure problems: Murmansk region (77 % of schools require major repairs), Kirov Region (69 %), Republic of Karelia (65 %) [4]. The fourth group consists of regions with structural deficits: the Republic of Tuva, where 21 % of urban schools are built of wood, the Nenets and Chukotka Autonomous Okrugs [4].

An analysis of regional practices shows the need for a differentiated government support strategy. It is advisable for the leading regions to scale successful practices through the creation of federal internship sites. For regions with an average level of development, the priority should be to eliminate the personnel shortage and modernize the material and technical base. Regions with critical infrastructure problems require the concentration of federal resources on large-scale modernization. The 192-fold gap between the Moscow and Murmansk regions requires urgent measures at the federal level. For regions with structural deficits, a comprehensive program is required, including the development of distance education and the creation of mobile technology parks.

Of particular importance is the creation in 85 regions of the Russian Federation of regional centers for the identification, support and development of abilities and talents among children and youth (“Mini-Siriuses”), which ensures systematic work

with gifted children throughout the country [5]. An analysis of the current state of the system of additional education for children in Russia shows the uneven development of the federal districts.

According to the Federal statistical Office for 2023, the participation of additional education organizations in the personalized financing mechanism is 26.6 % on average in Russia. At the same time, the Republic of Tyva (83.3 %), the Amur Region (62.9 %) and the Republic of North Ossetia-Alania (57.4 %) demonstrate the highest indicators, which indicates different rates of implementation of new financial mechanisms in the regions [5].

The transition to a new results-based industrial remuneration system covers 55.1 % of additional education organizations on average in the country. The leading positions are occupied by the Kostroma Region (96.5 %), the Udmurt Republic (94.2 %) and the Orel Region (92.4 %). These data reflect the different readiness of regional education systems to introduce modern mechanisms to stimulate pedagogical activity [6]. The analysis of trends in the development of the system of additional education shows the need to solve a number of systemic problems.

The priority areas are: acceleration of the introduction of personalized financing [7], modernization of the material and technical base of educational organizations, development of the digital educational environment and advanced training of teaching staff. The implementation of the Concept for the development of additional education for children until 2030 involves the creation of conditions for the self-realization and development of children's talents, as well as the upbringing of a highly moral, harmoniously developed and socially responsible personality.

The results of the study indicate positive trends in the development of the system of additional education for children in the Russian Federation, with significant regional differences. Further development of the system of additional education requires the intensification of interdepartmental cooperation and consolidation of efforts of federal, regional and municipal authorities.

The Russian Federation has achieved strategic targets for the coverage of children with additional education, and has created a large-scale infrastructure of modern educational centers. At the same time, critical inter-regional inequality, reaching sevenfold and 192-fold excess in certain parameters, requires a differentiated approach to government support. Scaling up the successful practices of the leading regions should be combined with targeted support for regions experiencing systemic problems.

The analysis of trends in the development of the system of additional education shows the need to solve a number of systemic problems. The priority areas are: accelerating the introduction of personalized financing, modernizing the material and technical base of educational organizations, developing a digital educational environment and improving the skills of teaching staff.

The implementation of the Concept for the development of additional education for children until 2030 involves the creation of conditions for the self-realization and development of children's talents, as well as the upbringing of a highly moral, harmoniously developed and socially responsible personality.

The experience of the existing system of additional education for children demonstrates the importance of an integrated approach to the modernization of the

industry, including the improvement of regulatory and legal regulation, the development of the material and technical base, higher salaries for teaching staff and the introduction of modern educational technologies.

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THE CONCEPT OF COMPETITIVENESS, MANAGEMENT AND MARKETING AS FUNDAMENTAL ELEMENTS OF MODERN MUSEUM ACTIVITY

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Abstract. The article is devoted to the study of the competitiveness of museums in a post-industrial society. The author emphasizes the need to transform traditional forms of museum activity due to changes in the needs of the audience and the leisure market. Special attention is paid to marketing tools and modern museum management methods, which make it possible to successfully compete with other leisure facilities and attract a new audience.

Keywords: museums, marketing, competitiveness, museum management, innovative technologies, resource management.

ПОНЯТИЕ КОНКУРЕНТОСПОСОБНОСТИ, МЕНЕДЖМЕНТА И МАРКЕТИНГА КАК ОСНОВОПОЛАГАЮЩИХ ЭЛЕМЕНТОВ СОВРЕМЕННОЙ МУЗЕЙНОЙ ДЕЯТЕЛЬНОСТИ

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Аннотация. Статья посвящена исследованию конкурентоспособности музеев в условиях постиндустриального общества. Автором подчеркивается необходимость трансформации традиционных форм музейной деятельности, обусловленная изменениями потребностей аудитории и рынка досуга. Особое внимание уделяется маркетинговым инструментам и современным методам управления музеями, позволяющим успешно конкурировать с другими учреждениями досуга и привлекать новую аудиторию.

Ключевые слова: музеи, маркетинг, конкурентоспособность, музейный менеджмент, инновационные технологии, управление ресурсами.

Modern post-industrial society is oriented toward the service sector, where the economy is characterized by increased competition across all industries, the development of markets that meet diverse consumer demand, and a decreasing share of the industrial sector relative to the service sector. The increase in the volume of services provided is driven by changes in the functioning of enterprises in the relevant industry: the range of services provided is expanding, competition for customers is

increasing, and the requirements for the quality of service are increasing. Doctor of Economics Miroshnikov N.I. notes that over the past twenty years, the domestic service sector has been modernizing faster than other sectors of the economy. However, when comparing the quality and customer focus of Russian services with those of foreign countries, one finds that the process of creating a fully-fledged modern service system in our country is still in its infancy [1; 2, p. 43]. During the transition to a market economy in Russia, significant changes have affected social services in education, healthcare, and culture. The organizational and economic status of many social institutions is changing, funding methods are evolving, the number of services provided and areas of activity are expanding, and organizations' connections with the outside world are expanding [2, p. 43]. The socio-cultural space is changing, undergoing radical transformations, and new forms of culture are being born. The emergence of the information society forms a new attitude of the individual towards the cultural heritage and the ways of its preservation and transmission to subsequent generations [3, p. 45].

Research by international and domestic museum experts emphasizes the importance of transforming the museum industry in the digital information age. Museum marketing specialist Bezzubova O. A., having studied museum communication methods, concludes: "Traditional museums with thematic and genre expositions are losing their ability to attract attention and arouse the activity of the general public..." [4, p. 236]. The author emphasizes the importance of museums finding innovative formats for communicating with audiences, which are necessary "for the successful functioning of the institution in the current conditions and meeting the diversity of cultural and educational needs of modern society" [4, p. 209]. It is obvious that changes in society have prepared for the transformation of the activities of the traditional museum and expanded its functions. The demands of society related to the organization of leisure have changed [5; 6]. There was a demand to increase its attractiveness by increasing its eventfulness, activity, and the use of original forms of its organization. The museum's working forms are being updated, and the functionality of museum staff is changing. In a highly competitive environment, museums are forced to actively attract audiences from leisure institutions and compete with other cultural organizations that are successfully mastering modern methods of interaction with visitors [7, p. 272].

Museum experts argue that the key roles of museums as public institutions are currently divided into two categories: traditional and contemporary.

The traditional category encompasses museum activities that have evolved over centuries of cultural institution operation and that have retained their significance to this day. These include the recording of historical materials, scientific research, educational activities and outreach, the development of national identity, and the transmission of historical heritage, cultural experience, and significant social knowledge.

The contemporary category, on the other hand, encompasses relatively recent forms of museum activity, shaped by the influence of information technology, communications processes, and the market environment. These include organizing

public leisure activities, ensuring interactive interaction with visitors, and maintaining a positive image of the institution [8, pp. 47-48].

Currently, these groups are interconnected and cannot exist without each other. The museum's functioning apparatus served as the foundation for the emergence of a new approach in museum science and the understanding of the museum as a self-sufficient instrument for reproducing social phenomena and cultural processes, endowed with significant informational, educational and communication resources [9].

According to the Strategy for the Development of Museum Activities in Russia until 2030, the full implementation of these functions significantly contributes to improving the quality of educational activities of museums, achieving the main goal of fully realizing the potential of Russian museums to strengthen the civic consciousness of Russians by preserving the traditional cultural and moral values of the multinational people of our country, creating the necessary conditions for citizens to exercise their right to freely acquire knowledge, use information and cultural benefits, actively participate in cultural life, and visit cultural institutions. In other words, this will improve the competitiveness of museums and strengthen their place in the educational services market.

The concept of "museum competitiveness" is complex and multifaceted. There are several approaches to the definition of this concept: economic, cultural and marketing.

In general, the competitiveness of a museum is determined by the organization's ability to maintain and strengthen its position among similar cultural institutions, offer unique products and services, meet the expectations of the target audience, and ensure sustainable economic and social development.

If we consider the economic approach, the competitiveness of a museum is assessed based on its financial stability, rational use of resources and the ability to generate profits. For example, according to a study by Gonyaeva N. V. and Starostova L. E. "Museum activity as a socio-cultural resource for shaping the image of a city", the economic efficiency of a museum is determined by the ability to effectively manage its assets and investments, ensure financial stability and profitability [10]. They emphasize the importance of optimizing costs, diversifying sources of financing, and attracting investments from individuals and organizations.

From a marketing perspective, a museum's competitiveness directly depends on brand recognition, the level of services provided, and the degree to which audience needs are met. According to research by Kotler P., Asplund C., Rein I., Haider D. "Marketing of places. Attracting investments, enterprises, residents and tourists to cities, communes, regions and countries of Europe" [11], the success of the museum depends on understanding the needs of the audience, developing an effective communication policy and creating a positive image of the organization. The key elements of marketing are the segmentation of the target audience, the positioning of the museum and the creation of unique offers that distinguish this institution from competitors.

From the point of view of the cultural approach, special attention in the issues of museum competitiveness is paid to the importance of cultural values and the identity of museums in the context of globalization and cultural competition. Museologists

Grusman V. M. and Stransky Z. Z. note that the competitiveness of the museum is associated with the preservation of cultural heritage, the development of creative initiatives and the involvement of the public in the processes of preserving traditions and innovations [12; 13]. Conceptually, it is important to form a connection between and society, strengthen social responsibility and increase the level of public confidence in the cultural institution.

In our case, we will use a marketing approach in determining the competitiveness of the museum, since, in our opinion, it is the key among the presented approaches. After all, it takes into account global trends in the development of the art and tourism industry, adapting museum initiatives to the new realities of the cultural environment, provides museums with the ability to quickly adapt to changing audience preferences and successfully implement relevant products and services in a rapidly evolving cultural offerings market.

Marketing, together with management, play a key role in the effective management of museum development [14, p. 9]. The museum now needs new management [15], which will be aimed at the development of this socio-cultural institute, to ensure its "survival" in conditions of fierce competition among leisure organizations.

The discipline of museum management emerged among other specialized fields of management in European countries and the United States in the late 1960s and early 1970s. Its development paralleled the final stages of the emergence of a consumer society. The last quarter of the 20th century was marked by a number of significant financial difficulties in museums. Government subsidies began to decline significantly beginning in the 1980s. This problem was particularly acute for cultural institutions in Germany, the Netherlands, Great Britain, and France. According to a Washington Times article in October 1991, declining budget revenues made the situation of many museums extremely precarious. For example, the Brooklyn Museum lost approximately 40 percent of its annual budget due to drastic cuts in the New York City treasury. During the same period, the Detroit Institute of Arts was forced to close for several days each week, lay off a significant number of employees, and introduce admission fees (a situation previously seen only during the Great Depression). Russian museums also faced similar challenges in the 1990s: declining government subsidies, coupled with a decline in visitor numbers caused by the country's economic downturn, necessitated a change in operational strategy. Faced with financial risks and declining public interest, museums realized that to maintain competitiveness and attract audiences, they needed to adopt a range of approaches used in the commercial environment. As a result, traditional management methods were supplemented with new concepts such as management and marketing [16, p. 402].

The first example of implementing management methods in museum operations was the nineteen Smithsonian Institution institutions in Washington, D. C. They proposed a concept within which the primary mission of museums would be to serve the needs of their audiences, including educational and everyday needs. As a result, the primary focus of museum activities was to be the development and implementation of new cultural offerings, as well as stimulating public interest in them. Museum institutions began to transform from traditional repositories of works of art and

historical artifacts into multifunctional cultural and entertainment complexes, including recreation areas, restaurants, and souvenir shops. Museum performance was now assessed with mandatory consideration of profitability and financial return. By the beginning of the 21st century, similar practices began to be actively implemented in Russian cultural institutions. The demand for digital formats for museum projects, consulting, and research services increased. The financial achievements of museums became as significant as their contribution to the development of society's cultural space. Museum activities became a significant part of the daily activities of many commercial entities. Today's social services and tourism industries are impossible without active cooperation with museum institutions [17, pp. 115-116].

An effective structure and competent resource management are important tasks for any museum. It is necessary to identify and optimally allocate available resources, among which finance, personnel, and logistical support are allocated. Equally important is the formation of a team of competent employees who ensure a high level of motivation and professional growth. Competent management of all types of resources contributes to the successful operation and development of the museum institution. The use of modern management approaches and techniques makes museums attractive and sought-after cultural heritage centers [14, pp. 9-10].

It is important for management to pay special attention to attracting visitors. In addition to interesting exhibitions, the museum should actively involve guests in the interaction process. This is possible through the use of innovative technologies, the organization of interactive exhibitions and educational programs. Equally important is the development of effective marketing and PR strategies that help to increase the recognition of the institution and attract a new audience [14, p. 10].

Marketing is an effective tool that not only identifies, anticipates, and satisfies the needs of museum consumers but also, in certain situations, specifically shapes and influences their preferences. Furthermore, a competent marketing approach can help a museum identify, address, and influence the needs of funding agencies, as well as attract the attention of potential sponsors [16, pp. 412-413].

Museum marketing is a branch of museum management aimed at understanding market demands and the cultural needs of various social groups, generating and satisfying demand for museum services, and enhancing their competitiveness. Although the ICOM Charter officially classifies museums as non-profit institutions, the use of marketing techniques is becoming increasingly common in museum practice. A museum's non-profit status doesn't deprive it of the right to earn a profit, but it does impose special rules on its use: revenues must be invested exclusively in the institution's own development, and its non-profit status grants the museum certain tax advantages. The museum provides access to its collections, creates conditions for self-development, creative interaction, and recreation, disseminates knowledge, supports educational initiatives and events, engages in advertising, and shapes its own image – all of these services are just a small part of the range of services it provides. A significant portion of them can be purchased and paid for not only by museum visitors, but also by scientific organizations, educational institutions, commercial enterprises, local government bodies, charitable foundations, the media, and other interested parties [16, pp. 412-413].

Today, most operating museums include a marketing department, whose primary goal is to increase visitor numbers, expand the target audience, and inform potential clients who are not regular visitors. Marketers collect data to inform the museum's development strategy, organize short-term promotional campaigns during special events, attract additional funding, and work on interactions with sponsors. Regardless of their focus, specialists follow a uniform algorithm: they research the market, develop plans, implement planned events, evaluate results, and make appropriate adjustments [16, p. 413].

The main distinguishing feature of the new marketing strategy is the shift of emphasis from the sale of already mastered museum services or products to their development, focused on the needs of visitors. Marketing is not a local activity, but a comprehensive museum strategy that requires the conscious involvement of every employee. It is impossible to effectively address museum issues and enhance the organization's competitiveness without addressing the museum's overall work in all its diverse aspects, including its substantive aspects. This involves addressing a number of key issues [18, pp. 74, 76]:

a) quantitative analysis, planning, forecasting, and monitoring the results and economic feasibility of marketing communications activities;

b) initiating and maintaining ongoing communication with marketing stakeholders who have the ability to leverage their marketing potential;

c) identifying new, effective communication tools and techniques that enable successful competition in the cultural services market;

d) minimizing communication costs in the face of uncertainty regarding the predictability of their impact on the market for products, goods, works, and services, as well as across a variety of organizations with varying ownership structures and scales of operations [19, p. 365; 20, pp. 372-373].

In our opinion, the third problem deserves special attention from museums, as the active use of new communication tools and methodologies, including innovative educational technologies, serves as an effective means of enhancing the competitiveness of cultural organizations. This contributes to increased visitor numbers and increased revenue from paid services provided to the public. Today, the cultural institutions that have most successfully realized their innovative potential are achieving the greatest success in overcoming current and long-term socioeconomic challenges. Furthermore, experimentation is a key factor driving change in museum operations, primarily through the implementation of advanced management methods and marketing solutions aimed at successfully achieving the institution's goals and attracting a wider audience. This also includes the use of new technologies in organizing exhibitions, cultural events, and educational projects.

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INNOVATIVE EDUCATIONAL TECHNOLOGIES IN MUSEUM PRACTICE

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Abstract. This article is devoted to the role of innovative educational technologies in modern museum practice. The author emphasizes the importance of using such technologies to increase the attractiveness of museums among the audience and strengthen their competitive position. However, the introduction of innovations is accompanied by conceptual, content and technical risks. To minimize risks, careful preparation and thoughtful design of technological solutions are proposed, taking into account the peculiarities of the museum audience and the content of the exhibitions.

Keywords: museums, innovative educational technologies, implementation risks, competitiveness, innovations.

ИННОВАЦИОННЫЕ ОБРАЗОВАТЕЛЬНЫЕ ТЕХНОЛОГИИ В МУЗЕЙНОЙ ПРАКТИКЕ

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Аннотация. Данная статья посвящена роли инновационных образовательных технологий в современной музейной практике. Автор подчеркивает значимость применения таких технологий для повышения привлекательности музеев среди аудитории и укрепления их конкурентных позиций. Однако внедрение инноваций сопровождается концептуальными, содержательными и техническими рисками. Для их минимизации предлагается тщательная подготовка и продуманное проектирование технологических решений, учитывающих особенности музейной аудитории и содержание экспозиций.

Ключевые слова: музеи, инновационные образовательные технологии, риски внедрения, конкурентоспособность, инновации.

The development of the cultural sector is made possible by the active implementation of cutting-edge technologies and innovations, which enhance the competitiveness of cultural organizations both now and in the future. Ignoring this innovative approach will reduce the attractiveness of cultural institutions to audiences and negatively impact their social and economic development [1, p. 371].

A profile of Russian museums' innovative activity shows a significant increase in their numbers and visitor numbers. Between 2000 and 2022, the total number of museums grew from 2047 to 3036, and annual attendance increased from 73 to 121 million [2]. This positive trend confirms the successful adaptation of museums to market conditions and the growing public interest in the cultural heritage and historical memory of their own country [1, p. 371]. According to researchers, the observed positive trend is explained by the widespread use of modern technological solutions, particularly interactive exhibits, augmented reality, and digital information and communication tools. Thanks to such innovations, museums are becoming dynamic venues, attractive to both adults and young people, contributing to the steady growth in popularity of museum spaces. Experts believe this trend will continue in the coming years.

Simultaneously, many museums have proven unable to adapt to the changing situation. Some institutions have failed to embrace modern technologies and have effectively stalled their development since the end of the last century. This situation will lead to a decline in museum competitiveness, which will negatively impact audience interest [3; 4].

In museum activities, it is customary to distinguish between various types of innovation: "technical / technological, methodological, organizational and managerial (innovations in the field of management), marketing, social" [5, p. 97; 6, p. 78]. They are closely related to museum and pedagogical innovations, since they are components of innovative educational technologies (technical / technological, methodological in matters of creation, organizational and managerial, marketing, social), and are also aimed at overcoming a number of difficulties typical for the cultural and educational activities of museums:

1) the challenges of museum education, which revolve around understanding visitors' goals and motivations, explaining their reasons for visiting museums and their understanding of the purpose of their visit;

2) the effectiveness of museum communication, which involves studying the impact of the museum itself, its spaces, exhibitions, and objects on visitors' perceptions;

3) the challenges of studying museum audiences, aimed at identifying the characteristics of those who visit museums and those who prefer to avoid them;

4) the challenges of developing and implementing innovative methodological approaches, educational programs, and exhibitions adapted to different categories of visitors;

5) the challenges of choosing the most productive forms of partnership and organizing joint activities with cultural and educational organizations [7].

Let's focus on innovative educational technologies in more detail, since they are generally at the heart of museum innovation processes in the context of the transformation of museums into multifunctional educational centers.

First of all, we need to consider the concept of "innovative educational technologies". In general, innovation means "novelty", "new feature". The main sign of innovation is a progressive approach to the development of museum and pedagogical practice, which differs from established traditions and mass experience [8, p. 5].

Innovations in education are the processes of updating and improving pedagogical technologies, including teaching methods, techniques, and tools. Today, innovative teaching is becoming a crucial component of the educational process at every educational institution. Innovative approaches not only shape institutions' competitiveness in the educational market but also set benchmarks for teachers' professional development and stimulate their creativity [8, pp. 6-7]. Innovation is sometimes defined as the application of known methods with minor changes or modifications. However, human innovation is distinguished by its desire to transcend traditional conditions, methods, and techniques, achieving not just new content but fundamentally different qualitative results.

The concept of "technology" is traditionally interpreted as a set of methods, techniques and methods of producing products, including the processing of materials, the manufacture of products, and the modification of their characteristics, forms and properties through professional skill and art. Technology in the "procedural" sense answers the questions of how to create a particular product and by what means. Moreover, these questions are preceded by a clear definition of the goal, indicating "what needs to be obtained". The meaning and purpose of any technology is to optimize the management process, to exclude from it all types of activities and operations that are not necessary to obtain a social result [8, p. 6].

There are numerous interpretations of the concept of "educational technology" in both foreign and domestic research. The terms "educational technology" and "pedagogical technology" are often used interchangeably in the teaching community. However, the term "educational technology" is broader, encompassing a wide range of aspects beyond just pedagogical ones: social, managerial, cultural, psychological, economic, and others. At the same time, the concept of "pedagogical technology" applies to the entire field of pedagogy, encompassing its various fields [8, p. 10]. All this leads to some difficulties in specifying the definition of "educational technology". We will attempt to do this on the basis of the table (Table 1), where the main interpretations of the concept will be presented [8, pp. 12-14; 9, pp. 13-15].

Table 1 – Interpretations of the concept of "educational technology"

Interpretations of the concept of "educational technology"	
Foreign	Domestic
M. Clark: "the use of inventions, industrial products and processes in the field of education, which are part of the technology of our time"	**L. G. Semushina, I. G. Yaroshenko**: "1) a way to implement the content of learning; 2) a system of forms, methods, and means of learning that ensure the effective achievement of goals"
F. Percival and G. Ellington: "any possible means of presenting information (these are equipment used in education, such as television, various means of image projection, etc.; in other words, technology in education is audiovisual means)"	**V. P. Bespalko**: "a meaningful technique for the implementation of the educational process. This definition focuses on the use of technology only in the learning process. This leads to a sharp narrowing of this concept as a pedagogical definition and the possibilities of using it in practical pedagogical activity"

UNESCO: "1) the use for pedagogical purposes of the means generated by the revolution in the field of communications, such as audiovisual media, television, computers and others; 2) a systematic method of planning, applying and evaluating the entire learning and knowledge acquisition process by taking into account human and technical resources and the interaction between them to achieve a more effective form of education"	**V. M. Monakhov**: "a well-thought-out model of joint pedagogical activity in the design, organization and conduct of the educational process with the unconditional provision of comfortable conditions for students and teachers"
D. Finn: "a way of organizing is a way of thinking about materials, people, institutions, models, and man-machine systems"	**M. V. Klarin**: "the systemic totality and functioning of all personal, instrumental and methodological tools used to achieve pedagogical goals"
P. D. Mitchell: "this is an area of research and practice (within the educational system) that has connections (relationships) with all aspects of the organization of pedagogical systems and the procedure for allocating resources to achieve specific and potentially reproducible results"	**G. Yu. Ksenzova**: "such a structure of the teacher's activity, in which all the actions included in it are presented in a certain integrity and sequence, and the implementation presupposes the achievement of the necessary result and has a probabilistic predictable character"
T. Sakamoto: "learning based on a systematic way of thinking"	**E. A. Levanova**: "an ordered and task-structured set of actions, operations and procedures that provide a diagnosable and guaranteed result in changing conditions"

Thus, educational technology is a system of scientifically and practically sound methods and tools that ensure the achievement of set goals in any educational field. They encompass a general strategy for creating a unified educational space. Their main function is predictive, and one of its main activities is project-based (planning common goals and results, main stages, methods and organizational forms of the educational process aimed at training highly qualified personnel) [8, pp. 9-10].

Having studied the concept of innovative educational technologies in parts, we can finally synthesize a general definition of innovative educational technologies. These refer to a set of advanced methods, approaches, and tools used in education to improve its quality, effectiveness, and attractiveness, ensuring flexibility, interactivity, and individualization of the educational process, facilitating the activation of students' cognitive interest, the development of critical thinking, creativity, and the formation of competencies necessary in modern society.

A large number of innovative educational technologies are used in museum teaching practice, which can be roughly divided into three large groups: information, communication, and interactive. In the table below (Table 2), you can see the distribution of technologies by these groups [5, p. 99; 10; 11, p. 154; 12, pp. 105-106; 13, pp. 276-278; 14, p. 76; 15; 16; 17; 18; 19].

Table 2 – Distribution of innovative educational technologies by groups

Groups of innovative educational technologies		
Information	**Communication**	**Interactive**
videos	groups, channels and communities on social networks and messengers	layout of exhibits or destinations (digital detailed map for online expedition routes)
specialized mobile applications (for example, Smart Museum, Artefact)	"creative industries": museum quarters, museum city, art residences	AR, VR and MR technologies
QR coding of texts and images	web representation on the Internet	audio and video art
digital storytelling	special platforms for educational blogging	tactile and sound exhibits (three-dimensional 2D and 3D art paintings and portraits, cast "talking" figurines); 3D mapping; 4D technologies
AI tracking	mini museum	project activities (local history, virtual, historical and cultural studies, etc. projects)
metaverse (convergence of physical, augmented and virtual reality in a shared museum space)	light coding system (LinkRay)	optical illusions; puzzles
information search engines (electronic guides to the museum)	on-line video lectures	information kiosks
multimedia projectors	teleconferences with the participation of scientists and technicians	animatronics
holography (holograms and holographic theater)	technologies of sense-generating representation	virtual museum tour, virtual guide
audiovisual installations	virtual museum	event technologies: educational games; quests within the framework of the edutainment direction – game and entertainment training; museum lessons; master classes; cinema lecture halls; creative meetings
robotic guides	chatbots and intelligent assistants	creative laboratories and clubs (for example, the museum theater)

The use of the above-mentioned technologies in museums is dictated by the desire to increase the number of visitors. However, the implementation of such systems poses many risks that must be avoided. They comprise 3 types of risks, namely: conceptual, content, and technical [20, p. 235].

Conceptual risks. From the very beginning, museums must clearly understand the purpose of the technologies they implement. Ignoring this issue risks turning exhibits into mere backdrops for vibrant multimedia effects. It's important to recognize that while modern technologies have become firmly entrenched in the structure of

museum spaces, their role should remain complementary – they serve merely as "tools that enrich the narrative with additional information and functions" [5, p. 101]. Therefore, the "abuse" of technological innovations can lead to the risks of loss and distortion of the cultural, scientific, architectural, and semantic aspects of museum activities. These risks manifest themselves in the following:

1) the transformation of museums into mass entertainment venues ("digital shows");

2) a technological decline in the quality of the cultural and valuable content of museum exhibitions ("digital degradation");

3) the emergence of conflicts over the interpretation of museum information among museum staff, online moderators, and internet users ("internet-interpretive conflicts");

4) the emergence of substitutes for traditional museum formats, displacing original exhibitions and events ("substitutization of museum products");

5) the loss of uniqueness and the specificity of the unique qualities of museum objects ("depersonalization of museum artifacts");

6) a decrease in interest in art and history and the level of understanding of them by visitors ("simplification of the audience experience");

7) loss of professionalism among museum staff due to the implementation of unprofessional initiatives and projects ("deprofessionalization of museum staff");

8) increased financial costs for the implementation of virtual, augmented, and mixed technologies (VR, AR, and MR projects) [5, pp. 101-102].

Content risks. Modern museums actively attract new audiences using flashy technologies, but they often miss the point: viewers value a compelling story and a clear plot more than impressive visuals that can only attract short-term attention due to their novelty [20, p. 237]. The proposed approach will negatively impact the quality of the exhibition itself. Ideally implemented multimedia solutions are designed to enrich the exhibition, clearly conveying the significance of each exhibit. However, there is another danger: information overload. Some museums overindulge in detail when describing objects, causing viewers to lose their attention. To prevent this, interactive elements of the exhibition should be designed with the overall concept and structure in mind, immersing viewers in a unified semantic space, highlighting specific objects and evoking emotions. The exhibition should prepare the audience for the perception of art objects. When viewers are deprived of physical contact with the object, it is important to create an atmosphere that allows them to connect with it through sensory perception. Technology and content alone should not become the purpose of the exhibition. Furthermore, visitor attitudes toward interactive equipment vary widely, and assessing the impact of these elements on the educational process is difficult. A thorough study of the impact of multimedia solutions on audience cognitive activity is necessary [21, p. 483].

Technical risks. When implementing an interactive system in exhibitions, it's important to remember that individual components of the device may no longer be manufactured by the manufacturer. Therefore, at the system design stage, the developer must provide alternative replacement options for each element should its production be discontinued. Before selecting components for interactive devices, a detailed study

of the museum's operations is necessary: assess the number of visitors, calculate the average load on the equipment when used by a single user, and compare these data with the manufacturer's stated component reliability. This analysis must be conducted individually for each system element and the results communicated to museum management to ensure timely budgetary allocation. Furthermore, the coordinated operation of all system components, including not only the equipment but also the research and creative teams, is critical [20, pp. 240-241].

In other words, technologies should not just be implemented, they should be constantly maintained and updated. And most museums do not have sufficient qualifications and experience in this field, which leads to problems with setting up and repairing equipment. In addition, the staff at museums very often includes those who are trying to bring the museum in line with the current rapidly changing world, to put it at the service of modern society, and those who, despite the obvious changes, want to work the old-fashioned way, perceives issues related to marketing as something contrary to high scientific and educational standards. The museum's ideals are being resisted by the introduction of new economic thinking (in fact, this situation demonstrates the ideological crisis in which the museum finds itself today) [22, pp. 76-77; 23, pp. 206-207].

Human resources are the most important factor ensuring the effectiveness of the museum's activities. The management style of the museum and its internal organization should ensure the greatest effectiveness of work, and for this the museum should become a single team in which each employee has not only a clear range of tasks and responsibilities, but also the opportunity to promote ideas, wants to introduce innovations that can become a valuable contribution to the development of the museum.

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ARTISTIC EXPERIMENTS AND THE AVANT-GARDE IN THE VISUAL CULTURE OF GRAPHIC STORIES

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Abstract. The article is devoted to the analysis of the phenomenon of avant-garde and artistic experiments in comics. The authors explore non-standard techniques, techniques and conceptual solutions used by modern comic artists to expand the expressive possibilities of the genre. The work covers the works of authors who use nonlinear plots, unusual frame structures, and meta-narrative techniques to create new expressive forms of graphic narrative.

Keywords: comics, experiments, visual culture, transformation of graphic stories, stylistic approach, multimedia format.

ХУДОЖЕСТВЕННЫЕ ЭКСПЕРИМЕНТЫ И АВАНГАРД В ВИЗУАЛЬНОЙ КУЛЬТУРЕ ГРАФИЧЕСКИХ ИСТОРИЙ

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Аннотация. Статья посвящена анализу феномена авангарда и художественных экспериментов в комиксе. Авторы исследуют нестандартные приемы, техники и концептуальные решения, используемые современными художниками-комиксистами для расширения выразительных возможностей жанра. Работа охватывает труды авторов, использующих нелинейные сюжеты, необычные структуры кадра и метаповествовательные приемы в создании новых выразительных форм графического нарратива.

Ключевые слова: комикс, эксперименты, визуальная культура, трансформация графических историй, стилистический подход, мультимедийный формат.

The study of the specifics of the experiment in the genre of comics is of particular importance in the light of the active growth in popularity of this area in the context of the transformation of views on the nature of the graphic language of storytelling. The history of the comic strip began at the beginning of the 20th century with the appearance of the first full-fledged printed editions of graphic stories, which laid the foundations for the genre identity of the visual narrative. Initially presented as a

sequence of images in a caricature style with a small amount of text, this form is gradually beginning to be perceived as an independent art form. This is how linear drawings acquire the ability to convey the dynamics of the plot, and the main characters of the story become trendsetters popularizing new meanings, images and trends in all areas of society.

The period known to us as the Golden Age is characterized by the development of expressive illustrations through the introduction of lines (stroke) and shadows. However, despite the progress, the drawings themselves remain simple and schematic, characterized by a flat structure of figures and static composition. The next stage is the Silver Age. The transition to a variety of storylines and the improvement of graphic techniques. Comic book writer Jack Kirby is an iconic figure of the Silver Age. Many researchers recognize him as a master of his time, who made a significant contribution to the comic's industry. Kirby used cinematic composition in his works with unusual viewing angles, clear contours and deep shadows, which gave his works volume and vitality (M. Evanier, 2008, J. Morrow, 2008, R. Ronin, 2004). Another influential artist is Steve Ditko. He enriched the idea of the universe of heroes with elements of surrealism and abstractionism, creating an atmosphere of mystery, vividly expressed in such characters as Spider-Man and Doctor Strange [1]. The beginning of the 1970s marks an important stage in the qualitative transition in the perception of comics. Previously considered only entertainment, comics began to acquire the status of serious literature that studies important social, philosophical, moral and personal issues. A significant example of this process was the creative path of Neil Adams, whose attention to detail and emotional transmission made his works reference (M. Carlson, 2022).

The phase of evolution begins in the last decades of the 20th century and continues up to the present. The introduction of computerized technologies is becoming important, opening up access to the creation of high-quality digital images, increasing the range of artistic methods and approaches. Today, modern artists freely combine traditional techniques with new digital capabilities, providing viewers with rich visual experiences. It is also worth noting the growing integration of comics with the world of animation and cinema, which enhances the process of cultural interchange and forms common standards for the perception of characters and spatial context.

The historical transformation processes of graphic design presentation of plots and new techniques have allowed the comic to go from a simple entertainment format to a complex system of artistic execution. These changes reflect the changing mass perceptions, aesthetic tastes of the audience and cultural demands of the era, further affirming the status of comics as a full-fledged and unique art form.

Speaking about comics as a phenomenon of mass culture, it is worth noting the long path of development that transformed graphic stories from primitive illustrative stories into complex and multi-layered visual art. The process of self-identification of creators seeking to express their own vision and originality reached its peak at the beginning of the 21st century, when a significant variety of individual stylistic approaches and methods of narrativization emerged.

To identify the key aspects that influence the formation of a unique product, it is necessary to analyze the visual components, which are the key ones. Four main aspects

can be distinguished: the visual component, the structure of the work, and the emotional impact on the reader. Let's look at it in more detail.

The visual component. The central element that sets the unique visual appearance of a modern comic book is the use of author's techniques in the design solution. A striking example is the work of Brian Bolland (“Batman: The Killing Joke”), demonstrating the successful combination of traditional pencil sketches with modern retouching and coloring, creating a unique aesthetic experience [2].

The trend towards minimalism and symbolic language of expression is also of interest, when authors abandon overloading with details in favor of concise visualization that emphasizes the essence of a character or scene. Thus, the works of Joe Sacco (“Palestine”) demonstrate how visually simple, but filled with aesthetics, manga is able to effectively convey atmosphere [3]. This approach may indicate the authors' desire to go beyond the traditional graphic narrative by expanding the boundaries of the visual narrative.

The structure of the work. Modern comics are characterized by their structural flexibility, allowing artists to create unusual compositional solutions. Many authors abandon the traditional linear sequence of frames, using alternative panel layouts, non-standard sizes and shapes of frames. A striking example is the work of Mike Dringenberg, Sam Kieth, Neil Gaiman (“The Sandman”) [4]. One of the most striking aspects of the artistic embodiment in the comic "The Sandman" is the compositional solution and the variability of the page design style. This work demonstrates a high degree of freedom in choosing the format for presenting visual information, which allows the reader to immerse himself in the expansive atmosphere of the plot.

It is worth noting the development of the practice of including interactive elements in the modern design concept of comics. Interactive comics are an innovative genre of graphic storytelling characterized by a wide range of multimedia formats and digital mechanisms of interaction with the audience. QR codes and augmented reality (AR) technologies occupy a special place among the many techniques and approaches used to create interactive comics. For example, Marvel used QR codes to enhance the depth and enrich the main narrative of the story. So, in 2024, The X-Men comic book series included QR codes that provided access to exclusive content. They were a kind of portals that allowed you to get acquainted with additional information that was not present in the main text. But the comic series “Moon Knight” showed hidden messages through QR codes, allowing viewers to learn the character's backstory. The creators of the interactive comic book “Neon Wasteland” have used augmented reality technology to create the impression of immersion in the world of a dystopian future. AR technologies in this case added animation movements to the fixed drawings of the comic, thereby increasing reader engagement.

Emotional impact. A characteristic feature of modern comic book design is the intensification of an expansive response from the perceiving subject through the deliberate formation of a special artistic environment and the mood of the work. The effect is achieved through a variety of expressive techniques, among which are the change of the color palette, the selection of angle solutions of the frame, the montage composition of episodes, the rhythmic organization of sequences of long and short-term fragments of the narrative. Such techniques contribute to the active involvement

of the viewer in empathizing with events, reveal the aesthetic and psychological potential of the genre and provide a large-scale artistic impression.

Modern authors focus on expanding the range of non-verbal influence on the audience. Creating impressions – feelings of anxiety, joy, compassion, anger – helps bring the graphic story to a new level of communication. So, Jason Aron ("Scaled") achieves a special differentiation of emotions, playing on the contrasts of the brutality of the criminal world of the Indian reservation and the graphic depiction of the humanity of individual characters. The stylistic design of the visual series of the comic epic "Scaled", developed by R. M. Guera, enhances the perception of the story. Graphics by R. M. Guera has a grunge aesthetic. She emphasizes the deliberately rough execution of the drawing and the lack of sharpness of the lines, without canceling the meanings laid down by D. Aron [5].

When researching non-standard methodologies used in the process of creating experimental comics, it is advisable to pay attention to the fact that such projects contain an authorial element (artistic feature) that reflects a conscious violation of the generally accepted canons of the genre. Table 1 presents an analysis of the personal approach to visual culture in the evolution of comics in the first half of the current millennium.

Table – Visual culture in the evolution of comics in the first half of the current millennium

Comics	**Artists Artwork**	**Artistic features**	**Contribution to the development of the genre**
By Brian Bolland	"Batman: The Killing Joke", "Camelot 3000", "The Batman. A killer Joke"	Exceptional detail, realism and dynamism, mastery of composition, expressive characters, experimentation with format, attention to color	The "British invasion" of the American industry, the recognition of graphic novels as an independent genre
Joe Sacco	"Palestine"	Realistic drawing, a combination of reportage accuracy with artistic insight, the inclusion of author's reflections, a detailed study of social problems	He created a new subgenre of documentary comics, showed the possibilities of comics as a tool for social analysis
Jason Aron and R. M. Guera	"Scalped"	Ostentatiously rough execution techniques – the drawing of dense contours, the use of massive shadow spots and uneven dashed overlays contribute to conveying an atmosphere of devastation and hopelessness, the integration of flashbacks and different points of view, graphic realism that conveys fading, the characters of the characters as the engine of the plot	Social realism in comics, a new form of neo-noir, complex, multifaceted characters, recognition of independent creativity

Each of the authors listed in Table played a significant role in the formation of comics as an independent form of artistic expression, expanding the boundaries of the genre and the range of its influence on the formation of the visual culture of the 21st

century. Based on the analysis of the above examples, one can observe the rejection of the application of classical norms of graphic narration and standard patterns of compositional constructions of visual narrative through the introduction of innovative informal solutions. The new methods of visual storytelling language used have radically changed the original role of the comic book, turning it from a superficial entertainment print product into a mature artistic judgment characterized by multiple levels of storytelling (simultaneous parallel storylines in one work), deep philosophical reflection (touching on fundamental existential issues), active interaction with the audience (involving the viewer in the process of interpretation), constant experimental search (demonstrating the constant overcoming of genre limitations) and social resonance (where the comic book functions as a means of critical reflection on social phenomena).

Based on the above, we can conclude that the new author's solutions we have studied have provided the comic book with well-deserved recognition along with other forms of art, confirming its active potential. Experimental comics are beginning to occupy a central place in the current cultural environment, acting as a catalyst for the destruction of established conventions, offering the public a renewed understanding of the nature of storytelling and visuality. As a tool for understanding current socio-ethical issues, visual experiments in the comic's industry contribute to strengthening the role of the genre.

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METHODOLOGICAL FOUNDATIONS FOR THE FORMATION OF LINGUOCULTURAL IDENTITY IN PRIMARY SCHOOL STUDENTS THROUGH ONOMASTIC MATERIAL

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Abstract. The article examines the problem of the formation of monologue word creation in children of senior preschool age in the context of the ethnolinguistic approach. Particular attention is paid to the use of traditional folk culture of the Ural region in the development of speech and creative potential of children. The pedagogical conditions, methodological techniques and ethnocultural materials that contribute to the formation of a coherent monologue statement are revealed.

Keywords: monologue word creation, ethnolinguistics, traditional folk culture, preschool education, oral folk art, Ural region.

МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ ФОРМИРОВАНИЯ ЛИНГВОКУЛЬТУРНОЙ ИДЕНТИЧНОСТИ МЛАДШИХ ШКОЛЬНИКОВ СРЕДСТВАМИ ОНОМАСТИЧЕСКОГО МАТЕРИАЛА

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Аннотация. В статье рассматривается проблема формирования монологического словотворчества у детей старшего дошкольного возраста в контексте этнолингвистического подхода. Особое внимание уделено использованию средств традиционной народной культуры Уральского региона в развитии речи и творческого потенциала детей. Раскрываются педагогические условия, методические приемы и этнокультурные материалы, способствующие становлению связного монологического высказывания.

Ключевые слова: монологическое словотворчество, этнолингвистика, традиционная народная культура, дошкольное образование, устное народное творчество, Уральский регион.

The modern system of preschool education is aimed at developing the child's personality, cognitive activity, independence, and creative self-expression. One of the most important indicators of a child's readiness for school is the level of speech development, especially monologic speech – the ability to construct coherent, logically complete utterances.

The problem of developing monologic speech in preschool children has long attracted the attention of psychologists, linguists, and educators. The theoretical foundations of this process were laid in the works of L. S. Vygotsky, who emphasized the social nature of speech and its role as a tool for thought formation. Vygotsky's concept of the zone of proximal development and the idea that speech emerges through social interaction and gradually becomes internalized are of fundamental importance for understanding how verbal creativity develops in children [1]. According to A. A. Leontiev, speech is not only a means of communication but also an activity that shapes consciousness, while F. A. Sokhin and O. S. Ushakova identified the preschool period as a sensitive stage for the development of coherent and expressive speech. E. I. Tikheeva's research focused on the pedagogical methods that support the transition from dialogic to monologic forms of speech, laying the groundwork for modern methodologies of speech formation in preschool education.

Issues of verbal creativity were addressed by T. A. Tkachenko, N. S. Zhukova, and V. I. Yashina, who emphasized that children's word creation is not limited to imitation but reflects the child's individual linguistic experience and imagination. From the standpoint of psycholinguistics, the process of generating coherent speech statements involves the integration of semantic, grammatical, and pragmatic levels of language, which are actively formed in preschool age. This idea correlates with the works of J. Bruner, who viewed language as a tool for constructing meaning and considered narrative activity a key mechanism in cognitive development. The ability to tell a story, according to Bruner, indicates a higher level of symbolic thinking and self-awareness, which makes the development of monologic speech a crucial educational task.

In the field of ethnolinguistics, a significant contribution was made by N. I. Tolstoy, S. M. Tolstaya, and E. N. Golubkova, who studied the interconnection between language, culture, and folk tradition. Their research demonstrated that language functions not only as a communicative system but also as a cultural code preserving the collective experience of the people. From this perspective, speech development in preschoolers cannot be separated from the cultural and value-based context in which the child grows. The ethnolinguistic approach thus serves as a methodological bridge between linguistic and cultural education, providing a holistic framework for the development of children's speech and personality.

Traditional folk culture serves not only as a repository of the lexical and figurative means of language but also as a methodological foundation for speech development, as it encompasses folklore genres (fairy tales, riddles, proverbs, ritual songs) rich in models of narration, description, and reasoning. Of particular importance is the ethnolinguistic heritage of the Ural region, where Finno-Ugric, Turkic, and

Slavic cultural layers are synthesized. Ural folklore reflects the natural features of the region, its labor culture, and mythological imagery, creating a rich linguistic and symbolic environment for the development of children's word creation.

Ethnolinguistics views language as a bearer of culture and a means of transmitting the traditions of the people. In the context of preschool education, this approach allows for the integration of linguistic, cognitive, and cultural development. N. I. Tolstoy noted that language is "the key to understanding a nation's culture", and introducing children to elements of ethnolinguistic heritage fosters not only linguistic competence but also a value-based attitude toward their native language.

The linguocultural potential of the Ural folk tradition reveals itself through the deep interrelation between the region's language, nature, and worldview, which together form a unique symbolic and emotional space for a child's speech development. The Ural region has long been perceived as the "mountain heart" of Russia, and its folklore reflects this natural environment with remarkable vividness. The mountains, forests, rivers, and minerals are not merely geographical features but living participants in oral narratives, embodying moral and aesthetic values that can be easily interpreted by children. For example, the mountain often symbolizes endurance and wisdom, the forest stands for mystery and protection, and precious stones and metals are associated with inner beauty, honesty, and strength of character.

In the tales recorded and reinterpreted by P. Bazhov, such as "The Stone Flower", "The Mistress of the Copper Mountain", and "The Silver Hoof", linguistic imagery is rich with metaphorical expressions that blend the natural and human worlds. The speech of the characters incorporates dialectal words, diminutive forms, and emotionally colored expressions that make the language expressive and authentic. When children are introduced to these stories, they not only absorb the melody and rhythm of regional speech but also grasp the underlying meanings – the respect for labor, the harmony between man and nature, and the sense of moral justice that pervades Ural folklore. The child begins to recognize that every word carries emotional weight, that speech can reveal both external and inner beauty.

The ethnolinguistic material of the Urals also includes local toponyms and appellatives that have preserved traces of Finno-Ugric and Turkic linguistic influences. Words such as "tagan" (tripod for a cauldron), "chugunok" (small cast-iron pot), and "zarnitsa" (distant lightning) create vivid mental images that bring to life the rhythm of traditional everyday existence. These linguistic elements, when introduced in storytelling or creative play, form bridges between the past and present, showing children that their native speech is a vessel of history and identity. The very sound of these words, their phonetic softness or ruggedness, evokes sensory and emotional associations that enrich children's speech perception and stimulate verbal imagination.

Another significant aspect of the Ural linguocultural heritage is the moral symbolism embedded in its folklore. The Ural craftsman, who works with stone, metal, or clay, is not portrayed merely as a laborer but as a creator who transforms the natural world through talent, patience, and moral purity. His speech in folk narratives is concise, rhythmical, and imbued with respect for the craft, reflecting the unity of word

and deed that is central to the regional worldview. When children reproduce such speech patterns in dramatizations or creative monologues, they not only practice coherent utterance but also internalize the ethical dimensions of the stories – perseverance, humility, and love for beauty created by human hands.

Equally rich in pedagogical potential are the regional folk songs, lullabies, and sayings that accompany seasonal rituals. The melodic structure of Ural songs, often calm and solemn, mirrors the rhythm of northern nature and promotes emotional regulation and speech expressiveness. Traditional verbal formulas such as blessings, greetings, and exclamations introduce children to figurative uses of language, teaching them how speech can simultaneously describe and inspire. Through such expressions, they discover that language is not only a means of communication but also a creative force that shapes reality.

The imagery of Ural folklore unites the tangible and the fantastical, offering fertile ground for linguistic creativity. Children readily empathize with personified natural elements – the talking stone, the whispering birch, or the singing ore – and these metaphors invite them to build their own stories where nature and humans coexist in harmony. When educators encourage children to create their own endings to folk tales or invent new characters inspired by regional myths, the process of monologic word creation becomes deeply connected to the emotional and symbolic heritage of the region. This not only enriches the child's speech but also strengthens the inner sense of belonging to the land, language, and culture of the Urals.

The use of decorative and applied art objects and folk toys (Dymkovo, Bogorodsk, and Ural clay toys) creates a special atmosphere filled with the images and symbols of folk culture. Such an environment stimulates imagination, fosters associative thinking, and promotes the development of artistic and verbal experience. While playing with traditional toys or examining elements of folk costumes, children begin to use figurative expressions, invent stories about artisans and heroes, and imagine the past life of their region [2].

An essential component of this work is the systematic use of folklore genres – proverbs, riddles, and small forms of oral folk art – which develop linguistic sensitivity, metaphorical thinking, and the ability to use expressive means of speech.

Creative speech situations play an important role: organizing dramatized games based on Ural tales, composing original stories inspired by local legends, and participating in projects such as "The Tale of the Mountain Masters" or "Legends of the Native Land" stimulates speech creativity and activates word creation.

An effective pedagogical technique is the use of regional linguistic material. Integrating dialectal and linguistic features into the educational process helps children appreciate the richness and uniqueness of the Russian language, and to see that speech reflects not only communication but also culture, tradition, and worldview. Dialectal words typical of the Ural dialect carry a special local color related to nature, labor, and everyday life, arousing children's interest in the history and linguistic heritage of their native region.

When introducing preschoolers to such words as kamenushka (a type of stone bird), podsnezhnik-vetrenik (an early spring flower), zapoloshny (frightened, restless), or zagovenye (a pre-fasting holiday), the teacher not only expands vocabulary but also creates conditions for creative linguistic activity. In games, storytelling, and dramatizations, children try to use these words in their own speech, which develops linguistic intuition and sensitivity to the semantic and emotional nuances of words. Gradually, the child begins to realize that every word has its own history and meaning, that words can be "alive", carrying the imprint of their native land [3].

Furthermore, the use of regional linguistic material fosters respect for cultural roots and a sense of belonging to one's native tradition. Through language, the child enters the living space of folk speech, perceiving it as part of their inner world. This not only develops speech but also contributes to the formation of a personality aware of their cultural identity. Thus, regional linguistic material becomes not merely a teaching tool but a powerful instrument of spiritual and linguistic development, integrating cognitive, emotional, and creative aspects of upbringing [4].

Practical work on the development of monologic word creation should include several stages. At the preparatory stage, children accumulate impressions of folk culture through stories told by the educator, excursions, and listening to tales by P. Bazhov. At the reproductive-creative stage, children retell folk texts, participate in dramatizations, and learn to use dialectal words. At the final productive stage, they engage in independent word creation – composing their own fairy tales, descriptions, and stories with elements of folk poetics ("Once there was a little stone…", "How the mountain flower was born", etc.) [5].

Methodologically, it is important to involve the child in the process of co-creation, where the adult acts not as a controller but as a co-author and interlocutor. This approach fosters initiative, emotional responsiveness, and a sustained interest in language.

Based on L. S. Vygotsky's ideas, the development of monologue is possible only through dialogue. Therefore, the educator organizes dialogic conversations that encourage reasoning:

— Why wasn't the craftsman afraid of the Mistress of the Copper Mountain?

— What helps a person to be strong and kind?

Such conversations naturally lead to independent storytelling, where children learn to express their thoughts in an expanded form.

Special attention is given to verbal creativity exercises, such as "Continue the tale", "Invent a name for a mountain spirit", or "What would the old Ural tell you?" These tasks encourage children to create original texts, combining folk imagery with personal impressions and thus developing an authorial type of verbal thinking.

To strengthen the intergenerational connection, it is important to involve parents in the process – organizing folk tradition days, family celebrations, craft workshops, and reading folk tales together. This not only enhances speech development but also fosters respect for the history and culture of the native land.

In conclusion, monologic word creation in senior preschoolers is an essential component of speech and personal development, forming the foundations of independent thinking. The traditional folk culture of the Ural region represents a unique resource for speech development, enriching vocabulary, nurturing imagery, and enhancing emotional expressiveness. The organization of pedagogical conditions that include the creation of an ethnocultural environment, the use of folklore genres, and creative speech situations ensures the effective formation of monologic word creation. The ethnolinguistic approach enables the integration of various educational areas – speech, cognitive, artistic-aesthetic, and moral-social development.

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PROSPECTS FOR TOURISM DEVELOPMENT IN NORTH KOREA

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Abstract. The article conducts a thorough analysis of the possibilities of developing the potential of the DPRK as a popular tourist destination among Russian tourists. It was concluded that the DPRK represents a wide range of tourist products that belong to three categories: ideological, historical-cultural and natural-recreational. The image of the DPRK in the mind of a Russian tourist changes from completely negative to the positive one, which opens up great prospects for tour operators.

Keywords: DPRK, tourism industry, tourist attraction policy, tourist infrastructure, inbound tourism.

ПЕРСПЕКТИВЫ РАЗВИТИЯ ТУРИЗМА В КНДР

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Аннотация. В статье проводится тщательный анализ возможностей развития потенциала КНДР как популярного туристического направления у российских туристов. Сделан вывод о том, что КНДР представляет широкий ассортимент туристического продукта, который относится к трем категориям: идеологический, историко-культурный и природно-рекреационный. Образ КНДР в сознании российского туриста меняется от полностью негативного к положительному, что открывает большие перспективы для туроператоров.

Ключевые слова: КНДР, туриндустрия, политика привлечения туристов, туристическая инфраструктура, въездной туризм.

The purpose of this article is to identify the tourism potential of the DPRK for Russian tourists. The purpose determined the objectives of the study: 1) to describe the current state of inbound tourism in the DPRK; 2) to consider the main problems for the development of inbound tourism in the DPRK; 3) to highlight ways of attracting Russian tourists to the DPRK. This study is relevant in light of recent geopolitical events, when Russians face difficulties in obtaining visas to some countries or the lack of direct flights to popular destinations. The novelty of the study lies in the enormous tourism potential of the DPRK, which has not been studied in sufficient depth.

Demand for trips to North Korea is growing among Russian tourists. According to the Russian Union of Travel Industry, interest in this destination has increased significantly both in the Far East and throughout Russia [1]. Currently, Russian tourists have only one option for reaching North Korea by air: Air Koryo flights between Vladivostok and Pyongyang, which operate three times a week. Direct air service between the countries, which was suspended due to the pandemic, resumed in August 2023. It is important to note that only organised tourism is possible in the DPRK. Tour operators such as VostokIntour already offer several tour options [2]. Accurate statistics on visits to the DPRK by Russian tourists over the past 5-10 years are limited in the public domain, and data for the pandemic period is completely unavailable. However, based on recent reports, a positive trend can be seen. After the resumption of communications in February 2024, the first group of Russian tourists in four years, numbering 100 people, visited Pyongyang and the Masikryong ski resort in the DPRK. Two more similar trips took place in March of the same year [2]. According to the Primorsky Krai administration, tourist traffic from Russia to the DPRK via Primorye from January to May 2025 increased by more than 1.5 times compared to the same period in 2024, reaching almost 700 people. At the same time, according to information from the tour operator VostokIntour, about 70 % of tourists come from regions of Russia that do not border the DPRK. A visa is required for the trip, which costs an average of €50. Russian entrepreneurs can visit the DPRK on tourist visas, but their business programme must be agreed with the host party. The average cost of an organised tour is about $800 (approximately 74,000 roubles) [3]. This amount usually includes flights from Vladivostok to Pyongyang and back, accommodation, meals, transport, guide services, entrance tickets for the programme and insurance.

After many years of isolation, North Korea (DPRK) is cautiously opening up to the outside world, and one of the key instruments of this policy is attracting foreign tourists. This opening is not mass, but strictly selective and regulated. Why is the DPRK opening up to Russia in particular? The main reason is to strengthen political alliances. As MP Svetlana Zhurova explained, Pyongyang sees Russia as a friendly country, ‘whose actions are above board.’ This opening up has been made possible by the signing of a comprehensive cooperation agreement. Russia is perceived as a partner with whom there is mutual understanding and common interests, including in overcoming the ‘stereotypes and myths’ that, according to the parties, exist about their countries in the West [4].

The tourist scheme in North Korea is radically different from what we are used to. Tourists travel exclusively in organised groups accompanied by guides who monitor their movements. Instead of free walks around cities, guests are accommodated in large resort complexes. These complexes have everything you need for a relaxing holiday – swimming pools, restaurants, shops – but you are not allowed to leave them. This creates the effect of an “ideal bubble” with high standards of cleanliness and service, but without access to the real life of the country. Tourists are required to adhere to a dress code, especially when visiting monuments and sacred sites, and to show respect for local customs [5, p. 85].

The policy of attracting tourists to the DPRK has several objectives:

1) Economic: to obtain the necessary foreign currency under international sanctions.

2) Political and propaganda: creating a positive image of the country, demonstrating its ‘achievements and stability’ to the audience.

3) Diplomatic: developing tourism is a tool for strengthening relations with specific countries, as in the case of Russia.

Despite the strictness, experts note a growing interest among Russians in North Korea. According to Inna Mukhina, CEO of a travel company, the Korean people are hospitable, and there are currently no visa issues for Russians – the main thing is to submit the documents in advance, approximately 45 days before the trip [6].

The DPRK's state policy in the field of tourism is not about freely opening its borders, but rather a strategically calibrated and strictly controlled process. The country does not seek mass tourism, but uses it as a tool to solve economic and political problems, offering foreigners a carefully crafted version of reality within isolated resorts. At this stage, Russia, as a key political ally, is the main source of relaxation of the rules.

Travelling to North Korea is a strictly regulated experience. All itineraries are approved in advance by the authorities, and any independent deviations from the programme are prohibited. Despite stereotypes about total control, special conditions are created for foreign tourists, and the country is actively developing its tourist infrastructure in an effort to attract more visitors.

The main attractions include visiting the grandiose monuments in Pyongyang, learning about the national history and Juche ideology, visiting sacred mountains, and relaxing at new seaside and ski resorts.

Main attractions of North Korea:

1. Juche Idea Monument: A 170-metre granite monument on the banks of the Taedong River, symbolising the will of the Korean people. At the top is an observation deck, and at the foot is a group of sculptures representing the working class, the peasantry and the intelligentsia. It was erected in 1982 to mark the 70th anniversary of Kim Il-sung's birth, to emphasise the fundamental importance of ideology for society.

2. Kim Il-sung Square: the central square of the North Korean capital, used for military parades and mass events. It is surrounded by a monumental architectural ensemble, including ministry buildings, the Korean Central History Museum and the Museum of Fine Arts.

3. Kumsusan Palace of the Sun: the world's largest mausoleum, where the embalmed bodies of two DPRK leaders, the country's founder Kim Il-sung and his son Kim Jong-il, lie in state. The Kumsusan Palace of the Sun is a symbol of the cult of personality and an important place of national memory in North Korea. Visiting it requires strict adherence to a dress code and rules of conduct.

4. Triumphal Gate: a monument built in honour of Kim Il-sung. The design is inspired by the architecture of the Arc de Triomphe in Paris, but incorporates traditional Korean elements.

5. Pyongyang Metro: one of the deepest in the world, it also serves as a bomb shelter. Tourists are only allowed to visit a few stations and only when accompanied

by a group. The Pyongyang Metro is not only a means of transport but also an ideological object. Its atmosphere is reminiscent of the 1960s in the USSR.

6. The Museum of the Victory in the Fatherland Liberation War is dedicated to the Korean War (1950-1953). The museum's guides are Heroes of the Republic and veterans who participated in the Fatherland Liberation War. On the river near the museum is the armed American spy ship Pueblo, captured by sailors of the Korean People's Army in 1968.

Historical and cultural sites:

7. Korean Central History Museum: the country's main history museum, covering Korea from the Palaeolithic era to the present day, with a focus on the struggle for independence.

8. International Friendship Exhibition (Museum of Gifts to Leaders): this treasure trove of a museum houses more than 117,000 gifts presented to DPRK leaders by heads of state and delegations.

9. Tomb of King Gongmin (Kaesong): The 31st king of the ruling Gongmin dynasty and his wife, Queen Noguk, are buried here. The site attracts visitors with its architectural perfection and rich symbolism.

10. Songjuk Bridge (Kaesong): an ancient stone bridge known as the site of the murder of Chong Mong Ju, an official loyal to the Goryeo dynasty.

11. Bohyeon Buddhist Temple: an active 11th-century temple near Mount Myohyangsan, where ancient Buddha statues and frescoes have been preserved. This sacred place is an important centre of Buddhist practice and cultural heritage.

12. Mangende Schoolchildren's Palace is a comprehensive educational institution for the country's youth. Here, students can engage in various activities, including study, sports, creativity, and other outdoor activities.

Natural sites:

13. Mount Paektu: a sacred volcano on the border with China, the highest point on the peninsula (2,744 m). According to a legend, the founder of Korea, Tangun, was born here, and the official propaganda claims that Kim Jong-il was also born here. The crater of the volcano contains the picturesque Lake Cheonji.

14. The Kumgangsan mountain range (Diamond Mountains) is famous for its picturesque peaks, waterfalls and gorges, which are especially beautiful in autumn.

15. Mount Myohyangsan (‘Mountain of Mysterious Fragrance’): a UNESCO biosphere reserve. There are hiking trails to temples and caves, as well as the aforementioned International Friendship Exhibition.

Resorts and recreation areas:

16. Masan Beach Resort: North Korea's most popular beach resort is located on the shores of the Sea of Japan. Foreign tourists often choose this place because it has a five-star hotel, a spa complex with a swimming pool, and a leisure area with billiards and bowling.

17. Rason Beach Resort is considered a more modern area. In addition to the pristine sandy beach, visitors can visit local markets, dine at various restaurants, and sample the local cuisine. The most popular activity among tourists is a boat trip. You can stop at Pipha Island, see sea lions, and visit a deer reserve.

18. Wonsan-Kalma Resort Complex: a promising tourist complex that is positioned as the future main resort for foreigners, including Russians. It includes long beaches, many hotels, restaurants, and entertainment infrastructure.

19. Masikryong: a modern world-class ski resort with slopes of varying difficulty, hotels, equipment rental and a cable car.

20. Ryonggang and Chonghak Sanatorium: health resorts known for their thermal radon springs and therapeutic mud. Guests are offered wellness treatments, and in some hotels, healing water is supplied directly to the bathtub [7].

The DPRK's tourist infrastructure offers a unique holiday experience, combining an introduction to the country's ideology and history with visits to monumental architecture and relaxation at developing resorts.

Relations between Russia and the DPRK have deep historical roots, which have largely shaped the initial and friendly basis for mutual understanding.

The USSR played a key role in the formation of North Korea in 1948 and was the first country to recognize it. In 1961, the two countries signed a Treaty of Friendship, Cooperation and Mutual Assistance, which provided for military support to North Korea in the event of conflict. North Korean leader Kim Il-sung visited the USSR on numerous occasions, meeting with Stalin, Khrushchev and Brezhnev. This period is associated with close alliance and ideological proximity, which left a mark on the memory of the older generation of Russians.

After the collapse of the USSR in the 1990s, bilateral relations virtually ceased to exist. Political contacts were minimized, and Russia, under the leadership of Boris Yeltsin, turned to the West. In 1996, the parties stated that the 1961 treaty had lost its significance. In the public consciousness, this period reinforced the image of North Korea as a distant, incomprehensible and problematic country, plunged into a deep crisis exacerbated by the famine of the 1990s.

It was during the 1990s and 2000s that a set of persistent negative stereotypes about the DPRK took shape in the Russian media and, as a result, in the public consciousness.

The most common stereotype is the perception of the DPRK as a totalitarian state with the Kim dynasty's permanent rule, a cult of personality, and a complete lack of political freedoms and human rights. The country's isolation only fuelled this image, making it convenient for simplistic analysis.

Many Russians remember reports of the devastating famine in North Korea in the 1990s. This created a lasting association of the country with poverty, ruin and chronic malnutrition among most of the population. The image of an economy entirely subordinated to military needs has also become one of the key stereotypes. Regular nuclear tests and missile launches, accompanied by aggressive rhetoric from official Pyongyang, have shaped the image of a country that destabilizes regional and global security. North Korea's nuclear programme is often perceived as a tool of blackmail rather than a necessary deterrent, as the DPRK leadership itself positions it.

The image of the DPRK as a ‘closed kingdom’ where it is impossible to enter freely and where any movement within the country is strictly controlled is one of the most persistent. This image has been reinforced by the accounts of the few tourists and

journalists who have visited the country, who emphasized the feeling of total surveillance and the staged nature of everything they saw.

Since the 2000s, and especially after 2014 and 2022, the image of North Korea in Russia has undergone a significant transformation, primarily at the official level and in media loyal to the state. Parallel to the official position, there is also an alternative perception based on personal experience and cultural exchanges.

Some Russian tourists who have visited the DPRK note a feeling that one of them described as ‘a happy Soviet childhood’. The abundance of children in pioneer ties, monumental architecture, a focus on collective values, and the reserved but sincere friendliness of the local people all evoke nostalgia in some Russians for elements of their own past.

Touring North Korean artists, the resumption of tourism and educational programmes contribute to the ‘humanization’ of the image. When people see not only political leaders, but also talented musicians, athletes or ordinary citizens, the stereotypical image of a ‘robotic’ population begins to fade.

The evolution of the DPRK's image in the minds of Russians is a movement from ally through a period of alienation and the formation of negative stereotypes to complex and contradictory cooperation. Today, negative stereotypes coexist with new official knowledge. However, in the mass consciousness, especially among the generation that did not experience Soviet friendship, stereotypes fuelled by Western and liberal media are deeply rooted. Overcoming them is an extremely difficult task. The image of North Korea in Russia remains fragmented and strongly depends on sources of information and personal experience [8, pp. 253-255].

Attracting tourists to North Korea requires a special approach that goes beyond standard beach or sightseeing holidays. Success lies in correct positioning this destination as an exclusive experience.

The first and most important step is to shift the focus from politics to uniqueness. North Korea should be promoted not as a ‘forbidden zone’ but as a destination for intrepid travellers. Marketing should be based on the language of exclusivity: ‘A journey that will redefine your perception of the world’ or ‘An once-in-a-lifetime adventure that you will talk about for years to come’. This will not attract mass tourists, but researchers, journalists, photographers and people seeking a deep immersion in a completely different culture.

Secondly, it is necessary to develop and promote themed tours that go beyond the standard sightseeing tour of Pyongyang. For example, architectural tours that will be of interest to urbanists, focusing on the unique style of the Pyongyang metro, memorial complexes and unusual public buildings. Ecotourism, active recreation in picturesque mountainous areas, such as the Diamond Mountains, with an emphasis on their natural beauty and unspoilt nature, should be applied too.

The third strategy is honesty and managing expectations. Instead of hiding strict rules, they should be presented as part of a unique ‘quest’ – special conditions for access to a closed country. A clear explanation of the need for a guide, restrictions on photography and adherence to the programme will help filter out unprepared tourists and build trust with those who understand the specifics of the trip.

Finally, visual content plays an important role. It is necessary to actively collaborate with travel bloggers and photographers who can show the DPRK through the prism of human stories, architectural aesthetics, and natural landscapes. High-quality photos and videos on social media with hash tags #UnknownKorea or #NorthKoreaTour will break stereotypes and generate healthy curiosity. By offering meaningful programmes and honestly describing the conditions, it is possible to create sustainable demand among those travellers for whom borders are just a point on the map, not a limit to knowledge.

The analysis allows us to draw a number of fundamental conclusions:

1. Inbound tourism to the DPRK, especially from Russia, is undergoing an active but strictly controlled revival after a period of almost complete isolation caused by the COVID-19 pandemic. Statistical data, although limited, clearly indicate positive dynamics.

2. The development of tourism in the DPRK is not an end in itself, but a tool for solving larger-scale economic, political and propaganda tasks. The opening of the country to foreigners, and primarily to Russians, is selective, regulated and strategically calibrated.

3. The DPRK offers an extremely diverse and unique tourism product, which can be divided into three main types: ideological and monumental, historical and cultural, and natural and recreational. This combination makes a trip to the DPRK a multifaceted experience that can appeal to different categories of travellers, from those interested in politics and history to nature lovers and ski enthusiasts.

4. The current image of North Korea in Russia can be described as fragmented: negative stereotypes coexist with a new, positive official image and eyewitness accounts. This creates both obstacles and opportunities for tour operators.

Conclusion

The potential of North Korea as a tourist destination for Russian tourists is real and significant, but niche. Its successful implementation depends on coordinated actions by both sides. North Korea should continue its course of cautious opening, developing resort infrastructure and demonstrating flexibility in its visa policy. Russian tour operators and marketers need to abandon the exploitation of the image of a ‘strange dictatorship’ and move towards positioning North Korea as a unique cultural, historical and natural anomaly, visiting which is an intellectual challenge and a privilege for the prepared traveller.

In the current international climate, when many traditional destinations have become less accessible to Russians, North Korea has every chance of establishing itself in the Russian tourism market as a stable and extremely memorable destination. However, its development will remain directly dependent on the overall dynamics of bilateral relations, remaining not an independent industry, but part of a broader political and economic dialogue between Moscow and Pyongyang.

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PROSPECTS OF USING QUEST EXCURSIONS TO ATTRACT TOURISTS TO THE REPUBLIC OF TATARSTAN

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Abstract. The article examines the possibilities of using quest excursions to attract young people to the tourism development of the Republic of Tatarstan. An online quest project is proposed, and its further development prospects are analyzed. It is assumed that the project, combining an entertaining format with educational elements, will contribute to the growth and development of the participants' creative thinking and cognitive abilities.

Keywords: quest, quest tour, quest excursion, online quest, tourism industry.

ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ КВЕСТ-ЭКСКУРСИЙ ДЛЯ ПРИВЛЕЧЕНИЯ ТУРИСТОВ В РЕСПУБЛИКУ ТАТАРСТАН

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Аннотация. В статье рассматриваются возможности применения квест-экскурсий для привлечения молодежи к туристическому освоению Республики Татарстан. Предложен проект онлайн-квеста, а также проанализированы его дальнейшие перспективы развития. Предполагается, что проект, сочетая развлекательный формат с образовательными элементами, будет способствовать росту и развитию творческого мышления и когнитивных способностей участников.

Ключевые слова: квест, квест-тур, квест-экскурсия, онлайн-квест, туристическая индустрия.

The purpose of the article is to identify the potential of using quest tours and quest-based excursions to increase interest in the Republic of Tatarstan and the city of Kazan among young people. This purpose defines the article's objectives: 1) to describe the features of using quest-based excursions among young people; 2) to propose an original project – an online quest through historical places of Kazan; 3) to determine

the development trajectory of this project for the next 3-5 years. The relevance of the research is explained by the increased interest of young people in online projects that do not involve third parties and utilize gadgets, which will help introduce residents and guests of Kazan to interesting and unique buildings, architectural monuments, and memorials associated with the history and traditions of the Tatar people in a game format. The novelty of the research lies in the fact that it is the first to examine the features of applying online quests in the Republic of Tatarstan.

The modern tourism industry is developing incredibly fast. New ways of promoting tourist products are emerging, as well as new types and formats of tourist activities. Tour operators now must rely less on their established reputation and traditional target audience, and more on an individual approach to organizing tours and attracting different social groups [1, p. 394]. In this regard, the use of quest-based excursions seems a very promising direction for attracting young people, as it represents an engaging game. As Terekhina Yu. V. notes, “the use of quest elements allows for the implementation of a tour program in a game format with riddles and puzzles on a specific theme”, and there is no need to involve additional personnel [1, p. 396].

Yurlova E. A. gives the following definition of a quest: “it is a popular entertainment game where participants move towards a goal according to a pre-developed plot, overcoming a series of obstacles, solving intellectual tasks, and performing various assignments” [2, p. 495]. A quest helps develop strategic thinking, the ability to make quick decisions, and improves the perception and subsequent assimilation of information. Furthermore, it fosters teamwork skills, communication skills, and satisfies society's need to achieve social and cultural goals. A quest contributes to a person's learning and development, teaching them to make quick decisions and think outside the box. It also develops the ability to search for necessary information, including on the Internet, and to use it.

The main objectives of quest tourism are: 1) finding an answer to a question, riddle, or puzzle united by a common theme, such as the history, architecture, or culture of the visited place; 2) searching for and visiting interesting cultural and historical sites; 3) acquiring new experience and knowledge in an accessible form; 4) team building and cohesion; 5) improving quick decision-making skills; 6) gaining positive emotions [3, p. 119]. A quest should include the following elements: time limits, thorough route development, preparation of interesting questions and riddles, a common theme, the presence of one or several groups of participants, familiarization with objects, and a final goal [3, p. 120].

It should be noted that youth tourism, i.e., the variety of tourist activities among young people and adolescents, pursues various goals – entertainment, education, sports. Youth, as consumers of tourist services, represent a special segment of the tourist market due to their specific characteristics: mobility, active lifestyle, desire for communication, acquiring new information, limited budget, and willingness to tolerate inconveniences for the sake of economy [4, p. 129-130]. Young people are always attracted to something non-standard, innovative, and modern, as opposed to traditional.

Thus, the use of online quests seems a good alternative to conventional excursions. The use of quest-based excursions among a youth audience engages participants in the game process, in solving tasks and puzzles of varying complexity. Quest-based excursions allow participants to try on different roles; they "evoke positive emotions and contribute to the cohesion of the quest participants" [5, p. 26]. Young people show particular interest in such events because they enjoy the competitive component more. The use of the latest communication tools – the Internet, phone cameras, digital maps, etc. – helps to engage young people.

The quest-based excursion we propose allows to tell guests of Kazan about its main sights in an entertaining format. City residents can take a fresh look at monuments and landmarks they have become accustomed to and may not find particularly interesting. The project's goal is to introduce residents and guests of Kazan to interesting and unique buildings, architectural monuments, and memorials associated with the history and traditions of the Tatar people in a game format. The project's objectives are: 1. To attract tourist flow to Kazan; 2. To convey information about historical facts and cultural features of the residents of Tatarstan in an entertaining form; 3. To increase interest in the historical past of the Republic of Tatarstan specifically and Russia as a whole.

It is assumed that tourists purchase the opportunity to participate in the quest. Via a Telegram channel, they receive messages with tasks. Their goal is to find the specified location as quickly as possible, take a photo with it, and send the photo to the quest organizer. If the answer to the task is correct, the participant receives the next task.

Here are some examples of quest tasks:

The origin of the name Kazan is most often associated with a legend according to which a sorcerer advised the Bulgars – the ancestors of the Tatars – to build a city where a cauldron buried in the ground would boil without any fire – which translates to "kazan" in Old Bulgar and Tatar. The ancient ancestors of the Kazan people found such a place on the shore of Lake Kaban. And you will begin your journey from this lake.

1. "I am in Kazan, in the kingdom of the Tatars. Placing my portfolio on my knees, I write to you from the shores of Lake Kaban". A. Dumas. Find the monument to the great Tatar enlightener on the shore of Lake Kaban and write his name.

2. This monument faces the mosque of the same name. Take a photo against the backdrop of this mosque.

3. Long ago, the Khan's treasures, thrown from boats by his nukers, were extinguished in the waves. The gold of the Khans is still being sought... On the shore, the forest spirit Shurale looks at people and smirks... Find the place near the Kamal Theatre where Shurale sits and read the inscription on the log.

4. Tatars hurry to Friday prayer. Pray, perform righteous deeds, and think of your soul. Head to Moskovskaya Street and take a photo of the Nurulla Mosque.

5. In Kazan, there are two unusual streets stretching along the banks of the Bulak channel – Levobulachnaya and Pravobulachnaya. Walk along these streets, count the number of bridges, and write their names.

6. The Kazan Kremlin is in front of you. Enter it and find the monument to the builders of the fortress and write their names.

7. Next to you is the Annunciation Cathedral – the oldest Orthodox church in Kazan. What color are the domes of this cathedral?

8. A special place in the Kazan Kremlin is occupied by the “leaning” tower. Its top deviates from the vertical by almost 2 meters. Approach the tower and find out its name.

9. The Kul Sharif Mosque is an adornment of the city of Kazan. Proceed to it and take a photo against its backdrop.

10. We leave the Kremlin through the Spasskaya Tower. Opposite it stands a monument to Musa Jalil in shackles. Find out who he was.

11. The National Museum of the Republic of Tatarstan is located on the Kremlin Hill. This is the main museum of the republic, housing unique exhibits. How many statues are above the museum entrance?

12. Continue along Kremlyovskaya Street to Kazan Federal University. Count the number of columns on the main building.

13. Sit down and rest on the “frying pan” next to the monument to the young Lenin.

14. Go down to Bauman Street via Universitetskaya Street. Enter the Old Prolomnaya Pharmacy and find out who founded it.

15. Now head to the carriage of Catherine the Great and take a photo inside it.

16. Find the famous Kazan cat, pet its belly.

17. To conclude our quest, let's go to the clock on Bauman Street, stop by the “Su Anasy” fountain, and find out what kind of comb she has.

Let us describe the project's development prospects for 3-5 years. The writing and development of quests on specific themes are planned: “In the Footsteps of the Liberation Warriors” (studying the biographies of heroes of the Great Patriotic War after whom streets in Kazan are named), “On the Route of Alexander Dumas”, “Sports Kazan”, “Symbols and Legends of Kazan”, “Cultural Heritage of Kazan”, and others. The development of quests for schoolchildren is scheduled: with a simpler program, within one district, according to the wishes of teachers and parents.

Conclusion: The use of quest-based excursions has significant potential and can be used to attract young people to the Republic of Tatarstan. Young people are attracted by the use of modern technologies, the absence of guides and tour leaders, and the competitive and entertaining component. The use of an online quest helps tourists visiting Kazan to better learn the features of Tatar culture and the history of the region. This project has all the necessary components for its development.

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THE DIAGNOSTIC ASPECT OF TEACHERS' WORK ON THE FORMATION OF ECOLOGICAL AND PATRIOTIC CULTURE AMONG 5TH GRADE STUDENTS BY MEANS OF DECORATIVE AND APPLIED ARTS

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Abstract. The article presents a diagnostic complex for assessing the level of formation of ecological and patriotic culture among 5th grade students by means of Belarusian decorative and applied arts. The structure of the complex aimed at studying cognitive, emotional-value and behavioral components is described. A system of criteria and assessment levels has been developed to monitor personal development. The practical value of the research lies in the possibility of using this toolkit to improve educational work in institutions of general secondary education.

Keywords: ecological and patriotic culture, diagnostic complex, decorative and applied arts of Belarus, 5th grade students, cognitive component, emotional and value component, behavioral component, levels of education.

ДИАГНОСТИЧЕСКИЙ АСПЕКТ ДЕЯТЕЛЬНОСТИ ПЕДАГОГОВ ПО ФОРМИРОВАНИЮ ЭКОЛОГО-ПАТРИОТИЧЕСКОЙ КУЛЬТУРЫ У УЧАЩИХСЯ 5-ГО КЛАССА СРЕДСТВАМИ ДЕКОРАТИВНО-ПРИКЛАДНОГО ИСКУССТВА

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Аннотация. В статье представлен диагностический комплекс для оценки уровня сформированности эколого-патриотической культуры у учащихся 5-х классов средствами белорусского декоративно-прикладного искусства. Описана структура комплекса, соотносящаяся с изучением когнитивного, эмоционально-ценностного и поведенческого компонентов культуры младших подростков. Разработана система критериев и уровней оценки, обеспечивающая анализ степени эколого-патриотической воспитанности школьников. Практическая ценность исследования заключается в возможности применения данного диагностического инструментария для совершенствования воспитательной работы в учреждениях общего среднего образования.

Ключевые слова: эколого-патриотическая культура, диагностический комплекс, декоративно-прикладное искусство Беларуси, учащиеся 5-го класса, когнитивный компонент, эмоционально-ценностный компонент, поведенческий компонент, уровни сформированности.

In the context of global environmental challenges and the need to preserve national identity, the modern education system is actualizing the search for new pedagogical solutions. According to the Concept of continuous education of children and students in the Republic of Belarus, "environmental education is aimed at the formation of an ecological culture of the individual, is determined by the universal significance of nature for man and society and includes knowledge about the components and their interrelationships in the system "man – society – nature" [1]. In this context, the integration of environmental and patriotic education into a single pedagogical process becomes a methodological necessity. The formation of an ecological and patriotic culture as an integrative personal education is a strategic task of the educational system of the Republic of Belarus in the context of addressing pressing issues of sustainable development and national formation of the younger generation.

This work is of particular importance in institutions of general secondary education, where a purposeful pedagogical process of formation of national identity and ecological consciousness is carried out. The period of early adolescence, corresponding to the 5th grade (10–12 years old), is characterized by increased susceptibility to the value-semantic content of activities. Students of this age group are actively developing theoretical thinking, the ability to reflect, and social cooperation, and the foundations of moral consciousness and social responsibility are being formed, which creates a favorable psychological and pedagogical environment for purposeful work on the formation of an ecological and patriotic culture. It is during this sensitive period that the foundations of a value relationship to the natural and cultural heritage of one's native country are laid, and an understanding of the dialectical relationship between patriotic feelings and environmental responsibility is being formed [2].

The methodological guideline in this process is the provision of the National Strategy for Sustainable Development of the Republic of Belarus until 2035, which emphasizes that "the formation of a moral, responsible, independent-minded and creative personality is impossible outside of a culture that helps everyone to form basic moral values" [3]. This strategic guideline actualizes the role of the cultural component in education as a foundation for personal education, which fully corresponds to the goals of the formation of an ecological and patriotic culture.

The decorative and applied art of Belarus, which has significant educational potential, acts as an effective means of solving this problem. Its uniqueness lies in the organic synthesis of aesthetic, historical, ecological and patriotic components, which act as complementary elements of a unified system in the educational process. Traditional crafts – embroidery, weaving, embroidery, straw weaving – are not only techniques of manual labor, but also the material embodiment of the centuries-old experience of adaptation of the people to the natural environment, reflecting the principles of sustainable use of natural resources and respect for resources [4].

Each of the listed crafts demonstrates a deep environmental conditioning: the use of renewable natural materials, cyclical production processes, minimal waste generation. At the same time, they carry a significant patriotic charge, being visual codes of national identity. The historical aspect is manifested in the preservation of archaic technologies and ornamental complexes, while the aesthetic aspect is manifested in the development of artistic taste and understanding of folk beauty ideals.

The synergetic interaction of these components in the educational process creates an emergent effect when schoolchildren form a qualitatively new systemic understanding of culture as the unity of man and nature, which is manifested in the ability to see environmental patterns in traditional technologies, decode natural symbols in ornaments, and realize the continuity of generations through craft traditions. The emerging holistic perception of national culture and natural heritage really surpasses the simple sum of acquired knowledge and skills, generating stable value orientations and a conscious civic position.

Between the theoretical substantiation of the potential of decorative and applied art and the assessment of its effectiveness lies a key stage of practical implementation, which requires clear methodological support. The development and implementation of diagnostic tools make it possible to translate the process of forming an ecological and patriotic culture into a practical plane, ensuring its manageability and measurability. This transition from a theoretical model to an empirically verifiable practice is a prerequisite for achieving the set educational goals.

The methodological basis of this approach is based on the principles of integrating diagnostics into the educational process, ensuring the unity of educational and educational activities. The system of diagnostic procedures inextricably links the content of educational programs with the value orientations of the individual, creating conditions for a holistic impact. This approach makes it possible to overcome the traditional separation of education and upbringing, ensuring their organic unity in the formation of the ecological and patriotic culture of students.

The effectiveness of the educational process for the formation of an ecological and patriotic culture in the context of general secondary education directly correlates with the level of development of its diagnostic component. The development of effective diagnostic tools is a key condition for the success of the pedagogical process, since it allows educational activities to be transferred from the field of intuitive assumptions to the plane of evidence-based pedagogical influence. Diagnostics, understood as an integral system of evaluation activity, provides management of the process of personality development through the consistent implementation of three interrelated functions: ascertaining, shaping and controlling.

The structure of the diagnostic component includes standardized tools for identifying the level of formation of ecological and patriotic culture and assessing the dynamics of the development of cognitive, emotional, value and behavioral spheres of the student's personality. The implementation of the diagnostic system provides objective data for timely adjustment of methods and content of work, allowing to differentiate pedagogical approaches taking into account individual indicators of student development. The presence of clear diagnostic criteria creates the basis for

designing targeted educational trajectories and provides meaningful feedback in the "teacher – student" system.

To achieve this goal, a specialized diagnostic complex has been developed, the structural organization of which is based on a three-dimensional personality model, including cognitive, emotional-value and behavioral components. Such a complex is a system of interrelated diagnostic procedures aimed at a comprehensive assessment of the level of formation of ecological and patriotic culture. The cognitive diagnostic unit includes tasks to identify knowledge about national symbols, traditional crafts and their natural foundations, using matching methods and open-ended problematic questions. The emotional and value component is assessed through a combination of standardized questionnaires using graduated assessment scales and projective techniques that reveal the depth of personal attitude to the natural and cultural heritage of the native land. The behavioral aspect is diagnosed through the analysis of solutions in simulated practical situations that simulate everyday choices and project initiatives with an ecological and patriotic orientation.

This approach ensures a comprehensive assessment and corresponds to the structure of the ecological and patriotic culture of 5th grade students, presented in the form of three interrelated and interdependent components. The developed assessment system includes detailed criteria for each component with a point scale, which allows not only to determine the current level of development, but also to track the dynamics of the formation of ecological and patriotic culture in the educational process. The validity of the complex is ensured by its compliance with the age characteristics of the students and the specifics of the curriculum content for service work.

To assess the cognitive component, tasks are used that reveal knowledge of national symbols, traditional crafts and their natural foundations. The diagnostic tools include test tasks to establish correspondences between the visual images of traditional ornaments and their symbolic meanings, which makes it possible to assess the level of assimilation of basic cultural codes. In parallel, open problematic issues are used that require a detailed answer based on an analysis of the interrelationships between natural resources and the technological features of traditional crafts. This comprehensive approach allows for a differentiated assessment of both the amount of factual knowledge about natural materials and technologies of decorative and applied arts, and the formation of the ability to establish cause-and-effect relationships between cultural heritage and environmental traditions of the region. Special attention is paid to identifying students' understanding of the environmental expediency of using specific natural materials in traditional crafts.

The emotional-value component is diagnosed using a combination of scaling methods and projective techniques that provide a multidimensional assessment of students' personal attitudes. A questionnaire using standardized graduated Likert-type assessment scales makes it possible to quantify the degree of expression of patriotic feelings, the level of environmental responsibility and emotional involvement in the preservation of cultural heritage sites. To obtain high-quality data, the method of unfinished sentences is used, aimed at identifying emotional reactions and deep value orientations. Additionally, a task is used to identify and verbally describe personally significant natural and cultural images of the native land, involving a reflection of

emotional experiences and personal meanings. A comprehensive analysis of the results includes both quantitative processing of scaling data and qualitative interpretation of projective materials, which ensures the validity of the assessment of the emotional and value sphere of personality. Special attention is paid to the analysis of emotional vocabulary and the degree of personalization of the described images, which makes it possible to differentiate between formal and genuine emotional and value attitudes towards natural and cultural heritage.

The behavioral component is studied through the analysis of solutions in simulated practical situations of two types: situations of everyday choice reflecting everyday environmental dilemmas, and project initiatives requiring a comprehensive solution to environmental and patriotic problems. The assessment of the behavioral component is based on a qualitative analysis of the student's choice between alternative behaviors: traditional (based on the reproduction of cultural practices), creative (assuming a modern interpretation of traditions), pragmatic (focused on utilitarian effectiveness) and individually formulated (demonstrating a personal attitude to the problem). This approach allows us to identify not only the willingness to translate internal attitudes into external activities, but also the level of formation of behavioral strategies consistent with the principles of sustainable development and cultural continuity. Of particular importance in the assessment is the analysis of the validity of the choice and the ability of students to argue their position based on environmental knowledge and cultural traditions.

The manifestation of the emergent effect in the diagnosed quality is traced through the emergence of a holistic systemic understanding of the relationship between natural objects and cultural artifacts. This effect is characterized by a qualitative transition from an isolated knowledge of ornamental symbols to a deep understanding of the ecological principles of traditional nature management, which is manifested in the ability of students to conduct a semiotic analysis of natural and cultural complexes. At the same time, there is a transformation of the emotional perception of national heritage into sustainable behavioral strategies based on a conscious choice in favor of environmentally balanced practices and the preservation of cultural traditions. The emergent effect is manifested in the synergy of cognitive, emotional and behavioral aspects, when students form an integral ecological thinking based on national cultural codes and expressed in concrete actions to preserve natural and cultural heritage. Of particular importance is the ability of students to independently identify environmental patterns in traditional crafts and transfer these principles into a modern context, thereby demonstrating the formation of stable axiological foundations of ecological and patriotic culture.

The developed scoring system provides for the quantitative measurement of the results for each diagnostic block, followed by their summation and assignment to one of the three levels of formation of ecological and patriotic culture. The system includes detailed assessment criteria for cognitive, emotional, value, and behavioral components with clear boundaries between levels. The high level is characterized by a holistic systemic perception of the relationship between nature and culture, a stable hierarchy of value orientations and the consistent implementation of an active civic position in everyday practice. The average level is characterized by a selective

understanding of these relationships, unstable value orientations, and situational manifestations of personal responsibility that depend on external circumstances. The low level indicates the fragmentation of environmental and cultural knowledge, the absence of a well-formed value system, and the predominance of random, unconscious behavioral reactions towards natural and cultural heritage. The established quantitative thresholds for each level make it possible to objectively classify diagnostic results and determine the directions of further work.

The introduction of this diagnostic complex into the practice of teachers of general secondary education institutions allows not only to establish the initial level of student development, but also to systematically monitor the dynamics of the formation of ecological and patriotic culture. The implementation of the diagnostic approach creates the basis for an objective assessment of the effectiveness of applied pedagogical strategies and timely correction of educational influences. The diagnostic data obtained make it possible to design individual educational trajectories, taking into account the identified features of the development of cognitive, emotional, value and behavioral spheres of students' personality. The organization of the diagnostic process is based on the principles of consistency and continuity, which finds practical expression in the implementation of a three-stage model, including the ascertaining, forming and final control stages. This approach makes it possible to ensure the integrity and continuity of diagnostic activities at all stages of the educational process.

Thus, the use of diagnostics focused on the specifics of the curriculum content and integrating the potential of decorative and applied arts ensures the objectivity, substantive validity and practical significance of assessing the process of forming an ecological and patriotic culture. The implementation of this approach is in line with the objectives set out in the State Program “Education and Youth Policy” for 2021-2025, which provides for the use of “forms and methods of work aimed at the civic and patriotic education of young people” [5]. The developed diagnostic complex, aimed at identifying the features of the development of cognitive (a system of knowledge about natural and cultural heritage), emotional-value (personal attitude to nature and cultural traditions) and behavioral (readiness for practical action) spheres of the student's personality, provides scientific validity and purposefulness of the pedagogical process in the context of general secondary education. The implementation of the complex makes it possible to establish the compliance of the achieved results with the planned targets set out in educational standards and educational program documentation. The testing of diagnostic tools has confirmed its relevance for tracking the dynamics of students' personal development and timely correction of the educational trajectory. The implementation of the diagnostic approach creates a methodological basis for designing personalized trajectories of student development and meaningful enrichment of educational work in institutions of general secondary education.

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NEUROLINGUISTIC AND METHODOLOGICAL ASPECTS OF USING SONG MATERIAL TO DEVELOP LEXICAL SKILLS

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Abstract. The article discusses the problem of developing lexical skills, focusing on the lack of practice in using stable phrases. It analyzes the cognitive mechanisms that explain the effectiveness of songs in learning. The innovative approach involves using an artificial intelligence algorithm to create a pedagogically sound material. The proposed three-stage set of exercises helps to automate the use of lexical units and increase motivation for learning.

Keywords: lexical approach, song material, chunks, neurolinguistics, cognitive linguistics, neural network technologies, artificial intelligence, secondary school stage, methods of teaching English.

НЕЙРОЛИНГВИСТИЧЕСКИЕ И МЕТОДИЧЕСКИЕ АСПЕКТЫ ИСПОЛЬЗОВАНИЯ ПЕСЕННОГО МАТЕРИАЛА ДЛЯ ФОРМИРОВАНИЯ ЛЕКСИЧЕСКИХ НАВЫКОВ

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Аннотация. В статье рассматривается проблема формирования лексических навыков, уделяется особое внимание недостаточной практике использования устойчивых словосочетаний. Анализируются когнитивные механизмы, объясняющие эффективность песен в обучении. Инновационный подход заключается в применении алгоритма искусственного интеллекта для создания дидактически обоснованного материала. Предложенный трехэтапный комплекс упражнений способствует автоматизации использования лексических единиц и повышению мотивации к обучению.

Ключевые слова: лексический подход, песенный материал, чанки, нейролингвистика, когнитивная лингвистика, нейросетевые технологии, искусственный интеллект, средняя школа, методы преподавания английского языка.

The development of strong lexical skills remains one of the central and most challenging aspects of foreign language teaching. Conventional pedagogical approaches that emphasise the rote memorisation of discrete word lists have been demonstrated to be ineffective in the development of lexical competencies and the long-term retention of lexical knowledge. In search of a solution to this problem, specialists in the field of foreign language teaching methods are turning their attention to authentic and emotionally rich resources, among which songs occupy a special place.

The contemporary conceptualisation of lexical skills has undergone a substantial evolution, marked by a transition in emphasis towards a more systematic lexical approach, initially proposed by M. Lewis. This shift in perspective subsequently gave a rise to the conceptualisation of language as a set of pre-established 'units' – word combinations, fixed expressions and idioms [1].

The ability to produce fluent and confident speech in a foreign language is contingent on the mastery of pre-formed units, as opposed to the construction of phrases 'from scratch' from individual words in accordance with grammatical rules. This perspective is echoed by Russian scholars such as E. I. Passov and R. K. Minyar-Beloruchev, who delineate lexical competence as the capacity to expeditiously retrieve lexical units from long-term memory and seamlessly integrate them into speech, in accordance with the communicative goal [2; 3].

This method is of particular importance when working with ninth-graders, who are in early adolescence, a period characterised by an active search for personal and social identity, when communication with peers and the formation of their own worldview become their dominant activities. For students in this age group, a foreign language ceases to be an abstract school subject and becomes a necessary tool for achieving future career success and accessing global culture and information. In this specific context, authentic songs that reflect contemporary themes and cultural codes of the generation in question are perceived by them as relevant content. These are not songs created for children, but rather for an adult audience [4].

The consolidation of lexical structures in long-term memory is optimised by song material, a finding corroborated by research in the field of cognitive science [5]. From a neurolinguistic perspective, the efficacy of song material is contingent on its capacity to engage both hemispheres of the brain concurrently, thereby enhancing memory through a complementary function in which the right hemisphere processes melody and the left hemisphere processes words. Furthermore, researchers have posited that musical and linguistic processing, such as pitch perception, occurs in the same area of the brain, namely the right superior temporal and left inferior frontal regions. This finding suggests parallels in the processing of musical and linguistic syntax [6]. Furthermore, it has been demonstrated that musical training, such as learning to play the piano, uniquely enhances cortical responses, particularly positive responses to mismatches in pitch in music and speech. This demonstrates enhanced overall processing of sounds in different areas [7].

The predominant neurocognitive mechanism that elucidates the efficacy of musical compositions is neural synchronisation, otherwise referred to as phase synchronisation. This is defined as the alignment of neural activity with a rhythmic input signal. This process is of crucial importance, since oscillatory dynamics,

especially within the slow delta (1-4 Hz) and theta (4-7 Hz) frequency ranges, facilitate the process of breaking down the continuous flow of speech into discrete linguistic units such as syllables and phrases. This is a prerequisite for successful communication and comprehension. Songs exhibit greater rhythmic regularity, a more stable fundamental frequency, discrete pitch changes, and a clear metrical structure in comparison to ordinary speech. This provides an important temporal structure that facilitates enhanced information tracking by the brain in comparison to the rhythmically irregular patterns of spoken language. Empirical evidence demonstrates that phase synchronisation is significantly higher for song fragments than for speech fragments in the theta range (3.67–5 Hz), particularly in challenging listening conditions, such as when speech is compressed by 50 % in time [8]. This advantage is likely attributable to subtle acoustic variations in song, such as the faster peak amplitude onset at the beginning of a syllable, which results in clearer acoustic boundaries that are more easily tracked by neural networks compared to the relatively slower changes in speech amplitude envelope. This increased phase coherence, particularly in the right fronto-central electrodes for compressed singing, is consistent with the right hemisphere's specialisation in extracting auditory features that require longer temporal scales, complementing the pitch and melodic cues present in song material.

The high degree of repetition in songs, reinforced by rhythm and melody, directly contributes to memory consolidation, which is a fundamental component of lexical skill formation. Music has been demonstrated to facilitate the development of all memory types, including auditory, motor, imagery, and visual memory. The rhythmic and melodic structure of the language fosters frequent repetition of linguistic structures, thereby ensuring the transfer of words, grammatical forms and linguistic patterns into long-term memory [9]. Such multimodal stimulation and repetition have been shown to contribute to the involuntary acquisition of vocabulary, which is crucial for acquiring the large vocabulary necessary for the effective use of a foreign language, a need that cannot be met by targeted learning alone [6]. The following factors have been demonstrated to contribute to the effective memorisation of song lyrics: rhyme, rhythm, melody and tonality [5]. Moreover, given that language material presented in musical form is frequently not perceived as conventional academic learning, it is memorised involuntarily, without significant conscious intellectual effort. The creation of a relaxed and pleasant atmosphere has been demonstrated to reduce learners' anxiety, thereby helping to remove the affective filter and optimise the assimilation of lexical material [5; 6; 9; 10].

In terms of specific lexical outcomes, the benefits of learning with song material have been demonstrated to extend to several aspects of lexical knowledge, including recognition of spoken form, the relationship between form and meaning, and recognition of word combinations. Research findings indicate that repeated listening to songs results in statistically significant enhancements in these three domains, suggesting that learners can more effectively recognise the spoken form of target words, establish links between that form and its meaning, and accurately identify word combinations embedded in songs [6]. Furthermore, songs have been demonstrated to serve as an effective medium for reinforcing pronunciation and intonation rules –

elements of language that share a musical basis [5; 6]. The exaggerated length of vowels in songs in comparison to speech, in conjunction with their integration into the melody, provides optimal training for the vowel sounds of the foreign language under study, which are frequently challenging for non-native speakers. Research has indicated that children who learn vowel sounds through the medium of song demonstrate a higher level of success in reproducing accurate vowel sounds when compared to those who learn through oral poetry. The rhythmic structure itself is encoded, thus enabling learners to use rhythmic cues to reproduce the text, even when they are unable to recall the exact word, thereby maintaining the correct number of syllables [11].

Turning to the practical implementation of this approach, it is important to note that the theoretical potential of song material must be tested in practice. This can be achieved primarily by analysing existing teaching materials and developing specific methodological recommendations. The Spotlight teaching materials for Year 9, which are utilised extensively in Russian educational institutions, were selected as the primary object of study [12]. The comprehensive nature of the course material, which includes a textbook, workbook, audio recordings, digital resources and more, is generally commensurate with the objectives of contemporary language education. However, a more in-depth analysis revealed that the vocabulary work in it is based on the traditional scheme of 'presentation – initial practice – application', with an emphasis on the mastery of individual lexical units.

The pedagogical value of the song material in the teaching materials is not fully realised, as it is presented in the 'Song Sheet' section. The proposed tasks, such as listening comprehension with general understanding checks or filling in the blanks, are receptive in nature. However, due to the lack of proper semanticisation and analysis of the language material, these tasks do not allow learners to move on to the active use of the lexical units they have heard.

This methodological contradiction led to the development of a special set of exercises aimed at automating the use of stable verb phrases, the correct use of which usually causes a number of difficulties for learners. The exercises developed are based on a three-stage model of working with audio texts (“PRE-listening”, “DURING-listening”, “POST-listening”). At the “PRE-listening” stage, the “Match the halves” exercise is effective, in which learners are asked to match verbs (e.g., *'take'*, *'make'*, *'dress'*) with the corresponding parts of phrases (*'up for a party*', *'part in a contest'*, *'a wish'*). At the “DURING-listening” stage, a task such as “Fill in the blanks in the chorus” has been shown to focus students' attention on detailed listening and accurate recognition of target vocabulary in the rhythmic flow of the song. The culminating stage of the exercise programme is the POST-listening stage, during which the “Personal stories” exercise facilitates the transfer of the learned phrases into a personal context that is emotionally connected to each learner's personality.

The utilisation of neural network technologies holds considerable promise in ensuring the provision of high-quality and pedagogically sound material. The utilisation of contemporary large language models (LLMs), including ChatGPT and Gemini, in conjunction with music platforms (e.g., Udio) facilitates the composition of songs that are characterised by the incorporation of target lexical units and align with

particular subjects of the modules within the examined teaching materials [13; 14]. The key parameters for generating song material are as follows: selection of A2-B1 level vocabulary, inclusion of lexical constructions specified by the teacher, use of predictable rhyme schemes (e.g., ABAB or AABB) to facilitate memorisation, and the creation of a memorable melody at a moderate tempo (120-140 beats per minute) [15; 16].

The methodological process of creating such material commences with the teacher determining the learning objectives and target vocabulary items. Following the creation of a vocabulary list, it is imperative that it is meticulously reviewed to ensure adherence to linguistic and cultural norms [17]. Subsequently, the neural network that generates the composition selects the parameters of the musical accompaniment. Prior to its integration into the learning process, the song undergoes a preliminary assessment in a small-scale test involving a control group of students. This assessment aims to determine the song's comprehensibility, appeal, and pedagogical effectiveness [18]. The assessment of learning outcomes should include monitoring vocabulary growth, evaluating pronunciation, and assessing the level of engagement through questionnaires [13; 14; 19].

The analysis demonstrates that the utilisation of songs in the development of lexical skills constitutes a scientifically sound and highly effective pedagogical strategy. The practical application of this approach has the potential to successfully bridge the gap between the formal study of words and their use in real life. Furthermore, it has been demonstrated that this approach fulfils the psychological requirements of intermediate learners and engages the brain's intrinsic mechanisms.

Consequently, the incorporation of song material created with the assistance of neural network technologies for specific tasks within the teaching and learning system is not merely an ancillary technique, but rather a comprehensive pedagogical strategy that furnishes educators with a valuable instrument for fostering a motivating educational environment and efficaciously cultivating lexical competencies in intermediate-level learners.

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THE FUTURE OF VISUAL PERCEPTION AFTER SORA AI

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Abstract. This article examines the potential transformation of visual perception under the influence of generative artificial intelligence models exemplified by Sora AI. It explores how these technologies provoke a shift in visual perception, actively blurring the boundaries between the “real” and the “generated”. The article identifies and analyzes the key consequences of AI integration for visual culture, including the decline of indexicality, the emergence of “synthetic authenticity”, and a trend towards content homogenization.

Keywords: Sora AI, artificial intelligence, visual culture, visual perception, cultural transformation, indexicality.

БУДУЩЕЕ ВИЗУАЛЬНОГО ВОСПРИЯТИЯ ПОСЛЕ SORA AI

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Аннотация. В статье рассматривается потенциальная трансформация визуального восприятия под влиянием генеративных моделей искусственного интеллекта на примере Sora AI. Исследуется, как данные технологии провоцируют сдвиг в визуальном восприятии, активно размывая границы между «реальным» и «сгенерированным». Анализируются выявленные ключевые последствия внедрения ИИ для визуальной культуры, включая снижение индексальности, возникновение «синтетической аутентичности» и тенденцию к гомогенизации контента.

Ключевые слова: Sora AI, искусственный интеллект, визуальная культура, визуальное восприятие, культурная трансформация, индексальность.

The relevance of studying the transformation of the visual environment is dictated by the rapid development and ubiquitous implementation of generative models’ “production”, particularly Sora AI – an analog social network in which all content is built on neural network generation. Sora represents not only a major technological shift in visual content creation but also a fundamental transformation visual perception, increasingly erasing the now fragile boundary between the “real” and the “generated”.

The scientific problem of this research lies in the critical analysis of AI's influence and "integration" into the system of visual perception, which was previously based on the principles of indexicality and representation, as well as in assessing the long-term consequences of this influence on human life and society in the future. The problem is how technologies like Sora challenge the indexical nature of traditional media (photography and cinema), transforming established practices of perception and criteria for assessing authenticity, and in evaluating the socio-cultural consequences of this process.

The aim of the work is to identify and characterize the fundamental transformations in visual culture initiated by generative AI (using Sora AI as an example), with special attention to the aesthetic shifts in media perception.

The recent emergence of ultra-realistic AI-generated video, exemplified by OpenAI's Sora, which was released for public use in October 2025, marks a turning point in media. Generative models that create images and video from text are no longer merely a technological novelty but represent a challenge to the established structures of human perception, becoming "an integral part of social processes" [1].

Traditionally, visual culture, defined as "the process of creation, translation, preservation and reproduction of the particular culture's basic ideals in visual forms" [2], relied on the "indexical nature" of photography and cinema ("traces of reality") – the assumption that an image is a physical trace of light from a real object. However, the emergence of tools like DALL·E, Midjourney, Stable Diffusion and others has led to vast volumes of synthetic imagery, actively created by the audience itself and, consequently, actively intruding into its visual perception of the world. These tools allow any user to quickly generate "large amounts of high-quality visual content" tailored to their needs, and as a result, the Internet and social media have become flooded with AI-generated imagery, forcing us to reconsider our relationship with visual media, in which the "indexical link" is now completely severed. [3]

Even though Sora AI is based on previous generative models, mainly GPT, it possesses a unique ability to create high-quality videos up to 60 seconds long, depicting complex scenes with multiple characters, movements, and detailed backgrounds. This makes the line between human- and machine-created content increasingly blurred. As N. Laba notes "AI-enabled image generators have captured the zeitgeist" and initiated "a major shift in the landscape of visual communication" [4]. Unlike previous "deepfake" technologies, which manipulated existing footage, Sora demonstrated an ability for *world generation* – the creation of coherent, physically plausible, and narratively complex video sequences from simple text prompts. This technological leap is a catalyst for a "fundamental transformation of visual culture", enabling the emergence of "digital-native" art that does not imitate reality but exists by its own laws.

It is clear that in this new era, the author's role is also changing: artists are transformed into curators and co-creators working alongside algorithms, often facing a crisis of their inability to compete with the algorithmic system; thus, such collaboration becomes forced [4]. As N. Laba concludes: "The art of the past no longer exists as it once did... In its place there is a language of images. What matters now is who uses that language for what purpose".

However, the danger of using artificial intelligence lies not only in distancing creators from their creation but also in fundamentally changing visual perception,

literally in real-time, altering the human response to received media and optimizing its personalized impact on the viewer [5]. Thus, Sora becomes not just a tool for generating previously non-existent objects using a large dataset but an "agent of reality construction" [6] that "interacts with and changes cultural practices, meanings, and social structures" [1].

Sora AI and other similar video generators (which will inevitably appear, seeking primarily to reach the same number of users as Sora), through the lens of Aliev's concept of metasimulacrum, can be seen as a "hybrid structure" that blurs the boundaries "between the original and the simulation, between truth and illusion" [6]. The generated images are not merely copies of a non-existent reality, "copies without an original" – as Jean Baudrillard described the concept of a simulacrum – but they "create new levels of reality", in which Sora acts as the ultimate engine for producing metasimulations.

Moreover, these tools create what Lev Manovich calls "artificial aesthetics". These AI models are "trained" on massive datasets of existing human-produced art, largely merely reproducing given requirements [7], unable to create consciously, thereby being "more of an imitator than an innovator", only reproducing existing images rather than introducing radical innovations [8]. As Koptseva notes, artificial intelligence "analyzes the styles of artistic works, their color palette and form, and forms, and then creates new works based on them" [2], which, according to Aliev, leads to a new cultural dynamic he calls "algorithmic schizophrenia" – the "ability to generate cognitive hallucinations and pseudo-realities that exist only at the moment of perception" [6]. Sora's "plausible" videos, which are already difficult to distinguish from reality or manual animation, are a perfect example of such "pseudo-realities" that feel real, even when we know they are synthetic. Moreover, this complexity of viewer perception and the visual dissonance between what has been seen before and what is generated by AI are intensified by the fact that AI models strive to eliminate "artifacts" (all kinds of distortions of reality and glitches that reveal the video's artificiality), making it increasingly difficult to distinguish generated content.

Furthermore, videos created by Sora can be viewed not as static products but as adaptive media, potentially capable of adjusting to the viewer's emotional responses, transforming passive viewing into an interactive experience. This feature could become evident in the current "trends" within this "neuro-social-network", where, for instance, childish characters are combined with adult themes or scenes of gameplay from non-existent games are shown, indicating AI's ability to capture and exploit the audience's collective desires.

Such a transformation of the media environment has profound fundamental consequences for the very process of cognition, calling into question not what we see, but *how* we know what we see is real. Essentially, Sora shifts visual media from the logic of representation (capturing what exists) to a logic of generation (simulating what could exist but has no analogue in reality). This conceptual shift forms what some scholars call a "new paradigm" of visual perception, since images and videos created based on detailed text prompts are no longer "evidence" of reality and thus lose their "documentary value" [4]. This leads to the main question: how will all visual information be perceived henceforth, if any video can be fabricated, and there is a possibility that no video can be fully trusted as a document reflecting reality?

Ultimately, we will be forced to modify our perceptual filters, prioritizing the question of whether what we are seeing is an artificial generation. Such uncertainty radically changes the perceived truth-value of all digital media, creating a “fog of perception”, where recognizing the artificial becomes a necessary yet exhausting cognitive task [2].

For almost 150 years viewers directly associated images with reality, as the power of photography lay in its indexicality – its physical link to reality (light hitting film as a “trace of reality”). Artificial intelligence completely breaks this connection. As Romanov states, we are already live in an era of “photography after photography”, where “digital image destroys photography while strengthening, glorifying, and immortalizing the photographic”, theoretically leading us to the “end of 'real photography'” [9]. Sora AI represents the final step in this process, and now a video, for example of a running dog, no longer proves not only that the dog was actually running, but that the dog existed at all. This lack of an anchor to the “real world” in the visual, constantly forcing one to doubt the authenticity of what is seen, compels our brains to find a new way to assess truth.

As the previously obvious and unconcealed distinction between the “real” and the “generated” (“fake”) becomes increasingly difficult to notice, viewers may theoretically develop a new perceptual criterion – “synthetic authenticity” – where viewers, even knowing about the artificial nature of the presented image, still accept it as “authentic” if it aligns with their emotional expectations or aesthetic desires. Moreover, the images themselves can naturally use various “visual tricks” (such as intentionally simplified or, conversely, overly complex styles, which take time to look at in order to understand their generative nature) to convince the viewer of their “reality” and “authenticity”. This new “authenticity” is based not on origin but on the viewer's emotional and aesthetic perception. Users quickly adapt to such “ideal” and largely "sterile" content. As a result, they become suspicious of reality that seems too perfect, even if it is not AI-generated. This is evidenced by numerous comments on online platforms under realistic but non-generated images (for example, “too perfect to be real” or “my brain says it's AI”), confirming a shift in the basic settings of perception.

As the indexical link to reality is disrupted, our perception adapts: we stop questioning the reality of the image and start asking “Is this plausible?”, evaluating the image not by its origin but by its internal coherence (does it follow the laws of physics? is the lighting correct?). Here, Aliev’s “algorithmic schizophrenia” becomes our new perceptual norm: AI “hallucinations” become our reality, existing “only at the moment of perception”. Within this context, that the “pseudo-realities” created by systems like Sora acquire the status of a new normality, forming the very “hybrid structure” that erases the boundary between the original and the simulation [6].

Finally, the mass and long-term impact of tools like Sora will reshape our shared visual language, as AI systems develop their own specific aesthetics based on the data they are trained on. Drawing on vast archives of human culture – films, photographs, artworks – they learn the “statistical average” of what we consider “beautiful”, “cinematic”, or “dramatic”.

Consequently, when millions of users employ the same tool to create content, this “averaged” aesthetic becomes dominant, potentially leading to a homogenization of visual styles [10], which Romanov termed “global visual convergence through the

dissemination of AI-generated styles" [9]. This new AI-based visual language is not the vision of a single human artist but a "remix" of all art that came before and this process is already evident, as AI influences contemporary design by optimizing it for "successful" (statistically popular and maximally plausible) aesthetics. The "future of art" may become a future of infinite variation within a narrowing aesthetic field determined by the "black box" of algorithms whose operating principles and algorithms remain opaque even to their creators.

Under these conditions, the role of the human artist also changes, transitioning from "creator" to "curator" or "coauthor" [11]. As Romanov describes, this "hybridization of the creative process" leads to "symbiotic forms of creativity", while the human role transforms "from a creator to a curator and designer of algorithmic processes" [12]. Koptseva also notes that AI has "already ceased to be just an instrument – it has become a coauthor", and the creative act represents the "interaction between human imagination and algorithmic processes" [2]. This "generative art" uses artificial intelligence to create "new content that did not exist before".

In conclusion, the emergence of generative systems like Sora AI heralds the arrival of a new paradigm in visual culture, characterized by a fundamental transformation in the processes of creation, perception, and interpretation of images. In this paradigm, the viewer will increasingly question what they see, while images will speak more loudly and, perhaps, more strangely than ever before. Those who wield this new language of image creation will participate in shaping our shared reality [13]. The key consequences of of this shift include: the erosion of the indexical link between visual media and reality; the formation of the phenomenon of "synthetic authenticity"; and the emergence of "algorithmic schizophrenia" as a new perceptual norm.

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A LINGUISTIC PORTRAIT OF A DARGIN PERSONALITY THROUGH PROVERBS

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Abstract. This article analyzes the linguistic worldview of a Dargin ethnos representative through the prism of proverbs as precedent texts. The study of 29 proverbs from a 62-year-old female respondent reveals key thematic clusters: evaluation of mental qualities, kinship, labor, and speech behavior. It is concluded that this individual linguistic picture of the world is shaped by a unique interplay of personal experience and ingrained national cultural values, highlighting the role of folklore in encoding a community's worldview.

Keywords: linguistic worldview, precedent texts, proverbs, Dargin language, linguistic personality, folklore, cultural linguistics, ethnolinguistics.

ЯЗЫКОВОЙ ПОРТРЕТ ЛИЧНОСТИ ПРЕДСТАВИТЕЛЯ ДАРГИНСКОЙ НАЦИОНАЛЬНОСТИ ЧЕРЕЗ ПОСЛОВИЦЫ

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Аннотация. В данной статье анализируется языковая картина мира представителя даргинского этноса через призму пословиц как прецедентных текстов. Исследование 29 пословиц, предоставленных респонденткой 62 лет, выявляет ключевые тематические блоки: оценка умственных качеств, родственные отношения, труд и речевое поведение. Делается вывод, что эта индивидуальная языковая картина мира формируется уникальным сочетанием личного опыта и укорененных национальных культурных ценностей, что подчеркивает роль фольклора в кодировании мировоззрения общности.

Ключевые слова: языковая картина мира, прецедентные тексты, пословицы, даргинский язык, языковая личность, фольклор, культурная лингвистика, этнолингвистика.

The concept of the "linguistic picture of the world" (LWP) is a central topic in modern cognitive linguistic and cultural studies. It represents a fragment of the overall worldview, a model of integral knowledge about the conceptual system of representations that is objectified and reflected through the means of language [1]. In other words, it is the reality as it is perceived and "dissected" by a specific language, containing the collective experience of an ethnos. As Z. D. Popova and I. A. Sternin state, the LWP is "the totality of ideas about reality fixed in the units of a language at a certain stage of the person's development, a representation of reality reflected in the meanings of linguistic signs" [2, p. 54]. This linguistic view is not identical to the broader cognitive picture of the world; rather, it captures those phenomena of objective reality that hold communicative significance for a given ethnic group.

Scholars argue that representatives of different nationalities possess specific distinctions in their linguistic worldviews, determined by the presence of national concepts characteristic of a particular culture [3]. These concepts and the values they encode are often most vividly and concisely expressed in precedent texts – stable, culturally significant verbal units that are well-known within a linguistic community. For the purposes of this study, we focus on proverbs as a quintessential type of precedent text. According to Y. N. Karaulov, such texts reflect the orientation of a personality, its motives, attitudes, interests, and goals, which constitutes a complex parameter in the study of an individual's identity [4]. Therefore, by analyzing the proverbs actively used by an individual, one can reconstruct the system of views of a linguistic personality belonging to a specific culture.

This paper aims to analyze the individual linguistic worldview of a representative of the Dargin ethnos, as manifested in the precedent texts (proverbs) she frequently uses in her oral speech.

In the field of linguistics, the specialized study of proverbs falls within the domain of paremiology. This discipline moves beyond simply collecting sayings and investigates them as complex linguistic and cultural signs. Paremiologists analyze proverbs as condensed repositories of collective wisdom, viewing them as tangible representatives, or verbalizations, of specific cultural concepts. These concepts, such as wisdom, folly, justice, kinship, or labor – are encoded within the concise and metaphorical structure of the proverb, making them a primary source for understanding a person's value system.

A widely accepted definition provided by scholar L. B. Savenkova describes a proverb as "a saying that is stable in the language and reproducible in speech, anonymous and generalizing in nature, wherein at least some of its elements carry a figurative meaning, and which is suitable for use in didactic purposes" [5, p. 100]. This definition effectively captures the essential characteristics that distinguish proverbs from other forms of speech. Their stability and reproducibility confirm their status as precedent texts, firmly entrenched in the linguistic consciousness of a people. Their anonymous origin underscores their collective, folk authorship, while their generalizing nature allows them to be applied to a multitude of specific life situations, providing a ready-made framework for interpretation. The presence of a figurative meaning is crucial; it is this metaphorical layer that elevates the proverb from a mere statement of fact to a powerful, evocative tool for conveying abstract judgment.

Finally, their didactic suitability highlights their primary social function: to educate, instruct, and transmit behavioral norms from one generation to the next.

Consequently, proverbs are not merely colorful phrases but are stable, logically complete linguistic units that serve as a vehicle for a linguistic worldview of a person. They provide a pre-formed, culturally sanctioned lens through which to perceive, evaluate, and express an attitude towards various social objects, relationships, and processes in the surrounding world. Whether commenting on the virtues of hard work, the dangers of careless speech, or the obligations of family, proverbs articulate a shared ethos. In this way, they act as direct reflections of a people's fundamental value orientations, their moral and ethical compass, and their collective common sense, making them an indispensable object of study for anyone seeking to understand the intricate connections between language, thought, and culture.

The research material was collected from the oral speech of a 62-year-old female resident of Dagestan, a representative of the Dargin ethnos. The primary method of investigation is a qualitative analysis of the precedent texts (proverbs) from her personal repertoire. A total of 29 proverbs, which form an active part of her idiolect and are regularly used in communication, were selected for analysis. The proverbs were transcribed from the Dargin language, provided with a literal translation, and grouped thematically to identify the core values and conceptual dominants of the respondent's linguistic worldview. The analysis involves interpreting the semantic and axiological (value-laden) content of these proverbs and comparing their prevalence in the respondent's idiolect with their place in the general corpus of Dargin proverbs to distinguish individual preferences from nationally widespread themes.

The analysis of the 29 proverbs revealed several prominent thematic groups that structure the respondent's linguistic worldview.

The first group is "Evaluation of Mental Qualities". It is the largest group of proverbs (10 proverbs), dedicated to the "mental human", presenting an assessment of intellectual qualities. A significant portion of these proverbs focuses on the concept of foolishness and how to interact with a fool. For instance, the proverb "Абда абдалдешлис хIуни жаваб бедадли, хIура абдал сайри" ("If you answer a fool's foolishness, you are a fool yourself") offers a rational behavioral prescription. Another, "Абда хIулби къакъла гIелар дирар" ("A fool's eyes are on his back"), provides a vivid, metaphorical characterization of a foolish person as short-sighted and imprudent. This group combines both rational and emotional comprehension of reality. It is noteworthy that while this theme exists in the general corpus of Dargin proverbs, it is not as dominant as it is in our respondent's repertoire. This leads to the conclusion that the central position of this theme is likely linked to the individual peculiarities of the informant's worldview and her personal philosophy, perhaps reflecting a life-long emphasis on wisdom and prudent judgment.

The second-largest group, "Kinship and Family Relations", characterizes kinship relations and emphasizes the value of family harmony. A prime example is "Цабалъунил хъалибарг гьалжана саби" ("Concord in the family is heaven on earth"). Most proverbs in this group are didactic, containing prescriptions for the behavior of different family members. For example, "Хьунуй саби муръо багьара либкьяхъяни" ("A wife increases her husband's worth") outlines a specific role within

the family structure. Unlike the previous theme, this one is widely represented in the general corpus of Dargin proverbs, indicating that the value of kinship and clearly defined family roles is a fundamental characteristic of Dargin culture, deeply ingrained in the respondent's worldview. One of the typical characteristics of the Dargin people is strong family cohesion. Dargins place great importance on preserving tradition, and the distribution of roles within the family reflects the masculine character typical of the broader Caucasian culture. The man is the head of the family, and his primary role is that of breadwinner, while the woman is responsible for keeping the house and raising the children [6].

"The Value of Labor" group of proverbs makes a significant portion, which asserts the value of labor and hard work. The proverb "УмсахIумсул уста италгьан" ("He who does not tire at work will not become a master") directly links perseverance and effort with skill and mastery. The informant's discourse condemns idleness and associates labor with prosperity. This thematic cluster aligns perfectly with the known ethnographic characteristics of the Dargin people, who have historically been distinguished by their diligence, craftsmanship, and well-developed folk crafts. Thus, this value appears to be a direct reflection of the national ethos in the individual's linguistic picture of the world. Among all Caucasian peoples, a strong work ethic was regarded as a cornerstone of proper upbringing for both young men and women. As a result, this virtue was consciously instilled in children from their earliest years. Within this cultural framework, labor was not solely an economic necessity but also a fundamental pedagogical tool. Therefore, diligence – the capacity to work skillfully and with intrinsic satisfaction – represented both the objective and the proven outcome of this comprehensive labor-centered education [6].

The theme of "Speech behavior" is also highly significant for the informant. In her worldview, speech is a crucial marker distinguishing the intelligent from the foolish. A special emphasis is placed on the ability to listen, as seen in "Хlурмат бякьили бигул, буруйши лихlилзан" ("If you want to be respected, learn to listen"). This proverb elevates listening from a simple communicative act to a social virtue tied to respect and, by extension, wisdom.

A smaller, yet important, "Universal Human Values" group of proverbs reflects universal human values such as friendship, love, humanity, justice, and truth. The proverb "Адамдеш дицес вирар, амма асес хIейрар" ("Humanity can be sold, but it cannot be bought") offers a profound philosophical insight into the intangible and irreplaceable nature of human goodness.

Summarizing the analysis, it is evident that the precedent texts from the respondent's personal repertoire carry a profound philosophical character. They reflect:

Causal relationships: "Абушадли – кабашар" ("What you throw in, that will come out").

Modal meanings of possibility/impossibility: "Абдал адамлис дарман агара" ("There is no medicine for a bad person").

Categories of similarity and difference: "Адам гьайли жагаиру, хIяйван – мукукрани" ("A person is adorned by speech, an animal by its horns").

Educational and admonitory meanings: “Ца чумал дякьикьала кьацар яхlбакьали, къийинти шираркьян” (“Endure a little, and the trouble will pass by itself”).

In conclusion, the peculiarities of the linguistic worldview of our informant are characterized by a rich set of proverbs related to life’s conditions, personal assessments of events, and a world picture specific to Dargin culture. The thematic structure of her proverb fund reveals a personality that highly values wisdom, family harmony, diligent work, and prudent speech. This individual linguistic picture of the world is not a mere copy of the national Dargin LWP; it is a unique configuration where culturally dominant themes (kinship, labor) are intertwined with personally emphasized ones (evaluation of mental faculties). This study confirms that the analysis of precedent texts in an individual’s idiolect serves as an effective method for reconstructing the complex interplay between collective cultural values and personal experience in forming a linguistic worldview.

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THE ROLE OF AI CHATBOTS AND PLATFORMS IN PSYCHOLOGICAL SUPPORT FOR THE MILITARY FAMILIES: FROM THE USER'S STANDPOINT

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Abstract. This article analyzes AI tools for psychological support of military families. Research highlights advantages of AI tools like 24/7 availability and anonymity, but also risks including lack of regulation and undefined therapeutic approaches. Thus, AI is a promising auxiliary tool, yet requires cautious application and further development.

Keywords: artificial intelligence, psychological support, military families, chatbots, mental health.

РОЛЬ ЧАТ-БОТОВ И ПЛАТФОРМ С ИСКУССТВЕННЫМ ИНТЕЛЛЕКТОМ В ПСИХОЛОГИЧЕСКОЙ ПОДДЕРЖКЕ СЕМЕЙ ВОЕННОСЛУЖАЩИХ: ТОЧКА ЗРЕНИЯ ПОЛЬЗОВАТЕЛЯ

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Аннотация. В статье анализируются инструменты ИИ для психологической поддержки семей военнослужащих. В исследовании выделяют такие преимущества ИИ, как круглосуточная доступность и анонимность, но также и риски, включая отсутствие регулирования и неопределенность терапевтических подходов. Таким образом, ИИ представляет собой перспективный вспомогательный инструмент, который требует осторожного применения и дальнейшего развития.

Ключевые слова: искусственный интеллект, психологическая поддержка, семьи военнослужащих, чат-боты, психическое здоровье.

The modern geopolitical landscape, marked by conflicts and military operations, places significant psychological strain not only on combatants but also on their families. The families of servicemen involved in hostilities experience a unique set of stressors, often characterized by intense fear, helplessness, and ambivalence. According to the stressor classification model by K. Aldwin, a student of R. Lazarus, events such as war and death are categorized as “trauma” – short in duration but powerful in impact [1, 2]. This creates an urgent need for systematic and accessible psychological assistance.

At the same time, artificial intelligence (AI) is becoming increasingly integrated into various spheres of life, including the field of mental health. AI-powered tools, such as chatbots, applications for mood tracking, and virtual assistants, offer new opportunities for providing psychological support. They can facilitate early diagnosis of emotional distress, offer self-help techniques, and provide a bridge to professional help [3]. However, despite the growing number of platforms offering such services, scientific research on the application of AI in psychology, particularly concerning the specific user experience of military families, remains insufficient.

The **relevance** of this topic is therefore determined by the current situation related to the special military operation and the need to provide effective psychological assistance to the families of mobilized military personnel.

The purpose of the research is to analyze the prospects and risks of using artificial intelligence in providing psychological support to military families.

Psychological assistance, in its broadest sense, is defined as the provision of emotional, semantic, and existential support to a person or community in difficult situations of personal or social existence [4]. A. A. Osippova states that this assistance includes psychodiagnostics, psychocorrection, psychotherapy, psychological counseling, and career guidance [5].

For families of servicemen, the primary stressors align with Aldwin's category of “trauma”. The constant threat to the life of a loved one, the uncertainty of the situation, and the influx of often-contradictory information from the media lead to a specific psychological state. Family members frequently experience:

— A pervasive fear for the life and well-being of the serviceman;

— Helplessness – a feeling of having no control over the situation;

— Ambivalence – simultaneous or alternating opposite emotions, such as pride in the serviceman's duty alongside anger at them, the situation, or even themselves for their perceived inability to change circumstances.

This state can lead to anxiety (a stable tendency to experience worry) and stress, defined here as an extreme degree of mental tension that negatively impacts activity. In this context, psychological support aims to combat these effects, helping individuals develop coping mechanisms and maintain mental stability.

According to O. A. Ul'yanina the key objective of providing psychological support to military families is to empower them in cultivating effective coping strategies. These strategies are essential for navigating the profound uncertainty and persistent anxiety that arise from having a loved one in a high-risk situation.

This support aims to facilitate a positive transformation within the family's motivational and value systems. A key focus is on strengthening the family's mobilizing function, which entails:

— fostering awareness: helping family members fully recognize their critical role in the psychological well-being and resilience of the service member.

— building readiness: developing their willingness and capacity to act as a consistent and reliable source of emotional and moral support.

— promoting action-oriented mindsets: encouraging the adoption of constructive attitudes and proactive behaviors that directly contribute to creating a stable and supportive home environment.

Ultimately, this process is geared towards enhancing the resilience of both the family unit as a whole and the service member they are supporting [6].

This research is based on a qualitative analysis of existing AI tools (chatbots and platforms). The primary method employed was comparison of functional characteristics: a systematic examination and comparison of the features, stated purposes, and functionalities of various AI-powered platforms and chatbots available on the market, particularly those accessible to Russian-speaking users.

The analysis of AI-supported tools and platforms revealed that, at present, there are no specialized AI solutions in Russian explicitly designed for providing psychological assistance to military families. However, the majority of existing general-wellbeing tools possess a functional flexibility that allows them to be adapted or are already partially applicable for these purposes, serving as a crucial stopgap. The analyzed tools can be conditionally divided into four main groups based on their primary function, with significant overlap as many tools belong to multiple categories.

1. Emotional state assessment.

This group comprises tools specifically designed to evaluate a person's cognition, mood, providing valuable metrics for self-awareness.

They include tracking bots like “Monday4me”, “Emo Trek (Эмо Трек)”, and “Mental Help Bot”, which allow users to regularly track their mood, emotions, and behavior, helping to identify patterns and triggers.

NLP (Natural Language Processing) text analysis tools analyze text messages written by the user to detect emotional tone, levels of stress, anxiety, and other psychological markers, providing an objective assessment of their state.

2. Self-help techniques and recommendations.

This category includes chatbots and applications that offer practical exercises and techniques for managing emotional distress.

The platforms like “Faino”, “DBT-skills”, “Emo Trek (Эмо Трек)”, “Epicur (Эпикур)”, “Spokoinyi Bot (Спокойный бот)’, the AI-based application "Antipanika" (Антипаника), and “Mood Balance” provide guided exercises for relaxation, meditation, mindfulness, and emotional regulation.

3. Positive habits development and behavior modification.

These tools are focused on long-term changing unwanted behavior by reinforcing desired behaviors and decreasing undesirable ones.

For instance, chatbots like “Michelle”, “GratefulBot”, “Askesa Bot” and “Slippi (Слипи)” help users set goals, track progress, and receive motivational support for

building healthy routines, which is crucial for maintaining stability during periods of chronic stress.

4. Virtual assistants.

This group consists of more complex bots that engage users in dialogue, analyze their responses, and provide tailored guidance.

“Slippi (Слипи)”, “Budu ryadom” (Буду рядом)”, and “Psycho (Псайко)” assistants can ask reflective questions, teach self-analysis techniques, and, importantly, direct users to psychologists when necessary.

The identified tools demonstrate significant potential, their use is accompanied both by substantial advantages and critical risks.

The first and foremost advantage is 24/7 availability. AI tools provide round-the-clock access to psychological support from any location with an internet connection. This is particularly vital in urgent situations when immediate help from a human psychologist may not be available.

Furthermore, these platforms guarantee a level of anonymity unattainable in psychological counselling. This is achieved by eliminating personal data storage and human factors like bias or judgment, ensuring maximum confidentiality. This protected environment helps reduce stigma and promotes help-seeking behavior.

Moreover, one of the key advantages of AI tools is their economic efficiency compared to traditional psychological consultations. This affordability is demonstrated in several ways: most services provide free basic functionality, and even paid subscriptions are typically cheaper than in-person sessions. Furthermore, users save on additional costs, such as transportation and time spent commuting.

At last robotic applications can provide psychological support in remote rural districts where access to qualified mental health professionals is limited.

Despite all those advantages there are still significant risks and limitations.

The first challenge concerns developer anonymity. A majority of AI projects do not transparently indicate their developer, often using vague formulations like “School of Psychological Enlightenment” or “A student of Clinical Psychology”. This lack of transparency undermines user trust and makes it impossible to assess the developers' qualifications.

The next is uncertainty of psychological approach. The services rarely disclose the theoretical foundation upon which their AI operates (e.g., Cognitive-Behavioral Therapy, Gestalt, Psychoanalysis). Without this information, it is impossible to evaluate the scientific validity and appropriateness of the methods being offered.

One more challenge is the lack of legal regulation. In the Russian Federation, there is currently no clear legislative framework governing the development and application of AI in psychological assistance. This creates substantial risks, including the uncontrolled use of unverified and potentially harmful methodologies.

Another limitation lies in the risk of AI addiction. Long-term use of these applications, without the guidance of a professional, carries the risk of users developing an addiction to the tool itself, potentially hindering the development of coping skills and real-world social support.

Another problem is data security concerns. The security of these devices and their protection from hacking and unauthorized digital tracking must be a paramount

consideration for developers. A breach could expose highly sensitive personal and psychological data.

Thus, the conducted analysis allows us to conclude that modern AI platforms possess significant potential as an auxiliary tool for providing psychological support to the military families. Their advantages – accessibility, anonymity, and cost-effectiveness – make them a valuable resource in a context of high demand and limited traditional resources.

However, the existing solutions have substantial limitations that cannot be ignored. The issues of developer anonymity, an undefined theoretical basis, the absence of legal regulation, and data security risks present real challenges to their effective and safe implementation. Therefore, AI tools should not be viewed as a replacement for professional human psychologists but rather as a supplementary layer of support within a broader ecosystem of psychological care.

Future efforts should be directed toward a multi-pronged approach: the development of specialized, scientifically-grounded AI solutions tailored to the unique needs of military families; the urgent establishment of a robust legal, ethical, and clinical governance framework; and the promotion of further rigorous research into the real-world efficacy, long-term impact, and user experience of these technologies for this vulnerable and deserving groups of people.

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TRADITIONAL FOLK GAMES AS A TOOL FOR DEVELOPING PATRIOTISM AND SOCIAL SKILLS IN PRESCHOOL CHILDREN

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Abstract. The article examines the pedagogical potential of traditional folk games in forming patriotic feelings and social skills in preschool children. The features of using folklore games as a means of cultural and historical heritage in modern preschool education are analyzed. The methodological aspects of organizing gaming activities that contribute to the development of children's sense of belonging to their culture and improvement of communication skills are revealed.

Keywords: traditional folk games, patriotism, social skills, preschool age, cultural heritage, gaming activity, folklore, socialization, national traditions.

ТРАДИЦИОННЫЕ НАРОДНЫЕ ИГРЫ КАК ИНСТРУМЕНТ РАЗВИТИЯ ПАТРИОТИЗМА И СОЦИАЛЬНЫХ НАВЫКОВ У ДЕТЕЙ ДОШКОЛЬНОГО ВОЗРАСТА

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Аннотация. В статье рассматриваются педагогические возможности традиционных народных игр в формировании патриотических чувств и социальных навыков у детей дошкольного возраста. Анализируются особенности использования фольклорных игр в качестве средств культурно-исторического наследия в современном дошкольном образовании. Раскрываются методические аспекты организации игровой деятельности, способствующей развитию у детей чувства принадлежности к своей культуре и улучшению коммуникативных навыков.

Ключевые слова: традиционные народные игры, патриотизм, социальные навыки, дошкольный возраст, культурное наследие, игровая деятельность, фольклор, социализация, национальные традиции.

Introduction

Modern preschool education faces the need to find effective means of forming the foundations of civic identity and patriotism in children. In the context of globalization and informatization, the role of preserving national identity increases, making it relevant to turn to traditional culture and folklore [1]. Traditional folk games, being an integral part of cultural heritage, possess enormous educational potential and

can serve as an effective tool for developing patriotic feelings and social skills in preschoolers.

The relevance of the research is due to the decline of children's interest in national culture, insufficient development of methods for using folklore games in modern preschool educational institutions, as well as the need to find effective means of patriotic education in preschool age. The purpose of this article is a theoretical analysis of the pedagogical potential of traditional folk games in the development of patriotism and social skills in preschool children.

Theoretical foundations of using folk games in preschool education

Traditional folk games have a centuries-old history and are a reflection of the national character, way of life, customs and traditions of the people. According to the research of E. V. Sokolova, folk games perform several important functions: educational, instructional, developmental and socializing [2, p. 45].

The educational function is manifested in the transmission of moral values, traditions, and norms of behavior. The instructional function is associated with expanding children's ideas about the world around them, national culture. The developmental function is aimed at forming physical, intellectual and creative abilities. The socializing function contributes to the assimilation of social norms, the development of communicative skills, and the formation of a sense of collectivism.

Patriotism in preschool age is formed mainly through the emotional and sensory sphere. As noted by L. I. Bozhovich, it is in preschool age that the foundations of civic identity are laid, a sense of belonging to one's family, people, and country [3, p. 78]. Traditional games, being part of folk culture, create an emotionally rich environment for forming love for the Motherland, respect for its history and traditions.

The social skills formed in the process of folk games include the ability to interact in a group, follow rules, show initiative, negotiate, resolve conflicts. Folk games often have a collective character, which contributes to the development of cooperation, mutual assistance, and responsibility for the common cause.

Pedagogical potential of folk games for the development of patriotism

Traditional folk games are an effective means of transmitting cultural heritage from generation to generation. In the process of the game, children not only master the rules and get pleasure, but also absorb national values, customs, and traditions. Each game has its own history, associated with the way of life, labor, and holidays of the people.

Russian folk active games, such as “Gorelki” (Tag), “Lapta” (a traditional Russian bat-and-ball game), “Rucheyok” (Brook), have deep roots in culture and reflect the peculiarities of the national character – the desire for freedom, justice, and collectivism. These games develop not only physical qualities (agility, speed, endurance), but also form such moral qualities as honesty, courage, and mutual assistance [4].

Tatar folk games, such as “Korshun i nasodka” (Hawk and Hen), “Tugan kyrlyar” (Native fields), contribute to the preservation of cultural diversity and the formation of a respectful attitude towards the traditions of different peoples. In polyethnic regions, the use of games of different peoples contributes to the development of tolerance and intercultural competence in preschool children [1].

Games with elements of labor activities (“Posadim kapustu” – Let's plant cabbage, “Zhatva” – Harvest, “Rybalka” – Fishing) introduce children to the traditional occupations of their ancestors, cultivate respect for labor, patience, and perseverance. In the process of such games, children learn to value the results of labor, understand the importance of collective work [2].

Games-dramatizations based on Russian folk tales (“Teremok” – The Little House, “Repka” – The Turnip, “Kolobok” – The Round Bun) contribute to the development of imagination, speech, and the emotional sphere of children. Fairy-tale characters become role models for preschoolers, teaching kindness, justice, and mutual assistance [4].

Formation of social skills through folk games

The social development of a preschooler is largely determined by his gaming activity. Traditional folk games provide unique opportunities for the formation of communicative skills and social intelligence.

In folk games, children learn to follow rules, which develops discipline and respect for established norms. For example, in the game “Klassiki” (Hopscotch), the child learns to accurately follow the rules, control his actions, which contributes to the development of self-regulation and volitional qualities [5].

Collective games, such as”Kazaki-razboyniki” (Cossacks and Robbers), “More volnuetsya” (The sea is waving), require coordinated actions from children, mutual understanding, the ability to support each other. In such games, skills of cooperation, distribution of duties, mutual assistance are formed. Children learn to negotiate the distribution of roles, which contributes to the development of negotiation skills and compromise [6].

Games with rules develop children's ability to plan their actions, anticipate consequences, and control their behavior. This contributes to the formation of self-regulation and volitional qualities. In the process of folk games, children learn to resolve conflicts in a gaming situation, which teaches them to find compromises and respect the opinions of others [7].

Methodological recommendations for using folk games

To effectively use traditional folk games in the educational process, the following pedagogical conditions must be observed:

Systematicity and consistency in conducting games. Folk games should be a regular component of the educational process, not a one-time event [2].

Creating an emotionally rich gaming environment. Before starting the game, the teacher should tell about its origin, historical significance, which creates an atmosphere of immersion in the culture [4].

Linking games with other types of children's activities. Folk games can be integrated with music classes (folk songs, round dances), visual activities (drawing folk patterns, holidays), speech development (nursery rhymes, jokes) [1].

Involving parents in the gaming process. Joint games of children and parents contribute not only to strengthening family ties, but also to the transmission of cultural traditions from generation to generation [7].

Compliance of games with the age characteristics of children. For younger preschoolers, simple round dances (“Vo sadu li, v ogorode” – In the garden, in the

vegetable garden, “Karavai” – Wedding cake) are preferable, for older ones – more complex active and plot-role games [5].

Taking into account regional features. In multinational regions, it is important to include traditional games of different peoples in gaming activities, which contributes to the formation of tolerance and respect for cultural diversity [1].

Conclusion

Traditional folk games are a powerful pedagogical tool capable of effectively solving the problems of patriotic education and social development of preschool children. They allow in a natural gaming form for children to transmit cultural values, form a sense of belonging to one's people and country, develop communication skills and social intelligence.

In modern conditions, when issues of preserving cultural identity and forming patriotic feelings acquire special relevance, turning to folk games becomes not just a pedagogical find, but a necessity. Educators of preschool educational institutions need to systematically include traditional games in the educational process, constantly improve the methodology of their conduct, involve parents and the public in this.

Prospects for further research are related to the development of comprehensive programs for the use of folk games in different age groups, as well as the study of their impact on the formation of intercultural competence in children in polyethnic regions.

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DEVELOPING CRITICAL THINKING THROUGH INTERACTIVE METHODS WITHIN THE FRAMEWORK OF PROBLEM-BASED FOREIGN LANGUAGE LEARNING (SECONDARY SCHOOL)

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Abstract. The article examines theoretical and practical aspects of integrating an interactive approach within problem-based foreign language learning for secondary school students. It describes specific methodological techniques and digital tools designed to foster skills in analysis, synthesis, information evaluation and solving complex tasks in English. Particular attention is paid to practical examples of organizing learning activities using online platforms, collaborative services and authentic digital resources.

Keywords: problem-based learning, interactive approach, critical thinking, foreign language, secondary school, information technology, digital educational resources.

РАЗВИТИЕ КРИТИЧЕСКОГО МЫШЛЕНИЯ ЧЕРЕЗ ИНТЕРАКТИВНЫЕ МЕТОДЫ В РАМКАХ ПРОБЛЕМНО-ОРИЕНТИРОВАННОГО ОБУЧЕНИЯ ИНОСТРАННОМУ ЯЗЫКУ (СРЕДНЯЯ ШКОЛА)

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Аннотация. В статье рассматриваются теоретические и практические аспекты сочетания интерактивного подхода в проблемно-ориентированном обучении иностранному языку обучающихся на среднем школьном этапе. В статье описываются конкретные методические приемы и цифровые инструменты, способствующие формированию навыков анализа, синтеза, оценки информации и решения комплексных задач на английском языке. Особое внимание уделяется практическим примерам организации учебной деятельности с использованием онлайн-платформ, сервисов для совместной работы и аутентичных цифровых ресурсов.

Ключевые слова: проблемно-ориентированное обучение, интерактивный подход, критическое мышление, иностранный язык, средний этап обучения, информационные технологии, цифровые образовательные ресурсы.

The relevance of our research is due to the need to introduce pedagogical technologies into the practice of teaching English, which comprehensively develop the foreign language competence and critical thinking of students. The object of the research is a process of studying English language at the middle stage.

The subject of the research is a method of applying interactive ways for development of critical thinking under the context of problem-based learning of English language. The goal of the research is to theoretically substantiate and develop methods of using interactive ways and methodical recommendations on usage of interactive ways in learning English language for development of critical thinking [1, p. 584].

The term critical thinking takes a central place in the modern educational paradigm, characterized by complicated interdisciplinary nature. Critical thinking is a complicated reflexive complex that includes associative perception, analysis, rating and self-regulation. It's a part of an integral understanding that lies on the brink of philosophy, psychology and pedagogy and makes thus underlining its interdisciplinary nature. An important aspect of critical thinking is its connection with independency and free-will education. The development of critical thinking requires a specifically organized educational environment where the teacher acts as an intermediary and the student is actively involved in the process of studying.

The current challenges of educational system dictate the need to move from paradigm of knowledge to the paradigm of competence.

In context of learning a foreign language it means that the final goal is not so much to digest grammar rules and lexical units, but to form an ability to use the language as a tool for effective communication, solving the real tasks and critical analyze of information.

The task becomes even more relevant on a middle stage of learning (5-9 grade), when students already have a basic language foundation and there is a demand for its practical use to understand more complex phenomena [2, p. 146].

A way out of this situation is integration of three pedagogical strategies: problem-based learning, interactive approach and modern information technologies. This triad makes a unique learning space, where a foreign language does not become an object of study, but a mean of exploration that directly impacts the development of critical thinking.

The goal of this article is to theoretically basis and recommend practical ways of using interactive approach and digital tools for developing critical thinking of students in problem-based education of foreign language at the intermediate level of knowledge.

One of the leading tasks of the theory and methods of study of foreign language is to develop a strong interest to lingual and cultural diversity of targeted language. Based on that, it is great to point out that the process of achieving this active goal is hindered by some difficulties in form of a lack of effective, theoretically proven

methods that take age statistics into account and promote the development of cognitive approaches in teaching young students.

A special role here is played by the use of interactive approach which ensures an effective interaction between students with other members of educational process of general educational environment. Interactive approach is key to successful mastery of communicative skills and harmonious development of students on this educational level. Problem-based education is a method in which the whole educational process is built upon solving real or modulated scenarios.

Problematic situation is a starting point of such educational method. Appliance of problem-based education develops critical thinking of younger students, helps to boost their motivation towards studying, develops independence and group working. Problem-based education is not only an educational element, but a whole system that prepares students for real challenges.

Problem-based learning (PBL) is a pedagogical method, developed by M. I. Makhmutov, in which the acquisition of new knowledge is built around a problem which is real for students [3, p. 122].

Unlike the traditional approach, where theory comes before practice, PBL begins with a stage of clash with the problem, requiring students to find and analyze information for themselves, propose and justify possible variants of its solutions [3, p. 307].

The interactive approach focuses on learning through dialogue and direct interactions. It proposes modulation of a learning process as a collaborative effort of a student and a teacher. The interactive approach in secondary school helps to create a more lively and effective education where students not only just remember the information given, but also apply it in practice.

It helps to develop communication skills, independence and cognitive activity in younger schoolchildren. The success of the interactive approach based on professionalism of the teacher, experience and skills of bringing creative and out-of-bounds tasks to the format of traditional lessons.

The use of interactive approach in teaching a foreign language in secondary school makes lessons more interesting and memorable. The interactive approach not only actively develop language skills, but also communicational skills, creativity and the confidence of a student in himself of how he uses the language.

The important thing is to find a balance between a game and educational goal and also to adapt those methods to the level of language level and interests of students [4, p. 89].

The synthesis of those two approaches results in ideal conditions for the development of critical thinking, which is understood as a system of judgements which allows to analyze the information, consciously identify cause-&-effect relations, reveal misconceptions and biases, formulate conclusions and take informed decisions [5].

The role of Internet Technologies (IT) in this process is a key, since they act as [6, p. 182]:

1. A source of authentic problematic situations

News outlets, social networks, forums give unlimited access to current and real problems of the countries of the language that being studied.

2. A tool for interactive interaction [7].

Online whiteboards, modern documentation, video conferences erase geographical and time constrains allowing to organize group work on a new level.

3. Platform for creativity and presentation of results

Students can make digital posters, videos and web-sites to demonstrate their research results in a form of free access, which in return greatly increases motivation and involvement in the subject.

Let's look at a specific example of how this triad can be done in practice:

We will take debates based on social media as our core basis – the topic is Social Media and Teens in Modern Society. Problem is that the school community examines the question of banning the use of smartphones on the territory of the faculty. Students must make a decision between Agree or Disagree and provide a well-reasoned argument on a foreign language.

Interactive component of such activity: 1) students are examining material on social media, examining hashtags, analyzing opinions e-users on social media (teens) from different countries about this question; 2) instead of traditional debates, a talk-show format is used with a video recording.

One group are the experts, and the other is the audience which ask questions from the broadcast chat (such a broadcast can be organized on platforms such as YandexTelemost and so on); 3) a public document is used to gather arguments (for example, Google Docs), where each team prepares a list, visible to the teacher [8]. Implementation of such approach is intertwined with a row of possible difficulties, and we examined the most popular of them and prepared possible solutions:

1. Digital inequality

Not every student can have same access to necessary gadgets and Internet. Solution is to combine online and offline activity, using school resources and group work (one internet-device per group).

2. Information Overload

Students can get lost in large amounts of online sources. Solution is to give clear instructions from the teacher and to present a list of trustable sources.

3. Language Barrier

Solution is to create favorable conditions and healthy psychological climate (or atmosphere) in the class. Note that authentic material may look complicated for understanding. Solution is to use materials which are pre-selected for the student's level of proficiency of the language and pre-teaching key vocabulary.

Thus, the integration of an interactive approach and modern technology in a problem-based study of a foreign language consists of a powerful educational resource for developing students critical thinking at the secondary school stage.

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ON FACTORS SHAPING TEENAGERS' READING TRENDS IN THE DIGITAL AGE

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Abstract. The study analyzes the transformation of adolescent reading practices in the 21st century under the influence of digital technologies. The focus is on identifying the factors that determine interest in reading and evaluating the role of electronic and audio formats in shaping modern reading preferences.

The study is based on a survey of 135 first-year students at the Moscow Financial College (aged 15-17). It shows that printed books remain dominant, while digital formats are expanding and changing access to literature and the structure of reading preferences.

The results reveal both new opportunities arising from the diversity of digital content and the ambivalent consequences of e-reading: selective perception and reduced offline communication. The integration of domestic and foreign research enriches the empirical understanding of contemporary adolescent reading practices and allows for the identification of practical directions for the development of reading culture.

Keywords: teenagers, reading, literature, technology, reading habits.

ФАКТОРЫ, ФОРМИРУЮЩИЕ ЧИТАТЕЛЬСКИЕ ПРЕДПОЧТЕНИЯ ПОДРОСТКОВ В ЦИФРОВУЮ ЭПОХУ

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Аннотация. Статья посвящена анализу трансформации читательских практик подростков в XXI веке под влиянием цифровых технологий. Основное внимание уделяется выявлению факторов, определяющих интерес к чтению, и оценке роли электронных и аудиоформатов в формировании современных читательских предпочтений.

Исследование основано на данных опроса 135 первокурсников Московского финансового колледжа (15–17 лет). Оно показывает, что печатные

книги сохраняют доминирующую позицию, в то время как цифровые форматы формируют расширяющийся сегмент, меняющий доступ к литературе и структуру выбора. Результаты выявляют как новые возможности, возникающие благодаря разнообразию цифрового контента, так и амбивалентные последствия электронного чтения: селективность восприятия и снижение офлайн-коммуникации. Интеграция отечественных и зарубежных исследований обогащает эмпирическое понимание современных подростковых читательских практик и позволяет определить практические направления развития культуры чтения.

Ключевые слова: подростки, чтение, литература, технология, читательские привычки.

Reading is an important aspect in the formation of communication skills. It helps to develop emotional intelligence, language stock and speech culture. Of course, in the digital age, reading is given less importance; nevertheless, books are the most effective way to find mutual understanding with the world [1, p. 17].

In the 21st century, digital technology has transformed reading habits by replacing traditional, edited sources like encyclopedias and newspapers with accessible e-books and audiobooks. This shift has made literature more available, breaking barriers of cost, space, and location, while broadening genre and author exploration. However, it also has downsides: digital reading fosters selective, superficial engagement over deep focus, favors short, light content for multitasking, reduces offline interaction, and risks eyestrain from prolonged screen time [2, p. 1].

Nowadays e-books and audiobooks have revolutionized our understanding of reading, making literature more accessible and convenient. This transition has also equalized reading opportunities, opening access to book masterpieces for those who previously faced obstacles in the form of lack of space, financial constraints or geographical remoteness. These innovations in the world of literature have greatly influenced people's reading preferences in general. For example, wider access to books has made it easier to explore new genres and authors.

However, there are also bad consequences of the mass transition to the electronic reading format. Digital reading changes students' reading patterns, leading to more selective and superficial reading, but less in-depth and concentrated reading. So digital reading, especially audio books, leads readers to prefer shorter “lighter” texts that can be easily consumed while multitasking. Reading e-books often reduces the level of offline interaction. People discuss the books they read less with their friends. Last but not the least are eye diseases as prolonged screen reading can cause eye fatigue and other vision problems [3, p. 4813].

The goal of the study is to explore how teenagers' reading habits have evolved in the 21st century due to digital technologies. Specifically, we aim to identify key factors influencing reading interest, assess the role of e-books and audiobooks, and determine the most preferred reading formats among teenagers.

To achieve these objectives, we conducted a survey among college students and analyzed the data to understand what influences their reading choices, the study is based on a survey of 135 first-year students aged 15-17 from the Moscow Financial

College of the Financial University under the Government of the Russian Federation. Alongside this, existing research on digital reading trends was examined to provide a broader context for the findings. Additionally, we reviewed relevant theoretical sources discussing digital-age reading habits. The key tasks of this study were first, to analyze teenagers' reading interests; second, to evaluate how digital formats like e-books and audiobooks affect their preferences; and third, to determine which reading formats are most popular among teenagers today.

Examining different sources, we can single out one main idea: the reading format of teenagers has changed a lot in the Digital Age compared to other generations. Then opinions differ, as A. Berezina and E. Kolosova believe that the number of schoolchildren who consider reading useless and boring has increased significantly recently, which may be due to increased demands from the school [4, p. 129]. Many authors also pay attention to the reading format, arguing that behavior of the alpha generation is changing a lot due to reading through technology. Therefore, digital reading is beginning to prevail over traditional reading, which has an impact on individual readers and on the education system as a whole. A. Mangen, on the contrary, argues that reading linear narrative texts on a computer screen leads to poorer reading comprehension than reading the same texts on paper [5, p. 67]. T. N. Lombina and N. A. Borisenko has a similar point of view, but complements it with the fact that one of the reasons for this is the different purposes for which we read printed and digital texts, because reading from the screen is often only a means for communication or for finding information [6, p. 99]. Modern teenagers learn digital reading spontaneously, without school involvement, which limits its nature. They mostly read short texts on social media from their screens – posts, comments, and rarely news. Fiction and educational literature are preferred in paper form (only one in four reads it from the screen) [7, p. 41].

The survey results reveal the following:

1. Nearly half of the respondents (42.2 %) read books frequently, which is encouraging. This suggests that a significant portion of the population may not engage with reading as a leisure activity.
2. Printed books are the dominant format (59.3 %), but digital formats (e-books at 19.3% and audiobooks at 9.6 %) are also popular. This reflects the growing trend of digitalization in reading habits.
3. A majority of people (40.7 %) spend less than 30 minutes reading daily, that can be caused by busy schedules or competing forms of entertainment.
4. Recommendations from friends and family (54.8 %) are the most influential factor and it could mean that word-of-mouth marketing remains powerful in the book industry.
5. TikTok (BookTok) is the most influential platform. However, there are respondents who are not influenced by social media at all. So, social media platforms, particularly TikTok, are becoming increasingly important for book discovery.
6. The responses range from “very often” to “never”, indicating that celebrity recommendations have varying levels of influence. Some respondents may be skeptical of celebrity endorsements, while others are more receptive.

7. The number of responses is approximately equal. This diversity suggests that access to books is relatively broad.

8. Most of the responders assert that they have full access to the books. However, there are some people who has restricted access; this could be due to factors like cost, availability in remote areas, or lack of digital infrastructure.

9. Entertainment (54.8 %) is the most common reason for reading, followed by educational requirements (14.1 %), self-development (12.6 %). Reading is primarily seen as a leisure activity, but its educational and self-improvement benefits are also recognized.

10. Fiction (e. g., fantasy, romance, adventure) is the most popular genre. This may be due to the fact that the most common reason for reading is entertainment, as the previous question showed.

From the survey results, it can be seen that social networks, as well as recommendations from friends, relatives, and famous people, have the greatest influence on teenagers' reading preferences. Each factor can focus on strategies tailored to their unique contexts, working together to foster a love for reading among teenagers. This collaborative approach ensures that reading habits are reinforced at home, in school, and within the broader community.

As a conclusion of or study, we suggest that there are three domains, which can help enhance reading habits in teenagers: family school and community. For families we can suggest the following:

1) promote daily reading habits. parents can lead by example, reading their own books alongside their teens, so that the child do not perceive reading as a chore;

2) encourage exploration of different genres: family can provide guided recommendations based on teens' interests and use family outings to bookstores or libraries to explore new genres together;

3) make reading spaces inviting: they create a cozy reading corner at home with comfortable seating and good lighting.

For schools we suggest the following:

1) foster a reading culture: school should involve students in selecting books for school-wide reading programs. Use class time for book discussions or creative projects based on reading;

2) leverage peer recommendations: create platforms for peer-to-peer book recommendations. Organize book clubs or reading groups where teens share their favorite books;

3) highlight the benefits of reading for self-development: educate teens about the long-term benefits of reading, such as improved critical thinking, creativity, and emotional intelligence. Organize workshops or talks in schools about the benefits of reading. Invite inspiring figures to share their reading experiences and success stories.

Communities should adopt the following practices:

1) harness the power of social media: bookstores can use social media platforms like TikTok, Vkontakte, and RuTube to promote reading. community organizations or libraries can host social media challenges or contests;

2) improve accessibility of books: initiate programs to improve book accessibility, such as free e-book lending programs, mobile libraries, or partnerships with local organizations;

3) connect reading to mass culture: community organizations or libraries can recommend books that have been adapted into movies or tv shows (e. g., “The Hunger Games”, “Harry Potter”). Host events where teens can discuss books and their screen adaptations;

4) offer diverse book formats: promote audiobooks for teens with busy schedules or those who struggle with traditional reading and offer workshops or tutorials on how to access and use e-books and audiobooks.

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ORGANIZATIONAL-ACTIVITY GAME AS A TOOL FOR MANAGING THE DEVELOPMENT OF A UNIVERSITY'S DIGITAL ECOSYSTEM IN THE CONTEXT OF INDUSTRY 5.0

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Abstract. This article explores the potential of using the organizational-activity game (OAG) as a project management tool for the development of a university's digital ecosystem in the context of the transition to the industry 5.0 paradigm. The study is based on the analysis of the digital transformation experience of Yugra State University, considering modern challenges such as the integration of human and machine intelligence, the need for continuous learning (lifelong learning), and the formation of collaborative environments. The author proposes a model for applying OAG to coordinate strategic initiatives, such as the development of a unified digital platform and the implementation of an electronic document management system, to achieve a synergistic effect and the emergent properties of the digital ecosystem.

Keywords: organizational-activity game, digital ecosystem, university, project management, Industry 5.0, electronic document management, digital transformation, human-machine interaction.

ОРГАНИЗАЦИОННО-ДЕЯТЕЛЬНОСТНАЯ ИГРА КАК ИНСТРУМЕНТ УПРАВЛЕНИЯ РАЗВИТИЕМ ЦИФРОВОЙ ЭКОСИСТЕМЫ УНИВЕРСИТЕТА В УСЛОВИЯХ ИНДУСТРИИ 5.0

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Аннотация. В данной статье исследуется потенциал использования организационно-деятельностной игры (ОДИ) как инструмента проектного управления развитием цифровой экосистемы университета в условиях перехода к парадигме Индустрии 5.0. Исследование базируется на анализе опыта цифровой трансформации Югорского государственного университета с учетом современных вызовов, таких как интеграция человеческого и машинного интеллекта, необходимость непрерывного обучения (lifelong learning) и формирование коллаборативных сред. Автором предлагается модель применения ОДИ для координации стратегических инициатив, таких как развитие единой цифровой платформы и внедрение системы электронного

документооборота, для достижения синергетического эффекта и эмерджентных свойств цифровой экосистемы.

Ключевые слова: организационно-деятельностная игра, цифровая экосистема, университет, проектный менеджмент, Индустрия 5.0, электронный документооборот, цифровая трансформация, взаимодействие человека и машины.

Introduction

The modern socio-economic landscape, shaped by the transition to Industry 5.0, sets new challenges for the higher education system. Industry 5.0, in contrast to the technological focus of Industry 4.0, emphasizes human-centricity, sustainability, and resilience [1]. This paradigm involves the integration of human and machine intelligence into a unified neuro-digital ecosystem, where collaborative robots (cobots) and artificial intelligence (AI) augment human capabilities rather than replace them [2]. In this context, the university transforms from an “educational factory” (University 3.0) into an open ecosystem (University 4.0), a center for generating knowledge and innovations that actively interacts with all stakeholders in the external environment [3].

This transformation is extremely complex and requires sophisticated project management tools that can account for the high degree of uncertainty and the need to coordinate the interests of numerous participants. One such tool, successfully tested in the practice of managing social and organizational systems, is the organizational-activity game (OAG). As D.V. Sannikov and E.V. Shirinkina note, OAG acts as a fundamental tool for implementing digital transformation at a university, allowing for the coordination of strategic projects such as digital development and a digital IT school [4].

The Digital Ecosystem of a University as an Object of Management in the Context of Industry 5.0

The concept of a “digital ecosystem” is becoming key to understanding the modern university. It represents a set of digital platforms, services, and data that interact with each other and with users, creating new value [5]. The core of this ecosystem is the integration of information technology, strategic initiatives, and personnel policy [2].

A critical element of this ecosystem, its “circulatory system”, is the electronic document management system (EDMS). As shown in the study of the Directum RX implementation experience at Yugra State University, the EDMS not only optimizes internal processes but also becomes the foundation for data-driven management and the formation of a digital footprint of the entire university community [6]. Resistance to innovation and fear of uncertainty, often associated with the transition to electronic document management, become significant barriers that OAG is designed to overcome [6].

The development of a university's digital ecosystem must also consider the global trend of “lifelong learning” and the need to develop collaborative skills among students and staff to effectively interact with intelligent systems [1, 2]. In this regard, the concept of “University in a Smartphone”, which involves the development of a personal account into a full-fledged digital platform with user profiles, a unified identification system, data storage, and API, seems promising [4]. The complexity of

designing such a platform directly depends on the current and target model of the university (from 1.0 to 4.0) [4, 6].

Organizational-Activity Game as a Meta-Tool for Project Management

The organizational-activity game is a method of collective mental activity aimed at solving complex interdisciplinary problems and designing new activities. In the context of digital transformation management, OAG allows for:

1. Identifying and aligning the interests of all stakeholders: university administration, faculty, students, IT specialists, and external partners.

2. Overcoming cognitive barriers and "fear of uncertainty" [6] by collectively developing a new language and understanding of digital transformation processes.

3. Designing a system of management processes for a dynamic object, which is the digital ecosystem, based on the principles of decomposition, hierarchy, and iterativity [7].

4. Forming a prototype of the future state of the digital ecosystem, which serves as a "working model" for subsequent implementation and experimentation [7].

The experience of Yugra State University demonstrates that the use of OAG allows for the formation of a strategic digital transformation project that combines the "Digital Development" and "Digital IT School" portfolios. This approach is designed to achieve a synergistic effect and the emergent properties of the digital ecosystem, where the whole becomes greater than the sum of its parts [4].

Model of Applying OAG for Managing the Development of a Neuro-Digital Ecosystem

Based on the analysis, a model for applying OAG to manage the development of a university's digital ecosystem in the context of Industry 5.0 is proposed. The game process should include the following stages:

1. Diagnostic Stage: Analysis of the current state of the university's digital ecosystem (as-is model). Identification of "pain points", contradictions, and fears, including those related to the implementation of AI and EDMS.

2. Target Stage: Formulating the image of the future (to-be model) in the context of Industry 5.0. Defining the principles of human-machine interaction, the role of the university as a center of a neuro-digital ecosystem [2], and the requirements for a unified digital platform [4].

3. Design Stage: Collective design of the target architecture of the digital ecosystem. Decomposition of strategic goals into specific projects and processes, including the development of user profiles, API, and integration of the EDMS as a system-forming element [4, 6].

4. Implementation Planning Stage: Developing a roadmap for implementing the designed changes. Forming project teams and defining mechanisms for iterative development and feedback, similar to the principles of prototyping dynamic systems [7].

This model allows for considering not only technological aspects but also the social and humanitarian dimensions of digital transformation, ensuring a balance between technological innovation and human-centricity, which is the core of Industry 5.0 [1, 2].

Conclusion

The transition of a university to the model of an open digital ecosystem in the context of Industry 5.0 is a complex project that requires integrated management approaches. The organizational-activity game proves to be an effective meta-tool that allows for coordinating strategic initiatives, overcoming resistance to change, and collectively designing a new digital environment. The experience of Yugra State University, analyzed through the prism of the cited works by D. V. Sannikov and E. V. Shirinkina, confirms the high potential of OAG for achieving synergistic effects between projects for the development of digital platforms, electronic document management, and personnel training. Further research may be related to the development of specific OAG scenarios for solving particular tasks of integrating human and machine intelligence within the university's neuro-digital ecosystem.

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DESIGNING A CHILDREN'S PLAYGROUND THROUGH THE EYES OF AN INDUSTRIAL DESIGNER: THE HARMONY OF FUN AND SAFETY

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ПРОЕКТИРОВАНИЕ ДЕТСКОЙ ИГРОВОЙ ПЛОЩАДКИ ГЛАЗАМИ ПРОМЫШЛЕННОГО ДИЗАЙНЕРА: ГАРМОНИЯ РАЗВЛЕЧЕНИЯ И БЕЗОПАСНОСТЬ

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Аннотация. В данной статье рассматривается процесс конструирования детских игровых зон с точки зрения специалиста в области промышленного дизайна. Автор акцентирует внимание на ключевых моментах, которые необходимо учитывать при создании эффективных и безопасных пространств. Утверждается, что основная цель дизайнера – найти компромисс между интересной игровой деятельностью, способствующей развитию и радости, и мерами безопасности, гарантирующими здоровье и благополучие детей. Описываются профессиональные подходы к проектированию, а также предлагаются рекомендации относительно последовательности шагов и методов для успешного решения этой задачи.

Ключевые слова: безопасность, эстетика, идея, воспитание, восприятие.

Designing a children's playground is a complex task that requires an industrial designer to balance fun and safety. Every element must attract the child's attention, spark interest, and foster development, all while remaining completely safe, secure, and comfortable. Before beginning work, any team asks themselves: how can all these requirements be met simultaneously?

This balance is achieved through a comprehensive analysis of all playground components: shape, color, materials, size, height, texture, and fastenings. It's important to understand that children perceive playgrounds differently than adults. Their perception is smaller in scale, more sensitive to color and shape, curious, and less

cautious. Therefore, the designer must see the playground through the child's eyes, imagining every action and attempt to overcome an obstacle [1, p. 24].

This duality of objectives is the primary challenge for industrial designers: to create a beautiful, inviting playground where children will want to play, jump, climb, develop, and have fun, while simultaneously eliminating any health risks [2].

The first step is to gather information about the planned playground site. Location, climate, site size, greenery, nearby housing, and infrastructure all influence the design. At this stage, the designer must already consider the layout, choice of materials, and the scale of the structure [3, p. 13].

The first step in designing a children's playground is preparation and information gathering, which is essential for accurately understanding the context, objectives, and expectations. A playground doesn't exist in isolation; it must fit perfectly into its surroundings. Before beginning the design, the designer carefully studies the chosen site. Each generation of children also has distinct interests, fitness levels, and perceptions of the world. Even among children of the same age, differences in play and preferences are observed. To create a high-quality project, the designer collects the following information [3, p. 158].

Observing how children behave at other playgrounds allows us to identify important behavior patterns and preferences. What do children like: hiding, overcoming obstacles, jumping, sliding, crawling up and down?

Questionnaires: Conversations with children and their parents help us understand what we would like to add or remove from the playground. What games do children enjoy most? Are there any concerns or concerns about existing playgrounds?

Working with experts: Consultations with psychologists and teachers provide insight into which elements are most beneficial for child development. Experts point out the need for certain exercises and games for a child's full development.

Collecting local data: Demographic data shows how many children live nearby, their ages, and how often they visit the area. This helps us understand how popular the new playground will be and what audience it will reach [4].

The second stage is the idea. It should be original, fresh, attractive, and unique. Your goal is to create something special, something that will immediately appeal to children and parents, leave a lasting impression, and make the playground recognizable and beloved. It is born from a combination of information analysis and the designer's imagination. It primarily concerns the shape and architecture of the playground. Often, the designer chooses a concept inspired by fairy tales, cartoons, nature, or sports. The main task is to come up with a unique structure that will attract children but remains accessible and easy to understand [4].

Children, especially young children, are extremely sensitive to the appearance and design of their spaces. Bright, playful, and unusual shapes have a profound effect on them. This is why playgrounds themed to resemble animals, the deep sea, or the plant world are so popular.

This design approach is called ergonomic, as it takes into account children's innate perceptual abilities, their desire to imitate, and explore. By designing a playground in the shape of a favorite character, plant, or animal, the designer makes it

attractive and engaging, encouraging children to return again and again for play and fun [3, p. 232].

It is important for the designer to immerse the child in a fairy tale, so they feel engaged and safe. A playground designed in the shape of an animal or plant becomes a true adventure. Children enter a magical world full of mysteries and surprises. Instead of a typical playground, an entire universe opens up before them, filled with impressions and discoveries. Playing on a playground shaped like an animal or starfish stimulates a child's imagination and creativity. Children invent stories, act out skits, and develop their speech and imagination. While playing on the playground, children also learn about the animal and plant worlds, gaining insight into biology, geography, and science in general. For example, playing on an elephant playground, a child learns how an elephant's ears work, why it has a trunk, and what sounds it makes.

The appearance of an unusually designed playground is pleasing to the eye, arouses admiration, and lifts the spirits. Bright colors, original shapes, and interesting elements delight children and their parents, decorating the street and yard.

There are some specific examples of solutions that demonstrate the enormous potential of an ergonomic approach:

Animals: Slides shaped like a giraffe, hare, dinosaur, bear, rabbit, or turtle. Swings shaped like a horse, bird, or cat. Frames shaped like animals and insects.

Marine Creatures: Slides shaped like sharks, cetaceans, octopuses, and crabs. Fun tunnels shaped like seaweed or underwater rocks.

Vegetation: Slides shaped like mushrooms, palm trees, ferns, and lotus flowers. Ropes and cords shaped like vines or tree branches.

Fairytale Characters: Playgrounds shaped like castles, dragons, knights, wizards, or princesses. Slide-ins and sandboxes shaped like rockets, spaceships, or fairytale animals [3, p. 102].

For an industrial designer, it's important to preserve the natural look and make the playground resemble the animal's or plant's natural habitat. Adding small details, such as paw prints, leaves, or petals, will create the feeling of a living organism.

All these examples are successful design solutions for playgrounds that demonstrate that both children and teenagers want to play there [1, p. 143].

The choice of materials is central to the third stage of design. The quality, durability, and safety of materials directly impact the attractiveness and reliability of the playground. It is important that the materials are resistant to external factors (climate, weather, aggressive substances), and have sufficient strength to withstand intensive use. The most common materials used in children's playground projects include:

Wood: an environmentally friendly and easy-to-work material with a warm texture and a pleasant color. Its disadvantage is its susceptibility to rot and deformation when exposed to moisture and sunlight.

Plastic: a versatile and inexpensive material that is resistant to mechanical damage and precipitation. However, plastic can become hot in the sun, which is dangerous for small children.

Metal: strong and durable metal structures ensure the long-term operation of the playground. Its main disadvantage is its high thermal conductivity, which can cause metal to become hot or cold depending on the outside temperature.

Rubber: used for covering bases and elements that come into contact with the child's body. The shock-absorbing properties of rubber help reduce the risk of injury from falls, but it also requires periodic maintenance and replacement.

Children's playground surfacing is also worth considering. It's designed to protect children from injuries from falls, protect their feet from scratches and burns, and create a pleasant tactile sensation.

There are different types of surfacing, such as rubber surfacing, which is made from crushed rubber crumb held together with a special adhesive. It's flexible, cushions falls, and reduces the risk of serious injury. The advantages of rubber surfacing include a long service life and resistance to water and frost. This type is the most common and widely used in the modern world. It's safe and has excellent performance characteristics. Sand surfacing is also available. It's soft, safe, and allows children to develop fine motor skills by digging holes and building sandcastles. The downside of sand is that it gets dirty quickly, requires regular replacement, and is prone to the risk of foreign objects getting in. A third option, lawn tiles or rolled grass, offers a natural and stylish look. They are soft, pleasant to the touch, and easy to maintain. However, such surfaces may require frequent watering and replacement and are susceptible to fading in the sun. These surfaces are used in private homes or luxury residential complexes, where daily maintenance is required. This category also includes grass or natural grass [1, p. 143].

The next less-successful options are crushed stone and asphalt surfaces. These are hard and hazardous surfaces and can be used temporarily or locally, for example, in schools.

A playground surface is more than just the top layer of soil. It performs important functions such as shock absorption, safety, and appearance, so it deserves special attention.

The most important aspect of children's playground design is the shape and structure of its elements. The playground's design depends on the chosen concept, goals, and preferences of the target audience. Properly chosen shapes and structures can enhance the playground's overall experience, making it engaging and attractive to children of all ages.

When determining shapes and structures, the developmental level and physical abilities of children of a given age should be taken into account. Low, lightweight structures are best for younger children, while more complex and challenging elements are recommended for teenagers. The playground should also blend harmoniously with the landscape and infrastructure, supporting the child's natural interaction with the surrounding environment. The structure should be simple and easy to use, considering children's needs for movement, learning, and creativity. Its appearance should be bright, engaging, and beautiful, encouraging children to return again and again [5, p. 43].

Safety is our number one priority. All products must undergo rigorous testing to ensure compliance with regulatory requirements and certifications. The structure must be durable, impact-resistant, free of toxic and allergenic materials, and meet the required dimensional specifications. Harmonious design means the perfect balance of form, color, material, and function. The designer strives to ensure that every detail is beneficial to the child. Every surface, every corner, every step – everything should help the child develop physically and intellectually.

The shape should be easy to grip, safe from falls, and allow the child to exert maximum effort. The material should be high-quality, durable, and easy to clean. Colors should be eye-catching but not tiring, conveying the desired mood. For example, red stimulates energy, green calms, blue helps focus, and yellow evokes joy. The right color combination gives the playground a special charm and appeal [5, p. 43].

Ensuring the child's safety is paramount. This is achieved through the selection of materials, the installation of reliable fastenings, the fencing of hazardous areas, compliance with standards, and periodic inspection of equipment. Safety should not compromise the playground's appeal [6]. A closed mesh fence can intimidate a child, while transparent polycarbonate creates the illusion of openness.

Designing a children's playground is a complex and engaging endeavor that requires skill and talent. A designer must be able to balance opposing objectives: creating interesting structures that are safe and reliable, suitable for children of all ages. Working with color, shape, material, and concept helps achieve the desired effect.

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PSYCHOLOGICAL WELL-BEING AND PATRIOTISM ARE THE KEY TO A HEALTHY SOCIETY

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Abstract. Youthful patriotism and psychological health are interrelated, creating the foundation for a healthy society. The combination of these factors is essential for the development of a harmonious society. In such a society, people feel part of something larger without losing their individuality. They feel a connection both to their country and to the global community. A study of students using correlation and regression analysis showed that patriotism is directly related to the ability to plan and foresee.

Keywords: psychological well-being, patriotism, student, test, questionnaire.

ПСИХОЛОГИЧЕСКОЕ БЛАГОПОЛУЧИЕ И ПАТРИОТИЗМ – ЗАЛОГ ЗДОРОВОГО РАЗВИТИЯ ОБЩЕСТВА

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Аннотация. Психологическое благополучие молодежи и их патриотические чувства тесно переплетены, формируя основу гармоничного социума. Интеграция этих аспектов играет важную роль в формировании сбалансированного общества. В подобном социуме индивидуумы ощущают свою принадлежность к общему делу, сохраняя при этом уникальность своей личности. Они испытывают чувство общности, объединяющее их как со своим государством, так и с глобальным сообществом. Применение корреляционно-регрессионного анализа в исследовании студенческой аудитории продемонстрировало наличие прямой зависимости между проявлением патриотизма и уровнем развития навыков планирования и прогнозирования.

Ключевые слова: психологическое благополучие, патриотизм, студент, тест, опросник.

Patriotism is a complex feeling that encompasses love for one's homeland, loyalty, and a sense of unity with its history and people. It is studied by various sciences, and it is particularly important to understand how patriotism manifests itself in young people [1, p. 9].

A high level of mental well-being is necessary for the stability of the psyche of young people, therefore, the creation of favorable conditions for learning and realizing the intellectual needs of students is required [2, p. 93]. Comparative tests allow you to identify differences in the assimilation of material and compare them with expert assessments [3, p. 333]. Working with a large amount of information in a short time can lead to violation of the regime and lack of sleep, causing stress [4, p. 59].

To form an active life position, young people are recommended to participate in conferences and competitions, as well as the realization of creative potential [5, p. 133]. It is recommended to use visual, audio and kinesthetic mechanisms of understanding and memorization [6, p. 18]. Combining these methods allows you to transfer the concepts and meaning of interdisciplinary metaphors between areas of knowledge [7, p. 65].

The cultivation of patriotism is essential for the development of society. Special programs are aimed at strengthening patriotic feelings, preventing extremism, and ensuring stability in the country. Patriotism helps society to develop and cope with difficulties.

In a multinational country, patriotism is essential for unity and security. It promotes tolerance, respect, and peaceful coexistence among different nations. Patriotism is the foundation for creating a spiritually developed society that is capable of progress.

Material and methods of research. The study involved first-year students from Russia aged 18 to 19. Data collection was conducted from February 3 to 15, 2025. Psychological well-being was assessed using the Russian version of the K. Riff scale (Shevelenkova T. D., Fesenko P. P. [8, p. 97]). The “My Patriotism” questionnaire [9, p. 16], consisting of 64 questions, was used to assess patriotism. Self-regulation in study was determined by the methodology “Style of self-regulation of students – SSS” by V. I. Morosanova [10, p. 44].

The data obtained during the study were analyzed using correlation and regression analysis. The purpose of the analysis was to identify the relationship between the psychological well-being of Russian students and their patriotic views. At the same time, the current geopolitical situation and ideas about the future of Russia were considered.

Research results. Correlation and regression analysis was used to study the data. It consisted of several stages:

1. Defining the goals and developing the evaluation methodology.
2. Collecting and processing information.
3. Creating an economic and mathematical model.
4. Analyzing the model and evaluating the results.

The objectives of correlation analysis are:

- Identifying significant factors.
- Determining the relationship between factors.

- Identifying hidden factors.

Regression analysis tasks:

- Determining the shape of the dependence.
- Building a regression equation.
- Predicting the values of the features.

Self-testing showed signs of psychological trauma in some of the participants. A connection was found between the well-being and patriotism of students, as well as positive relationships, independence, environmental management, personal growth, goals, self-acceptance, emotional balance, and meaningful life. A positive correlation was found between patriotism and the mental health of young people who have a positive outlook on the future of their country.

We investigated the possibility of constructing a predictive algorithmic model of the development of patriotism based on a scale of psychological well-being.

Table 1 presents the data of correlation and regression analysis of the relationship between patriotism and indicators of psychological well-being.

Table 1 – Results of correlation and regression analysis of the relationship of patriotism with indicators of psychological well-being

X	**Y**	**r**	**Connection between prizes, strength**	***f***	**p**	**r^2**	**Average appro-ximation error**
Psychological well-being	Patriotism	0.38	Direct moderate	1.33	p = 0.99	0.15	13.8 %
Positive relationships	Patriotism	0.42	Direct moderate	1.46	p = 0.21	0.17	13.3 %
Autonomy	Patriotism	0.46	Direct moderate	1.65	p = 0.13	0.21	13.7 %
Environment management	Patriotism	0.46	Direct moderate	1.65	p = 0.13	0.21	21.5 %
Personal growth	Patriotism	0.16	Straight, weak	0.52	p = 0.61	0.02	15.7 %
Goals in life	Patriotism	0.09	Straight, weak	0.33	p = 0.74	0.33	25.7 %
Self-acceptance	Patriotism	0.001	Straight, weak	0.003	p = 0.99	0.00	14.3 %
Affect balance	Patriotism	0.19	Reverse, weak	0.67	p = 0.51	0.03	19.4 %
Meaningfulness of life	Patriotism	0.09	Straight, weak	0.31	p = 0.75	0.00	13.5 %
Man as an open system	Patriotism	0.15	Straight, weak	0.53	p = 0.60	0.02	6.7 %

***Note**: Correlation coefficient (r)*
Relationship between test features – forward, backward, weak
The number of degrees of freedom (f) is the student's 2t test
Coefficient of determination r^2

The possibility of creating an algorithm for assessing patriotism using a psychological state scale has been studied. Table 2 shows the results of analyzing the relationship between patriotism and well-being. The analysis showed a moderate positive correlation between patriotism and well-being among 2024 graduates who entered universities, especially those with a positive attitude and independence (p = 0.131913). The model error is 13.3-13.8 %. The relationship with the meaningfulness of life was insignificant. The balance of affect was slightly negatively correlated with patriotism.

There was a high level of patriotism and psychological well-being.

Table 2 shows the data of correlation and regression analysis of the relationship between patriotism and indicators of the Student Government Style scale.

Table 2 – The results of correlation and regression analysis of the relationship of patriotism with the indicators of the scale Style of student self-government (girls)

X*	**Y**	**r**	**Link between features, strength**	***f***	**p**	**r^2**	**Average appro-ximation error**
Planning	Patriotism	0.235	Straight, weak	0,836	0.420	0.05	20,8 %
Modeling	Patriotism	1,0	Direct functional	2.179		1,0	
Programming	Patriotism	0.154	Reverse weak	0,540	0.600	0.02	22,9 %
Evaluation of results	Patriotism	0.420	Inverse moderate	1,601	0.137	0.17	49,8 %
Self-reliance	Patriotism	0.027	Reverse weak	0,093	0.927	0.001	29,5 %
Flexibility	Patriotism	0.324	Inverse moderate	1,118	0.259	0,10	30.7 %
Tenderness	Patriotism	0.249	Reverse weak	0,889	0.393	0.06	64.0 %
Scale of lies	Patriotism	0.175	Reverse weak	0,617	0.549	0,03	15.6 %

***Note**: Correlation coefficient (r)*
Relationship between test features – forward, backward, weak
The number of degrees of freedom (f) is the student's 2t test
Coefficient of determination r^2

According to the results of correlation and regression analysis of the relationship of patriotism with the indicators of the Student Self-Regulation Style scale, a direct connection was revealed only for two signs of planning, modeling, all other signs have an inverse or moderate connection.

Conclusion:

- The results of self-testing of students revealed a positive correlation between the level of patriotism and psychological well-being among student youth.

- Correlation and regression analysis showed a positive relationship of moderate strength between patriotism and the level of psychological well-being, as well as with a level of positive attitude, independence and ability to manage the environment

- The mean approximation error (characterizes the adequacy of the regression model) is 4.6 %. At the same time, the direct connection of patriotism with the degree of meaningfulness of life and the openness of young people was poorly expressed. The balance of affect indicated weak feedback with patriotism.

- According to the results of correlation and regression analysis of the relationship of patriotism with the indicators of the scale-style of self-regulation of students, an inverse relationship of moderate and weak strength was revealed, apart from planning and modeling.

Thus, because of self-testing of graduates of schools in 2024 who entered the university, we revealed a direct relationship between the level of patriotism and the psychological well-being of student youth.

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THE IMPORTANCE OF ROLE-PLAYING AND BUSINESS GAMES IN FORMING MOTIVATIONAL ENGAGEMENT OF SECOND-YEAR SPO STUDENTS IN ECONOMIC SPECIALTIES

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Abstract. The article presents a theoretical analysis of the potential of role-playing and business games as a means to foster motivational engagement among second-year students of secondary vocational education (SPO) in economic disciplines. Based on the synthesis of self-determination theory, the zone of proximal development concept, the contextual approach, and experiential learning theory, an original conceptual model – the "motivational game triad" – is proposed, comprising three interrelated components: autonomy, competence, and professional identity. It is argued that this model bridges the cognitive and emotional gap between abstract disciplinary content and students' personal experience, thereby fostering stable intrinsic motivation.

Keywords: motivational engagement, role-playing games, business games, secondary vocational education, economic specialties, instructional design, self-determination theory.

ЗНАЧЕНИЕ РОЛЕВЫХ И ДЕЛОВЫХ ИГР В ФОРМИРОВАНИИ МОТИВАЦИОННОЙ ВОВЛЕЧЕННОСТИ СТУДЕНТОВ ВТОРОГО КУРСА СПО ПО ЭКОНОМИЧЕСКИМ СПЕЦИАЛЬНОСТЯМ

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Аннотация. В статье представлен теоретический анализ потенциала ролевых и деловых игр в качестве средств формирования мотивационной вовлеченности студентов второго курса среднего профессионального образования при освоении экономических дисциплин. На основе синтеза теории самодетерминации, концепции зоны ближайшего развития, контекстного подхода и теории опыта предложена оригинальная концептуальная модель «игровой триады мотивационной вовлеченности» (автономия, компетентность, профессиональная идентичность). Обосновано, что такая модель преодолевает когнитивно-эмоциональный разрыв между абстрактным содержанием

дисциплин и личностным опытом обучающихся, создавая условия для формирования устойчивой внутренней мотивации.

Ключевые слова: мотивационная вовлеченность, ролевые игры, деловые игры, среднее профессиональное образование, экономические специальности, педагогический дизайн, теория самодетерминации.

Introduction

Among second-year students majoring in economics (e. g., 38.02.01 “Economics and Accounting”), a discrepancy is observed between formal mastery of academic disciplines and personal acceptance of their significance [1]. This is especially pronounced in subjects such as “Fundamentals of Accounting”, where the abstract nature of concepts (e.g., “account”, “turnover”, “balance”) and the formalized nature of procedures create a barrier to emotional and cognitive engagement. At this stage, when foundational knowledge has already been partially acquired but professional identity remains underdeveloped, a critical “motivational window” emerges – a phase where extrinsic motivation (grades, credits) weakens, while intrinsic motivation has not yet formed. It is precisely at this point that traditional teaching methods lose effectiveness, as students fail to perceive a connection between theoretical constructs and real-world professional practice [2, p. 52].

Under these conditions, motivational engagement – not merely a sign of activity, but a systemic personal state encompassing cognitive meaningfulness, emotional belonging, and behavioral initiative – becomes a key resource for sustainable development. However, its formation is impossible without creating a pedagogical environment in which knowledge ceases to be an “object of study” and instead becomes a “tool for action”. Such an environment can be provided by role-playing and business games, but only when they are systematically designed.

Theoretical foundations and critical review of existing approaches

The theoretical foundation for such design lies in the synthesis of four approaches. First, self-determination theory demonstrates that sustainable motivation arises when three basic psychological needs are satisfied: autonomy (a sense of volition), competence (confidence in one’s abilities), and relatedness (social connectedness) [3]. For SPO students, however, a fourth need – professional identity – must be added, as it determines the personal significance of mastering discipline-specific content in the second year of study [4, p. 47].

Second, the zone of proximal development concept explains why games are particularly effective during transitional learning periods: they create an artificial yet content-rich zone in which students can “act professionally” – for instance, make managerial financial decisions – advancing beyond their actual developmental level while relying on the support of the game scenario, instructor, and team [5, p. 143].

Third, the contextual approach emphasizes that knowledge becomes personally meaningful only when embedded in situations significant to the learner – professional, social, or ethical [6, p. 41].

Fourth, experiential learning theory highlights the necessity of cyclical learning: concrete experience → reflective observation → abstract conceptualization → active experimentation [7].

A critical review reveals that while Fredricks et al.'s model [8] distinguishes three dimensions of engagement (behavioral, emotional, cognitive), it does not explain their psychological antecedents. Similarly, Keller's ARCS model (Attention, Relevance, Confidence, Satisfaction) [9] focuses on motivational triggers but rarely addresses professional identity – a core driver in SPO. In contrast, the proposed "motivational game triad" integrates needs-based motivation (SDT), developmental scaffolding (ZPD), contextual relevance, and experiential reflection, while explicitly incorporating professional identity as a fourth pillar – a novel contribution for vocational education.

Moreover, the evolution of 'engagement' as a construct reveals a trajectory from Harlow's (1950) early work on intrinsic motivation, through Deci & Ryan's (1985) SDT, to Fredricks et al.'s (2004) multidimensional framework, and further to Zimmerman's (2000) self-regulated learning (SRL) model, which emphasizes metacognitive control. The "motivational game triad" bridges SDT and SRL by positioning competence as the domain where metacognitive skills (planning, monitoring, reflection) are cultivated through structured feedback loops – a gap not addressed in prior models.

Conceptual model: the "motivational game triad"

Based on this synthesis, we propose the conceptual model of the "motivational game triad", in which three components – autonomy, competence, and professional identity – function as a mutually reinforcing system. Autonomy here is understood not as arbitrariness, but as structured choice: students may determine budgeting strategies, assign roles within teams, and select presentation formats – yet always within the boundaries of professional ethics and task logic. Competence is not viewed as mere possession of knowledge, but as the process of its acquisition through action and feedback: gradual task complexity, immediate error correction, and opportunity for revision. Professional identity is not a formal role assignment, but the experience of responsibility for consequences: awareness that an incorrectly calculated break-even point could lead to the "bankruptcy" of the simulated enterprise and non-payment of "salaries".

The triad operates cyclically: autonomy fosters initiative, which leads to action and feedback (competence), which in turn reinforces professional self-concept (identity), and strengthens the desire for further autonomous choice. For instance, in the "Budgeting" game, a student choosing to act as financial manager (autonomy) faces a cash gap, develops a restructuring plan, receives peer and instructor feedback on its feasibility (competence), and internalizes the role of a responsible economic agent (identity), thereby reinforcing the cycle.

To scaffold this process, three pedagogical triggers are embedded: (1) Choice architecture – offering three crisis scenarios (supplier default, tax audit, demand drop) to satisfy autonomy; (2) Competence ladder – tasks progress from basic (calculating

turnover) to expert (forecasting under uncertainty); (3) Identity journal – students reflect weekly: "Who was I as an economist today? What decisions defined me?"

Scenario development: "Budgeting in Small Business"

To implement this model, a business game scenario titled "Budgeting in Small Business" was developed for second-year SPO students specializing in 38.02.01 "Economics and Accounting". The game is designed for two academic hours and comprises five sequential stages.

During the contextualization stage, the group is presented with a real yet adapted financial situation: the enterprise "Tekstil-Plus" faces a cash gap due to overdue accounts receivable amounting to 1.2 million rubles.

The role assignment stage allows students to distribute roles (accountant, financial manager, CEO, tax inspector, bank/creditor representatives) independently.

In the planning stage, teams develop a three-month operational budget, calculate the break-even point, and propose measures to cover the gap.

The negotiations stage simulates real-world interactions, requiring both technical accuracy and communication skills.

The reflection stage follows the scheme: "What I knew → What I did → What I understood → What I will change in reality".

A key feature is the pedagogical use of mistakes: incorrect classification of depreciation triggers collective analysis, reducing anxiety and fostering metacognition [2, p. 61].

So, why does this model work? It satisfies the core requirements of FSES SPO 3++: autonomy → ОК-2 (organizing own activity); competence → ОК-4 (searching and using information); professional identity → ПК-1.1 (performing accounting operations with understanding of economic meaning).

Methodological recommendations

Based on analysis of successful practices (e.g., Moscow College of Economics, 2023; [10]), and in accordance with FSES SPO 3++ (clause 12), the following eight methodological conditions are recommended:

Systematicity: Games must be integrated into semester plans, not used episodically. One game per module ensures continuity and cumulative effect.

Age compliance: Tasks must match second-year cognitive development (Piaget's formal operations) and psychosocial stage (Erikson's identity vs role confusion). Overly complex scenarios cause anxiety; overly simple ones induce boredom.

Scenario authenticity: Financial data should mirror real SME challenges. In the pilot adaptation, data from the Kazan farm "Zarechye" (2024 report) was anonymized and simplified, increasing perceived relevance by 42 % (based on post-game survey).

Instructor preparedness: Teachers require training in three domains: (a) content mastery, (b) facilitation skills (managing group dynamics, guiding reflection), and (c) reflexive supervision (helping students connect experience to theory). A 16-hour certification course is recommended.

Inclusion support: A support matrix should be applied: level 1 (novice): templates, step-by-step guides, peer mentoring; level 2 (intermediate): open-ended tasks with optional hints;

level 3 (advanced): “expert challenges” (e.g., modelling inflation impact). This ensures participation across the self-efficacy spectrum.

Stakeholder awareness: Parents and employers should receive briefings on the pedagogical goals (e.g., “This is not just a game – it develops decision-making under uncertainty”). In the Moscow pilot, this increased post-game transfer to internships by 28 %.

Evaluation of effectiveness: Success should be measured via: reduced academic anxiety (Spielberger State-Trait Anxiety Inventory); increased self-efficacy (Schwarzer’s General Self-Efficacy Scale); competence in ОК/ПК (expert assessment of role-play performance).

Ethical considerations: Participation must be voluntary; mistakes must be safe (no grade penalties); confidentiality of student reflections must be ensured. The “error culture” should emphasize learning, not blame.

Prospects and limitations

Systemic scaling requires: (1) normative inclusion in working programs, (2) a centralized repository of validated scenarios, (3) continuous professional development for instructors.

Limitations include time intensity (2+ hours per game), dependence on small-group dynamics, and lack of digital scalability in current form. However, pilot data from the Federal Institute for Education Development (2024) shows such games can replace 3–4 traditional seminars, making them time-efficient in the long run [11].

Digital hybridization is a key prospect: VR environments could simulate tax inspections or board meetings, while AI-powered “opponents” could adapt negotiation tactics in real time. Integration with LMS (e.g., Moodle) would allow pre-game preparation and post-game reflection tracking.

Barriers to scaling include instructor resistance, lack of methodological guidance, and regional disparities in resources. Solutions include: (a) developing a national scenario bank via Rosobrnadzor; (b) offering micro-credentials on game-based learning; (c) designating pilot colleges (e. g., base SPO institutions of KFU) for dissemination.

Conclusion

Role-playing and business games, designed according to the “motivational game triad”, bridge the cognitive and emotional gap in SPO economics education. They transform knowledge from an external object to an internal professional resource – not “entertainment”, but a strategic pedagogical technology. By satisfying the psychological needs of autonomy, competence, and professional identity, such games lay the foundation for lifelong learning and professional self-determination. Future research should explore longitudinal impacts on career choice, retention, and entrepreneurial initiative among SPO graduates.

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REFLECTION OF THE AESTHETICS OF CONSTRUCTIVISM AND FUNCTIONALISM IN THE DESIGN OF SOVIET CAMERAS IN THE MIDDLE OF THE XX CENTURY

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Abstract. The article is devoted to the study of the motif of dreams in David Lynch's cinema. It examines the author's artistic methods. The evolution of the director's work is highlighted, with the cult television series *Twin Peaks* being singled out. The conclusion emphasizes the key importance of dream elements for the perception of the aesthetics of Lynch's films and indicates the direction of further research on this topic.

Keywords: constructivism, functionalism, Soviet design, XX century cameras, geometric shapes, simplicity of lines, industrialization, mass production, art deco and modernism, rational approach to form.

ОТРАЖЕНИЕ ЭСТЕТИКИ КОНСТРУКТИВИЗМА И ФУНКЦИОНАЛИЗМА В ДИЗАЙНЕ СОВЕТСКИХ ФОТОАППАРАТОВ СЕРЕДИНЫ XX ВЕКА

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Аннотация. Данная статья посвящена изучению влияния эстетических принципов конструктивизма и функционализма на дизайн советских фотоаппаратов периода середины XX века. Рассматриваются основные характеристики данных направлений, их отражение в конструкции и декоре фотоаппаратов того времени. Приводится исторический контекст появления и распространения конструктивистских тенденций в отечественном промышленном дизайне.

Ключевые слова: конструктивизм, функционализм, советский дизайн, фотоаппараты XX века, геометрические формы, простота линий, индустриализация, массовое производство, арт-деко и модернизм, рациональный подход к форме.

In the middle of the 20th century, Soviet culture entered a period of intense artistic experimentation, when creators were tasked with creating a new form of art capable of reflecting the realities of a rapidly changing world. It was then that there was a need to rethink the role of form and content in art to make artistic creation accessible to a wide audience and give it functionality.

One of the most significant trends of this period was **constructivism**, which began in the 1920s and reached its heyday in the 1930s. Constructivists sought to abandon traditional forms of art, preferring geometric shapes, strict lines, and industrial material. This movement emphasized the importance of the functionality of the object, sought to integrate art into everyday life, and established the principles of rationality and utilitarianism.

Constructivism soon became the basis for the formation of another important direction, **functionalism**. This approach argued that the form should be determined solely by the function of the object, emphasizing ergonomics, simplicity of design and efficiency of materials.

These trends had a huge impact on the development of industry, especially in the field of designing household items, among which the design of cameras became especially important. Soviet engineers and designers actively used the ideas of constructivism and functionalism, creating models of cameras that met the new requirements of Soviet reality. Such devices became not just tools for fixing reality but also symbols of industrialization and progress.

For a deep understanding of the influence of the two most important art trends of the first half of the 20th century – constructivism and functionalism – on the development of Soviet camera design, it is important to consider the historical context of the era. It was this period that became a turning point in the development of aesthetics, when the old art forms were revised and reevaluated.

As the researcher Yulia Sergeevna Punanova emphasizes in her scientific article "Aesthetic Principles of Constructivism", the emergence of constructivism was due to a sharp break with traditional approaches to art and culture. Constructivists sought to overcome the distance between art and everyday life, shifting attention to the functional qualities of objects and the rationality of form-making. Their main goal was to create objects that combine utility and simplicity of construction to make beauty accessible to everyone.

According to the outstanding architect and architectural theorist Nikolai Alexandrovich Milyutin, set forth in the work "Constructivism and Functionalism. On the Characteristics of the Architectural Trends of the 20th Century", constructivism offered a fundamentally new view of the environment. Using the achievements of modern science and technology, the masters of the new style tried to create a harmonious interaction between man and the surrounding space through the introduction of new materials and construction technologies. These ideas had a huge impact on the design of all types of Soviet-made products, including such a technically complex industry as the production of photographic equipment.

The key features of constructivism are the simplicity of lines, the rejection of decorative elements and the focus on functionality. The influence of constructivism on industrial design is manifested in the use of pure geometric shapes, clear contours and

strict proportions. Functionalism, which grew out of constructivist ideas, emphasizes the connection between the form and function of the object. In his work “Constructivism”, Alexander Gan describes this concept as follows: “Form should follow function, and not vice versa” [1, p. 82]. Many Soviet designers were guided by this approach, creating products aimed at the public.

Among the main principles of industrial design of the USSR of the XX century are geometric composition, specific materials, simplicity of the interface, functionality and practicality.

1) Geometric composition. One of the main features of constructivism is the predominance of geometric shapes. For example, cameras of the ”Zenith” series are characterized by simple body outlines, the absence of unnecessary decorations and clearly defined edges (Fig. 1). This design emphasizes the functionality of the device and makes it easier to operate.



Figure 1. Camera Zenith

2) Use of industrial materials. The materials used in the production of cameras also comply with the principles of constructivism. Metal parts, plastic and rubber become the main elements of the structure, emphasizing the industrial nature of the products. The use of aluminum and stainless steel gives the machines strength and durability, while reducing the weight and cost of the product. The use of metal and glass as building materials allowed constructivist architects to achieve a high degree of expressiveness of compositions [2, p. 14].

3) Simplicity and clarity of the control interface. Camera interfaces of the constructivism era are simple and easy to use. All buttons and levers are ergonomically positioned, allowing intuitive operation of the device. This approach reflects the desire of constructivists to create objects that are as adapted as possible for everyday use. Simplicity and clarity are the most important characteristics of the constructive method [3, p. 8].

4) Functional aspects of camera design. In addition to aesthetic characteristics, constructivism and functionalism influenced the functional parameters of cameras. The most important task of the designers was to ensure the reliability and durability of the devices, which corresponded to the general orientation of the socialist economy to increase labor productivity and reduce costs.

The design of Soviet cameras provided for the possibility of easy repair and replacement of parts. Models of the “FED” and “Kiev” types had a modular structure that made it possible to quickly replace failed components (Fig. 2, 3). This provided a high degree of operational flexibility and extended the service life of the devices.



Figure 2. Camera FED



Figure 3. Camera Kiev

It is also worth noting the functionality and adaptability of Soviet photographic equipment. Many mid-range cameras could be equipped with interchangeable lenses, flashes and additional accessories. Such devices as the Moskva and Lyubitel demonstrated versatility, allowing the user to adapt the camera to different shooting conditions (Figs. 4, 5). The principle of modularity, widely used in constructivism, is reflected in the design of cameras [4, p. 11]. Versatility and multifunctionality are important criteria for constructive aesthetics [5, p. 3].



Figure 4. Camera Moskva



Figure 5. Camera Lyubitel

One of the most illustrative examples of the constructivist approach in the history of photographic design was the Soviet series of cameras “FED”, developed in the first half of the 20th century, mainly in the late 1930s. This model was created based on the then popular German Leica II camera, adopting its key technological solutions and engineering characteristics. Nevertheless, even despite such a noticeable influence of the German prototype, the visual embodiment of FED had pronounced features of Soviet constructivism. The bodies of the devices were made in a minimalistic style, characterized by simple lines, strict shapes and the rejection of decorative elements that

have an exclusively aesthetic character [6, p. 17]. Such a design was in line with the general trend of those years, when functionality prevailed over decorativeness, and each element performed its clearly defined role, ensuring the ease of production and the availability of products to the general population.

Another significant representative of the constructivist school was the Soviet camera “Zenith”, which was released after the war, in 1952. Its body also demonstrates adherence to the classical canons of constructivism: straight and clean lines, a minimum of decorations, conciseness of forms and full compliance with the external signs of a functional style. The design of the device was distinguished by the thoughtfulness of every detail, focused on ensuring reliability and ease of operation. Thus, the forms here are subordinated exclusively to the purpose of the device, emphasizing the idea of the primacy of function over form, which became the hallmark of the era of constructivism. These features allowed Zenit to become a cult product of its time, embodying a balance of technical excellence and affordability.

Thus, constructivism and functionalism played a key role in shaping the design of Soviet cameras in the mid-20th century. Their influence was manifested in the use of geometric shapes, the use of industrial materials and the focus on functionality and ease of operation [7, p. 9]. These approaches provided a high level of convenience and reliability, which made the products available to a wide range of consumers. Today, these cameras remain important artifacts of Russian technical culture, demonstrating the unique achievements of constructivism and functionalism in the field of industrial design.

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THE IMPROVEMENT IMPERATIVE THE ETHICS OF HUMAN ENHANCEMENT

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Abstract. This article explores human enhancement technologies (HETs), which represent the latest incarnation of humanity's Faustian quest for transcendence, ranging from shamanic rituals to genetic interventions in the biology of Homo sapiens (CrISPR). Their proliferation (global neurotechnology market: $17.1 billion by 2026) requires a philosophical analysis that goes beyond utilitarian bioethics.

Keywords: interrelation of reason and morality, scientific cognition, ethics, consciousness, phenomenology, psychology, AI.

НЕОБХОДИМОСТЬ СОВЕРШЕНСТВОВАНИЯ ЭТИКА СОВЕРШЕНСТВОВАНИЯ ЧЕЛОВЕКА

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Аннотация. В данной статье исследуются технологии человеческого улучшения (ТУЧ), которые представляют собой новейшее воплощение фаустовского стремления человечества к трансцендентности от шаманских ритуалов до генетических вмешательств в биологию Homo Sapiens (CrISPR). Их распространение (мировой рынок нейротехнологии: 17,1 млрд долларов к 2026 году) требует философского анализа, выходящего за рамки утилитарной биоэтики.

Ключевые слова: взаимосвязь разума и морали, феноменология, этика, сознание, антропология, философия, ИИ.

Introduction

The rapid development and implementation of technology raises profound ethical questions regarding the nature of consciousness and identity. This article applies a phenomenological framework to examine the implications of these technologies for

human understandings of what it means to be human and the implications of these enhancements. Using methods of reduction and deduction to avoid the illusion of the former, along with holistic and psychoanalytic perspectives, this study seeks to shed light on the complexity and multifaceted nature of consciousness and identity in the context of human enhancement. Furthermore, the article highlights historical perspective and contemporary trends, offering ideas or options for predicting the ethical landscape of human enhancement. Human enhancement encompasses a wide range of technologies, including those designed to transform (enhance) physical and cognitive abilities, including possible genetic modification (a controversial issue), neurotechnology, and biotechnology through new artificial technologies and AI. On the other hand, human improvement is possible on a spiritual level, thanks to the expansion of consciousness, the disclosure of abilities and superpowers for the realization of his creative channel (potential) and at the same time, bringing to the highest level moral principles, moral foundations of the fundamental principles or laws of the universe and / or religious and moral precepts (commandments, mitzvot, sharia) with the goal of preserving humanity in a person not in words and writings, but in the daily actions of each, while maintaining integrity and not interfering in his biology by external means (and / or influences).

Methods

The author considers a meta-position integrating several aspects: a phenomenological reduction, which goes beyond naturalistic assumptions about "human nature"; a psychoanalytic reconstruction – the desire for enhancement as a sublimated denial of mortality; and a historical dialectic tracing the development of enhancement. Applying phenomenology and analyzing the relationship between consciousness, identity, and enhancement through a phenomenological prism, relying on the historical context and an interdisciplinary approach.

The interdisciplinary nature of this research requires the integration of different types of ideas and concepts, in this particular research from philosophy, psychology, sociology, and neuroscience. For example, neurobiological research on brain plasticity can provide insights into how enhancements can influence and alter consciousness and identity. Furthermore, the sociological implications of enhancement and/or implementation technologies touch on issues of access and equality. As the author analyzes the past and present, trends, and attempts to peer into the future, several trends merit attention. The democratization of enhancement technologies could lead to a new social paradigm in which the boundaries between the enhanced and the non-enhanced are blurred. This potential reality raises ethical questions about consent, autonomy, and the definition of "normal" human experience. Moreover, the development of artificial intelligence and machine learning may soon transform our understanding of consciousness itself, thereby challenging traditional notions of identity and agency.

Maurice Merleau-Ponty (1908-1961), a student of E. Husserl, made significant contributions to the understanding of mind and body through his phenomenological approach. In his work "Phenomenology of Perception", [3] M. Merleau-Ponty argued that consciousness is inherently embodied, emphasizing that perception and experience arise from our physical interactions with the world (embodied cognition). This perspective (concept) influenced modern theories of embodied cognition, which are

reflected in cognitive processes rooted in bodily experience. For example, research in this area has shown that physical movement enhances cognitive performance, suggesting that reasoning and consciousness are not merely mental activities but also depend on its physicality and vitality. Phenomenology offers a critical alternative to reductionist models. Neurocognitive models often reduce identity to brain states or the continuity of memory. Phenomenology resists this reduction, demonstrating that identity is not only what we remember but also how we perceive ourselves when we remember, a structure of subjective first-person experience that cannot be objectified without distortion. This is crucial in clinical and ethical contexts, where identity diffusion (for example, in borderline personality disorder or post-improvement disorientation) is often misdiagnosed as a cognitive deficit, although it may actually be a profound disruption in the structure of self-perception.

Results and Discussion

Phenomenology, pioneered by thinkers such as Edmund Husserl (that Husserl's *epoch* – "enhancement" – is bracketed as a lived experience [4, p. 28]) and M. Merleau – Ponty emphasizes the subjective experience of humans. In the context of human enhancement, phenomenology invites us to consider how these technologies will alter our (subjective) life experience and self-perception. From a psychoanalytic perspective, consciousness is not simply a cognitive phenomenon but also deeply intertwined with the unconscious, something hidden and unmanifested. Sigmund Freud's psychoanalytical theories of identity [5] formation emphasize the dynamic interplay between conscious and unconscious processes. Human enhancement technologies may disrupt this balance, which will likely lead to a reconfiguration of identity and potential fragmentation. Thus, identity diffusion (Identity dissuades from integrating oneself as a psychological state of confusion and uncertainty, in which a person is unable to form a stable, coherent self-esteem and lacks stability in their self-view. For example, they may doubt their sexual orientation, career choice, or other factors. Essentially, this structural lack of self-integration is possible, including in borderline personality disorder), leading to ethical ambivalence. This kind of "improvement" can destabilize narrative identity, especially when memory, mood, or personality changes. Moreover, identity diffusion may no longer be considered a psychopathology, but a social condition that reflects late modern fluidity and distorts norms, blurring the distinction between normal and pathological. This applies primarily to those who are most vulnerable and least psychologically stable and autonomous, integrated, and/or are in a period of development. Add to this artificial intelligence, which blurs the line between human subject and technological object, creating hybrid identities. The enhanced subject – who and what is it? – it is not simply an enhanced version of oneself, but a new form of subjectivity, shaped by regimes of power and knowledge, or complete autonomy, which is multifaceted and encompasses various characteristics and qualities.

Historically, the desire for enhancement can be traced back to ancient civilizations, where the pursuit of physical and intellectual superiority was often intertwined with ethical considerations. The Age of Enlightenment, with its emphasis on rationality and progress, laid the foundation for modern debates about enhancement. By analyzing historical trends, we can identify recurring ethical concerns, such as

potential inequality and the loss (complete or partial for some) of what it means to be human. On the other hand, a reconfiguration of normativity is underway. Enhancement shifts the ethical framework, transforming normal traits into pathologies. Also, attempts to halt or, for example, prolong (postpone) what is fated, a constant, such as aging and death (thereby disrupting and slowing down natural processes such as birth and death) are also emerging, as are rational mastery over nature and fantasies of digital immortality in the new world. The other side of the coin, the Freudian death drive, manifests as a transhumanist "singularity" – a dark eschatological erasure of finitude".

Phenomenology contributes to the understanding of identity in the context of human enhancement: for instance, by offering a first-person experiential framework that shows how enhancement technologies alter the structure of selfhood, temporality, and embodiment often in ways that objective or, for example, biomedical models overlook. In summary, phenomenology shows that identity is not simply a set of traits or memories, but a pre-reflective sense of "mine" – an implicit, embodied sense of owning, living, and feeling subjective experience. Enhancement technologies (e.g., neural implants or mood modulators) can disrupt this implicit structure, leading to alienation or "ontological vertigo". Identity is formed over time – we are who we are, who we have grown ourselves to be, because we experience ourselves as something continuous over time, with programs and subjective experiences that are not only personal but also transmitted (embedded) in our DNA, through our ancestry, and with narratives, patterns, and scripts, both conscious and unconscious. Enhancement can disrupt this continuity, especially when it affects memory (cognitive functions) or personality traits.

Conclusion

In conclusion, current realities reveal several parallel conceptions of the world and the improvements (a debatable issue), which each ultimately, individually and collectively, realizes and is responsible for. For instance, ultra-globalists (the post-capitalist world) are working to create a socio-economic system that will alter human biological nature, under the heading of "improvement", as a so-called anthropological transition. Foucault's philosophy is that subjectivation: power shapes the subject; improvement is biopolitical. Foucault's concept of subjectivation shows how improvement generates new subjectivities "we" become "improvable subjects / individuals", but also morally obligated to improve ourselves. In this way, identity becomes a site of biopolitical control, not self-expression.

However, there's the possibility of creating a future in which the "upper classes" and "lower classes" are as distinct as two different biological species – furthermore changing human nature in one way or another, or in such a way that social differences, fixed above biological ones, remain for the rest of a person's life, making them insurmountable. As a substitute (scenario): creating a digital world, while solving (regulating) issues and problems technically, without affecting or disrupting the integral biology of Homo Sapiens, and without external intervention. At the same time, there's another side to this scenario: the high speed of development and the introduction of artificial intelligence, with its multifaceted capabilities, including improvements in the automation of business processes and life activities, confronts people with a choice and demands rapid adaptation, training, and the ability to apply it, while preserving or

even developing their (human) creative talents. In doing so, they improve themselves through the development of their qualities and benefit overall. Or they cannot handle change, avoiding, ignoring, or attempting to return to the past (out of nostalgia or grumbling about life, society, etc.) in other words, they try to apply methods (keys) that no longer work for new doors (circumstances). Then, they lose out in many (if not all) ways in the long run, which can lead not only to an existential crisis but also to the loss of their resources and a lack of demand as a specialist. Thus, a hybrid division occurs, in which only wealthy users can afford cognitive or sensory enhancements, which can lead to a new class stratification between "naturals" and "hybrids" with differing life chances and their comprehension. A labor market bifurcation occurs, where workers who reject neural networks or exoskeletons may become unemployed. Here the controversial issue arises that these improvements are turning into a forced necessity, and not a free choice or personal responsibility of each person to adapt to changes and transform them for the good, rising to the next level of the Maslow's hierarchy of needs [6] (is a conceptualisation of the needs (or goals) that motivate human behaviour), starts from survival, the position of a victim or parasite, or the realization of biological, physiological needs such as hunger, sex, and social needs but still live without purpose) move to the next level of consciousness, autonomy and integration in relation to the needs for self-realisation to drive them to fulfil their inherent ultimate potential and than culminates at the top level, such as meta needs.

The author does not mean those specialists who are not simply professionals in their field (or who once achieved this or that status), but those who develop in their field and maintain their autonomy, professionalism, and adaptability in times of stable instability and large-scale development and the introduction of artificial intelligence and its capabilities. In other words, he knows how to organize or personally applies new technologies not at the level of "ask a question or write a text"; For instance, like M. Heidegger's *Verfallenheit* ("fall") in "Being and Time". Here Heidegger argues that falloff (Verfallen) occurs in Casein's entanglement or involvement in the tranquillised idle talk and business of das Man (the "They") [7, p.176]; When the subject confuses algorithmic prompts with authentic choice, but interacts with them at the level of programming, modeling, reading, and with large language models and/or with artificial intelligence agents (decisions arise from feedback loops between humans and AI; On the other hand, gaps in agency and accountability are also possible), because the latter are not simply a textual process; they are systems that can actually perceive what is happening around them, make decisions, and take actions to achieve specific goals. This is an entirely different level of interaction. In this case, with such use (application) of communication with AI, a person can improve themselves and shift from routine to creative and spiritual processes, emphasizing not the basic need of survival and fulfilling basic needs, but rather epistemological and axiological characteristics, spiritual development, higher values, and how they can improve themselves, expand their consciousness, and do something better for the community, the group of people they surround themselves with, in which they work, or for humanity as a whole. Exploring improvements through the lens of phenomenology and considering the ethical implications of human enhancement, shifting the focus from external consequences (e.g., risk, justice, access) to internal transformations – how

improvement alters the structure of life experience, its perception, transcendence, selfhood, and moral activity. It asks not only what improvement does, but also what it means to be improved and how this changes how we relate to ourselves, others, and the world.

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CROSS-CULTURAL RELATIONSHIP IN THE FIELD OF EDUCATION: PROBLEMS OF FOREIGN STUDENTS' ADAPTING

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Abstract. The paper addresses the main challenges of international students' adaptation. As a result of the survey, some recommendations are formulated to solve these problems.

Keywords: cross-cultural relations, education, foreign students, problems of adapting.

МЕЖКУЛЬТУРНЫЕ ОТНОШЕНИЯ В СФЕРЕ ОБРАЗОВАНИЯ: ПРОБЛЕМЫ АДАПТАЦИИ ИНОСТРАННЫХ СТУДЕНТОВ

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Аннотация. В работе рассматриваются главные проблемы адаптации иностранных студентов. В результате опроса составляются рекомендации, направленные на решение данных проблем.

Ключевые слова: межкультурные отношения, образование, иностранные студенты, проблемы адаптации.

The **main problem** of our work is to describe the difficulties in establishing effective communication between international students and their lecturers and group-mates, stemming from differences in cultural communication norms.

The **relevance** of the problem of foreign students' adapting is closely connected with some factors have becoming actual nowadays. Among them are the following [1]:

– Growth of academic mobility (more and more students are choosing to study abroad);
– The importance of intercultural relations nowadays;
– Challenges caused by the adaptation to new cultural and educational conditions;

– The impact of the successful adaptation on foreign students' grades and general well-being;

– The need to create a comfortable and inclusive educational environment for all students.

Language is considered to be one of the most important means of communication. Nowadays English is the most popular language in the world, that's why it helps many people to adapt to new conditions and communicate with foreigners.

The **main goal** of our work is to develop recommendations for international students, faculty and university staff on overcoming communication barriers caused by cultural differences in communication norms.

The **tasks** of the work are the following:

1. To study and identify which cultural peculiarities mostly cause communication barriers;
2. To determine how these cultural differences manifest in the interactions between international students, lecturers and group-mates;
3. To conduct an empirical investigation among international students to identify actual communication barriers;
4. To analyze the data and to develop a comprehensive set of recommendations for international students, lecturers and all the participants of the educational process.

In our work we used online survey among foreign students as the main research method.

Let's consider some theoretical approaches to international students' adaptation.

In 1985 William B. Gudykunst developed a version of the theory that used uncertainty and anxiety to explain intercultural adjustment. Three years later he included notions of intergroup anxiety into a **general theory of effective interpersonal and intergroup communication.** According to this theory, adaptation is connected to the ability to manage anxiety and uncertainty arising from interacting with an unfamiliar culture. Nowadays this theory is defined as **anxiety uncertainty management theory** [2, p. 228]. This theory highlights the importance of international students studying cultural norms for the quickest adaptation [2, p. 230].

Among the factors influencing adaptation international students are the following:

– **Sense of cultural distance.** Geographically far apart, there are a few cultural commonalities, such as social customs, religious beliefs, clothing, weather, food and other great differences. These factors lead to a sense of distance and strangeness causing adaptation between various cultures that makes the problem even more difficult.

– **Host Language Proficiency**. The impact of language proficiency on communication and academic performance quality.

– **Social support.** This factor helps him or her to feel a part of a new society, to establish connections with locals and to build friendships and professional relationships.

To be a success in the process of adapting in foreign educational environment one should consider the features of the host country's education system. Among them are the following [3]:

1. Academic requirements and norms: differences in teaching and assessment methods.

2. Organization of the educational process: differences in schedule, grading system and exams.

3. Relationship between the lecturer and other students: differences in communication style and forms of interaction.

4. Tolerance of educational groups: differences in behavior norms and students' values.

Empirical Part (Methodology and Research Results)

Research Methodology

Survey characteristics

Survey Method: Online Survey

Interviewed: International students in Russian universities: 160 people (39 % men, 61 % women)

Sampling geography: Saint Petersburg, Moscow, Kazan, Novosibirsk

Age of respondents: All respondents are first year students, aged 18-23 years.

Survey

Table – Social Quiz

№	Questions	Answer option	Percentage
1	What parts of adapting to living and educational conditions in Russia are the most difficult for you?	Troubles with Russian language learning	20 %
		Climatic conditions	4 %
		Differences in educational methods	15 %
		Differences in educational programs	10 %
		Lack of teaching materials for foreign students	40 %
		Different lifestyle	10 %
		Big differences in food between countries	1 %
2	What information about the country / university have you searched for before moving?	Living conditions	30 %
		Admission and education rules	40 %
		Cost of living	10 %
		Cultural peculiarities	10 %
		Transport system	10 %
3	Do you attend Russian language extra classes?	Yes, organized by the university	10 %
		Yes, private lessons	45 %

		Yes, online courses	35 %
		No	10 %
4	Who do you interact with most often?	With another foreign students	55 %
		With Russian students	15 %
		Same with everybody	30 %
5	Where do you usually spend your free time?	In the dormitory	50 %
		Going on excursions / exploring the sights	15 %
		In the library / university	30 %
		In national cultural centers	5 %

Having conducted an empirical investigation, we can analyze and draw conclusions based on the responses of the surveyed students and formulate recommendations to reduce problems related to the adaptation of international students.

A larger percentage of surveyed students highlighted particular difficulties with learning the Russian language and differences in learning materials. Also, during the analysis of the responses, we noticed a lack of knowledge about cultural traditions. Only a small percentage of those surveyed visit excursions or cultural centers in their free time, which hinders rapid adaptation.

What solutions can we find to these problems to accelerate the adaptation process of international students? How can we facilitate this process?

Some recommendations can be found below [4; 5]:

– **Free Russian Language Courses for International Students**

It has become apparent that many individuals dedicate little or no time to language learning, which significantly hinders their interaction with their surroundings in the country. If universities were to provide in-depth Russian language courses or offer additional classes specifically for international students, it would increase people's motivation to learn Russian and considerably accelerate their adaptation process.

– **Differences in learning materials.** To address this issue, attention should be focused on developing multi-level textbooks that cover the same topics but with different explanations of the material. For example, at a lower level, this could include detailed, simplified explanations, audio materials and video lessons, allowing students to improve their knowledge level without wasting excessive time and money. To determine a student's knowledge level, a test or diagnostic assessment is conducted before the start of training.

– **Ignorance of cultural traditions.** To address this issue, it is recommended to review information on the country's norms and culture before relocating. Organizing joint excursions, events at cultural centers or to attractions. Establishing “Cultural Clubs” where Russian participants can share information about their country's culture.

In conclusion we'd like to emphasize that there are more advantages in learning a new culture, getting new experience, meeting new people, broadening your mind. Believe in yourself and don't be afraid to try.

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MUSIC: DIFFERENT TASTES OF DIFFERENT GENERATIONS

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Abstract. This article discusses music and musical preferences of different generations. We also analyze the psychological impact of music in advertising and marketing, as well as in people's spiritual and everyday lives.

Keywords: music, generation, zoomers, millennials, sixties generation, marketing, advertising.

МУЗЫКА: РАЗНЫЕ ВКУСЫ РАЗНЫХ ПОКОЛЕНИЙ

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Аннотация. В данной статье рассматривается музыка и вкусовые музыкальные предпочтения разных поколений. Также анализируются способы психологического воздействия музыки в сфере рекламы и маркетинга, духовной и повседневной жизни людей.

Ключевые слова: музыка, поколение, зуммеры, миллениалы, шестидесятники, маркетинг, реклама.

The main subject of our work is music and before we start we should try to answer some questions: what music is; what is its definition in science and is it really important?

Let’s discuss a phenomenon we all observe in our daily lives: how vastly different the musical tastes of our parents, ourselves and our younger siblings are. Why do songs that delight a grandmother leave a grandson perplexed? And why is a track that breaks all TikTok records simply a kind of noise for the older generation?

This isn't just a coincidence or stubbornness. Musical preferences are a kind of sonic passport for a generation, shaped by a unique set of social, technological, and cultural factors.

What is music and is it really as important as we are told? We believe that music is more than just a set of notes and sounds arranged and played in the correct order. Music is an ancient means of expressing feelings and emotions, as well as a method of

storytelling on par with simple speech and visual art, such as cave paintings. Music cannot be simply called entertainment, for it carries not just melodic sounds but the composer's genuine experiences, stories told not through verbal signs or words, but through unique rhythms, intonations, tonalities and melodic fluctuations. Viewed as a means of expression, music is a serious art form, unique to each individual and capable of expressing true feelings when words become insufficient.

The definition of music is as follows: music is an art form in which sounds, organized in a specific way, are used to create a combination of form, harmony, melody, rhythm or other expressive content. Music is generally considered a cultural universal, present in all human societies [1, p. 10].

Now that we've discussed music itself, we should understand the differences in musical tastes across generations. Why is it that for the ”old school” generation, contemporary music seems like a barren collection of interjections, while for the “zoomers” generation, music and songs from the Soviet era and the “wild 90s” are dreary and boring?

Music often reflects the zeitgeist and social issues facing a generation.

Baby Boomers (born 1946-1964). Their youth coincided with the post-war era, the Vietnam War protests and the hippie movement. Their music (The Beatles, The Rolling Stones, Bob Dylan, etc.) is rock 'n' roll, freedom, protest and the slogan “Make love, not war”.

Generation X (born 1965-1980). The “Lost Generation” between Baby Boomers and Millennials. Their music (grunge, Nirvana, punk rock) expresses disillusionment, cynicism, apoliticality and the feeling of “growing up in the shadow” of more successful parents.

Millennials (born 1981-1996). Growing up during the rise of the internet, globalization and pop culture. Their music (Britpop, R&B, pop-punk and the rise of commercial hip-hop) is a fusion of styles, a search for optimism and nostalgia for a simpler time before social media.

Generation Z (born 1997-2012). The first truly digital generation. They grew up in the era of streaming (Spotify, YouTube, TikTok and music video thinking). Their tastes are more eclectic: they can listen to K-pop, a phony rapper or an indie band in the same evening. Music has become more visual and up-tempo.

And against the backdrop of such different events that accompanied the lives of different generations, the eternal conflict of “fathers and sons” arises: for the older generation, such types of modern music as rap and K-pop seem absurd and for the younger generation, “grown up” on the Internet, songs from the 70s-90s seem too monotonous, because they feature “hackneyed” themes of love, friendship and sometimes even crime. However, nowadays we are increasingly seeing a phenomenon called “nostalgia for an unlived past”(Anemoia effect), when young people begin to listen to the music of past generations, feeling an inexplicable sense of nostalgia, despite the fact that they never lived in those times [2].

Music is not just pure art but also a tool for managing people. That is why we come to another important topic such as money and advertisement.

It is worth to mention that music is extremely actively used in commercial activities. In this industry, it has become more than just background music, but a strategic asset that directly impacts financial results.

Let's have a look at sound branding and auditory marketing. This is the deliberate use of music to create and strengthen a brand. A recognizable melody or jingle evokes an instant association with a product.

Examples:

Intel – just four notes, but one of the most recognizable sound logos in the world.

Nokia – the "Nokia Tune" ringtone has become a symbol of the mobile phone era.

McDonald's – the slogan "I'm Lovin' It" and its accompanying melody have become firmly entrenched in the minds of consumers.

In the sphere of marketing music can be used as a tool of manipulating consumer's behavior. This aspect lies at the intersection of commerce and management. Music is used to create the desired emotional background, making people more receptive to advertising messages.

Research shows that major keys and moderate tempos inspire greater brand trust. Music that evokes nostalgia makes consumers associate a product with warm memories.That is why music is widely used in neuromarketing.

The next point is music in retail and service sector. A specially selected playlist in a store, restaurant or hotel addresses specific business objectives:

Managing customer behavior: slow, calm music (classical, jazz, lounge) encourages visitors to slow down, linger longer and, as a result, make more impulse purchases.

Influencing tempo: More rhythmic music can speed up the flow of people in fast-food restaurants during rush hours.

Image development: An upscale boutique uses exclusive or avant-garde music to emphasize its status, while a youth-oriented store prefers current hits.

In our work we should say a few words about music industry as a commodity.

Some researchers define music itself as a commodity and its production and distribution as a multi-billion dollar industry [3, p. 7]. However, modern commerce has shifted from album sales to models based on:

Streaming: subscriptions (Spotify, Apple Music, Yandex.Music) have turned music into a service.

Syncing: selling rights to use tracks in advertising, films, TV series and video games have become a major source of income for artists and labels.

Merchandise: concerts and sales of related merchandise (clothing, posters) often generate more revenue than recording sales.

Music can also be successfully used as a mind control tool [4, p. 5]. And no, we are not talking about conspiracy theories about "aliens using sound waves from outer space to enslave humanity". This is a much more mundane approach. On our opinion, music's function is more subtle and profound. It involves influencing the emotions, behavior and worldview of large groups of people.

Music takes its special place in productivity management, creating a particular mood that is why it is widely used in music therapy and even in workplace. The impact

of certain genres on the psyche has been scientifically proven [5, p. 16]. Classical music can reduce stress, while rhythmic music can increase energy. Many companies allow employees to listen to music on headphones to enhance concentration and creativity, while masking distracting background noise.

Music can be considered as a formation of a group identity and mass control as well.

Anthems, military marches and patriotic songs are used to unite the nation, raise morale and serve as propaganda. A striking historical example is the use of mass songs in the USSR to build a communist society [6].

On the other hand, music can be a tool of resistance. For example, songs by Bob Dylan, Viktor Tsoi and Rammstein become anthems for generations, expressing dissent from the existing order.

The last important point of our topic is social programming through content.

Popular music, especially pop and hip-hop, often conveys certain life scenarios: the cult of success, wealth, hedonism, or, conversely, social protest [6, p. 187].

Repeated listening to such tracks shapes the audience's (especially young people's) system of values and behavior patterns.

As you can imagine, a huge amount of money is spent on all of this, but the profits periodically exceed the costs by tens or even hundreds of times and allow for the achievement of certain goals, such as changing the thinking and behavior patterns of a society with the help of songs that promote what is beneficial to their "seller". Music has long ceased to be "just an art" form. In the modern world, it is a high-tech, finely tuned instrument with immense power. This power lies in its ability to directly appeal to human emotions, by passing critical thinking. As a commercial tool, it increases sales and builds brands. As a management tool, it shapes moods, unites communities and channels social energy. Understanding this dual nature of music allows us to go beyond passive consumers of sound and understand the hidden mechanisms that govern our perceptions and behavior in a global world.

In conclusion, we'd like to say that our musical tastes aren't simply a matter of "likes" or "dislikes". They're a complex blend of spirit of times, technological progress and our personal experiences growing up.

Different generations speak different musical languages, but they all tell the same story – a story of self-discovery, love, protest and hope. And this is our shared great symphony. Different musical tastes are a natural consequence of each generation growing up in its own unique world, with its own challenges and its own ways of coping with them. They're a reflection of the world they grew up in, their problems, dreams and technologies.

It's worth developing your taste not only in music, but in culture and arts in general. And it's worth listening to music not just for pleasure or "because it's trendy", but for the sake of spiritual and mental development.

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FAST FASHION: IS IT THE “KILLER” OF YOUR PERSONAL STYLE?

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Abstract. In this article the influence of fast fashion culture on our way to buy clothes and style ourselves is considered. Is it true that personal style doesn’t exist anymore? By analyzing the progress of fashion industry over the past six to seven years we will try to explore the impact of fast fashion on young people’s self-expression.

Keywords: fast fashion, personal style, fashion, individuality, hyper consumption, clothes, ecology.

БЫСТРАЯ МОДА: ЯВЛЯЕТСЯ ЛИ ОНА «УБИЙЦЕЙ» ЛИЧНОГО СТИЛЯ?

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Аннотация. В статье рассматривается влияние культуры быстрой моды на наш способ совершения покупок и стилизацию собственных образов. Автор предлагает определение личного стиля и ставит вопрос о реальности его существования в наши дни. На основании анализа прогресса индустрии моды за последние шесть-семь лет рассматривается, какое влияние оказывает быстрая мода на самовыражение молодежи.

Ключевые слова: быстрая мода, личный стиль, мода, индивидуальность, гиперпотребление, одежда, экология.

How often do you go shopping? And how often do you really need to buy new clothes? Do you find yourself throwing away another piece of clothes because it has more holes than it has, the color pigmentation or because it’s just out of fashion even though you’ve only put it on twice? Do all the suits, shirts, shoes and dresses look the same on the shop windows and do you often see people outside wearing the same clothes? The answers to all the questions above will most likely be yes, and the reason behind it is fast fashion.

Fast fashion is a retail strategy where retailers adopt marketing approaches to respond to the latest fashion trends by frequently updating products with short renewal

cycles and turning the inventory at a rapid rate [1, p. 15]. Here are some examples of companies that use the fast fashion strategy: H&M, Zara, Uniqlo, Shein and some others. The problem of fast fashion has only recently come to light: most of the research was conducted two or three years ago. All of these studies focus on the environmental and economic impacts of fast fashion, but there is almost no research or articles that explore the impact of fast fashion culture on the individuality, style and self-expression of young people.

Personally I have recently come face to face with this problem and I couldn't help but notice its direct connection with hyper consumption. This problem is familiar to almost everyone, and each person in his life has at least once heard the phrase "I have nothing to wear", despite possessing a more than sufficient and quite diverse selection of clothes in his wardrobe. It looks like a paradox, but even though your closet is packed with clothes, you still often catch yourself with this intrusive thought and can't shake the feeling that you don't have enough pieces of clothes? Perhaps, you have become a victim of recently developing problem such as hyperconsumption, which is directly linked to the culture of fast fashion. Nowadays hyper consumption is defined as the process of excessive purchasing and consumption of goods and services, often beyond what is necessary for basic needs [1, p. 16]. It is driven by consumer culture, mass marketing, and the pursuit of status or identity through material possessions. This connection is quite easy to define; it is explained by a fundamental economic law that states an increase in demand stimulates an increase in supply [3, p. 2]. Trends are changing rapidly and the primary goal of any consumer is to keep up with everyone. In turn, global companies set their main objective to produce as many units of goods as possible as quickly as possible, because fashion trends often change within an incredibly short period of time. This is where the problem of hyper consumption originates: when a consumer, without considering whether they truly need the item they are purchasing, without thinking about its reliability and durability and how long it will last, buys an item simply because everyone else has it now, and it aligns with current fashion. Consequently, these things are quickly worn out or are simply forgotten, collecting dust deep within wardrobes and as a result are discarded. This briefly outlines the process leading to the creation of so-called textile dumps, which inflict significant environmental damage.

Nevertheless, our purpose is not to delve into the origins of environmental threats. We also try to analyze the factors that have normalized the culture of fast fashion and the issue of hyper consumption in contemporary society and to understand why individuals do not learn from their actions, discarding kilos of garments and visiting shopping centers for trendy clothing for the third time in a month.

We believe that social media is the main reason for fast fashion culture spreading. Without a doubt, social media is having an impact on the way what and why we buy. A lot of consumers pay attention to what the people they follow are choosing to share. Let's face it, we've all been there: impulsively buying something online or offline just because a popular influencer we follow was raving about it with a smile and a convincing tone. What's important is that in these moments, we sometimes forget that product advertising is always paid for and a purchased item can significantly differ in reality from its social media presentation. Furthermore, people nowadays spend so

much time on their phones that they are constantly exposed to products they often don't need.

So in a nutshell, why shouldn't you fall for the propaganda of popular fast fashion? Firstly: the quality of the clothes. After all, we all want to feel comfortable in the clothes we wear and in the stores of companies that use a fast fashion strategy this is often lacking. Remember how long your last item bought from a mass-market retailer lasted? Most likely, the print on the t-shirt disappeared after just a few washes and the zipper on your pants quickly lost its quality. The culprit is fast fashion. The goal of such companies, as mentioned earlier, is quantity, not quality.

The second point is individuality, or to be specific, its loss. Self-expression has always been characteristic of young people, both in the last century and in this one, before and after the advent of fast fashion culture and I believe this should not change, because having individuality is really cool. Whichever subculture you may belong to, clothes that fit its style will likely be hard to find in mass-market stores, and that's not a bad thing! On the contrary, it means you will pay more attention and find truly high-quality and stylish clothes that suit you specifically and which perhaps no one else around you will have. I believe that developing a personal style is truly a big, complex and time-consuming endeavor, but it's absolutely worth it, especially in today's world where people on the street sometimes look so alike it can even drive you a little crazy. Wouldn't you love to have your own signature scent, accessory or style that your acquaintances would associate specifically with you?

However, unfortunately, not all people perceive individuality and being different from others as something positive. One of the reasons why young people nowadays prefer wearing clothes that allow them to blend in easily with their peers is insecurity, fear of ridicule and judgment [4, p. 3]. Teenagers often have lack self-confidence and extremely low self-conscious, so they try to compensate it with fashionable clothes popular among their peers [4, p. 3]. The author is personally familiar with this problem and with the constant thoughts like: “What if they look at me with disapproval?”, “What if they laugh at me?”. But in moments of self-doubt, I usually tell myself that the condemnation of self-expression and people with individuality has existed for a really long time, exists now, and will continue to exist until people learn not to judge each other for no particular reason and understand that absolutely nothing in their lives will change if they see a person with brightly-colored hair or facial piercings. Moreover, to some extent, it makes me happy that I can evoke emotions in people around me – after all, emotions of any kind remain emotions. Therefore, we believe that a person should express themselves and seek their own style at every opportunity they have.

But where can we actually find beautiful and affordable clothes that won't harm nor the economy neither the environment? In second-hand stores! Fortunately, there is a trend that Generation Z has recently shown a growing interest in shopping at thrift stores rather than fast fashion retailers. Here’s where social media does actually good job: people are sharing store addresses and shopping tips on their social media pages.

In conclusion, it can be said that fast fashion, with its rapid collections and affordability, truly threatens our individuality and personal style. The hyper consumption it generates leads us to perceive clothing as a disposable commodity

rather than a means of self-expression. True personal style is not formed by the speed and quantity of purchases, but by conscious choices and respect for one's own individuality. Therefore, despite the allure of fast fashion, it can become a “killer” of personal style if it devolves into a mere mechanical repetition of trends without one's own creative interpretation. To preserve one's personal style, it is important to approach clothing choices consciously, prioritizing quality and uniqueness over quantity.

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MANAGING MULTI-GENERATIONAL TEAMS: BRIDGING THE GAP BETWEEN GEN Z, MILLENNIALS AND GEN X IN THE WORKPLACE

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Abstract. The article presents an analysis of the characteristics and challenges of creating an effective work environment in multigenerational teams, including representatives of Generations X, Y (millennials), and Z. Based on data from a global Deloitte study (2024) and other sources, the key values, career orientations, and behavioral patterns of each generation are examined. Particular attention is paid to aspects such as the search for meaning in work, financial and environmental agendas, attitudes toward technology (Generative AI), and employee mental health. The study identified key areas of generational conflict and synergy and proposed practical tools for managers, such as reverse mentoring and creating an inclusive culture, aimed at transforming differences into a resource for organizational development.

Keywords: multigenerational team, Generation X, millennials, Generation Z, HR management, corporate culture, motivation, values, feedback, mental health, generative AI, reverse mentoring.

УПРАВЛЕНИЕ МУЛЬТИПОКОЛЕНЧЕСКИМИ КОМАНДАМИ: ПРЕОДОЛЕНИЕ РАЗРЫВА МЕЖДУ ПОКОЛЕНИЯМИ Z, Y И X НА РАБОЧЕМ МЕСТЕ

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Аннотация. В статье представлен анализ особенностей и вызовов формирования эффективной рабочей среды в условиях мультипоколенческого состава команд, включающих представителей поколений X, Y (миллениалов) и Z. На основе данных глобального исследования Deloitte (2024) и других источников рассматриваются ключевые ценности, карьерные ориентации и поведенческие паттерны каждого поколения. Особое внимание уделяется таким аспектам, как поиск смысла в работе, финансовая и экологическая повестка, отношение к технологиям (Generative AI) и ментальное здоровье сотрудников. В результате исследования выявлены основные зоны генерационного конфликта и

синергии, а также предложены практические инструменты для руководителей, такие как reverse mentoring (обратное наставничество) и создание инклюзивной культуры, направленные на превращение различий в ресурс для организационного развития.

Ключевые слова: мультипоколенческая команда, поколение X, миллениалы, поколение Z, управление персоналом, корпоративная культура, мотивация, ценности, обратная связь, ментальное здоровье, генеративный ИИ, reverse mentoring.

The modern workplace is experiencing an unprecedented shift in generational boundaries. Today, a single team may include people born in different eras, raised in different cultural, technological, and economic realities. On the same office floor, you'll find Generation X, millennials (Generation Y), and Generation Z-each with their own perspective on careers, values, communication, and the meaning of work. This multigenerational dynamic opens up opportunities for synergy, but also creates challenges that require leaders to develop not just management skills, but true mastery of building an inclusive culture.

Understanding these differences begins with understanding the context in which each generation was formed. Generation X, born between 1965 and 1980, grew up during a period of relative stability, industrial heyday, and the dawn of the digital revolution. They are often referred to as the “middle generation” – those caught between baby boomers and millennials. Gen X values independence, professionalism, and personal responsibility. They are skeptical of loud corporate slogans, prefer results to words, and strive for autonomy. Recognition, career advancement, and stability are important to them, and communication most often occurs through face-to-face meetings or email-channels that maintain formality and clarity [1].

Millennials, or Generation Y, were born between 1983 and 1994-a time of globalization, widespread internet access, and a series of economic crises. This is the first generation to embrace technology from childhood, yet they also faced intense competition and instability in the labor market. Millennials strive for development, flexibility, and, most importantly, meaning in their work. They expect feedback, recognition, and the opportunity to influence processes. Corporate social responsibility, inclusivity, and opportunities for career advancement are key factors in their satisfaction [2].

Generation Z, born between 1995 and 2005, is the first fully digital generation. They don't just use technology-they live in it. Having grown up with the internet, smartphones, and social media, Gen Z is focused on security-financial, environmental, and mental. They value transparency, quick feedback, and working for the purpose, not status. Unlike millennials, who still believed in long-term company loyalty, Gen Z trusts their beliefs more and is willing to change jobs if their employer's values don't align with their own [3].

When it comes to stress and burnout among younger workers, it's easy to assume the main culprits are excessive workloads or long hours at a computer. However, Deloitte 2024 data paints a different, far more profound picture: the true sources of anxiety for Gen Z and millennials lie not in the amount of work time, but in the quality

of their experience. More than half of these generations report that a lack of recognition of their contributions causes the greatest stress – for 53 % of millennials and 51 % of Gen Z, this becomes a serious emotional barrier. Almost the same number – nearly 50 % – experience anxiety when they feel their opinions aren't listened to, and when decisions directly affecting their work are made without their input. A third, but no less significant, pain is a sense of meaninglessness: 48 % of millennials and 46 % of Gen Z say that work without a clear purpose or visible impact becomes a source of constant discomfort. These numbers aren't just statistics; They reflect a fundamental shift in how young people perceive work. For them, work isn't a neutral space for exchanging time for money, but an ecosystem in which they seek respect, engagement, and meaning. And when even one of these elements is missing, it's not just fatigue that results – it's a sense of disconnect between personal values and the reality of the workplace. This is why traditional approaches to stress management – flexible schedules or bonuses – are increasingly proving ineffective unless they're backed by a genuine culture of recognition, transparency, and engagement.

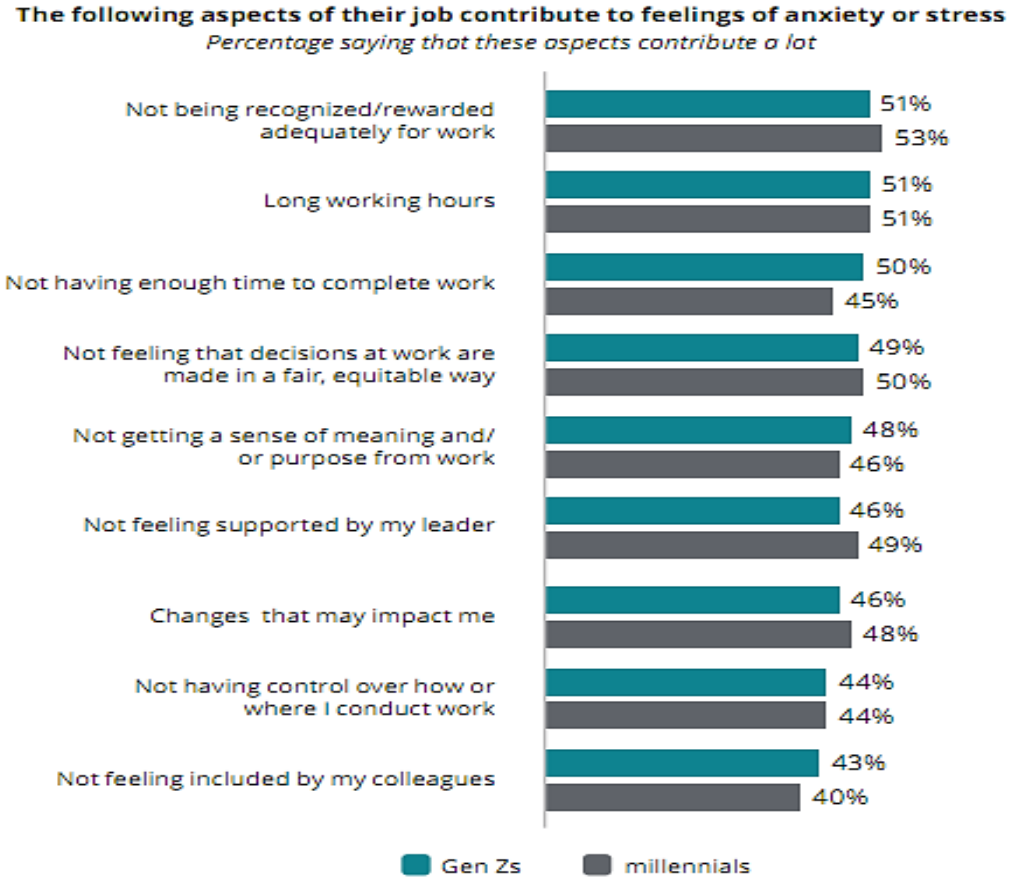


Figure 1. Sources of Anxiety at Work: Gen Z and Millennials' Take on What Makes Work Unbearable

This internal discord directly explains why young employees are increasingly demanding not only flexibility from companies but also ethical clarity – from caring for their mental health to consistent actions in sustainability. For them, there's no separation between “the office” and “the world”: how a company conducts business,

how it treats people and the planet, becomes an integral part of their daily work experience. And if this experience brings anxiety instead of confidence, alienation instead of belonging, then no amount of perks can compensate for the loss of meaning – the main motivating resource for this generation.

Interestingly, despite all their differences, the two young age groups-millennials and Gen Z-share a number of key attitudes. According to a large-scale 2024 Deloitte study, which surveyed more than 22,800 respondents from 44 countries, having meaning in work is critically important for 86 % of Gen Z and 89 % of millennials [4]. Moreover, nearly half of them – 44 % of Gen Z and 40 % of millennials-have already turned down a potential employer due to a value mismatch.

The younger generation doesn't just demand financial compliance – they respond to it with actions like monitoring, exercising, and feeling important. Deloitte 2024 data shows how differences in how companies perceive this impacts employee engagement and satisfaction.

		They have the power to drive change within their organization	They currently have opportunities to learn, develop new skills and/or receive mentoring	Their values and purpose are aligned to their current organization's	They are very satisfied with the pay/financial reward and workplace benefits of their current job	They are very satisfied with the work/life balance in their current job	They strongly agree/agree that their employer takes the mental health of employees seriously
Gen Zs	Employee promoters*	**80%**	**61%**	**57%**	**53%**	**60%**	**77%**
	Total respondent base	61%	35%	31%	29%	37%	54%
millennials	Employee promoters*	**83%**	**64%**	**61%**	**53%**	**62%**	**80%**
	Total respondent base	58%	33%	30%	27%	34%	55%

*Employee promoters are those who are most likely to recommend their company as a place to work

Figure 2. Employee Engagement and Satisfaction Based on Alignment with Company Values (Gen Z and Millennials, Deloitte 2024)

When a company's values align with those of its employees, engagement, loyalty, and even financial satisfaction increase. Ignoring this risks losing talent. The reasons for this choice are varied, ranging from a company's negative environmental footprint to ignoring employee mental health issues or unfair working conditions. These data demonstrate that for young people, work is not just a source of income, but a way to realize their beliefs and impact the world.

Financial instability remains one of the most pressing issues. Despite growing optimism about the economic situation in their countries-shared by 32 % of Gen Z and 31 % of millennials-more than half of both generations live paycheck to paycheck, and one in three admit to feeling financially insecure [5]. This paradox-between hope and anxiety-influences their career decisions, stress levels, and attitudes toward flexibility. This is why work-life balance continues to be a top priority when choosing an employer, even surpassing salary. However, over the past year, many companies have

begun implementing return-to-office policies: 64 % of Gen Z and 66 % of millennials reported that their employer had implemented such measures. The results were mixed: some employees noted improved engagement and communication, while others reported increased stress, decreased productivity, and worsened financial situation due to additional travel and food expenses [1].

The environmental agenda also occupies a central place in the lives of young employees. Six in 10 Gen Z and 59 % of millennials felt anxious about climate change in the past month. Not only are they trying to minimize their environmental impact themselves-over 70 % are taking some kind of action-but they are also actively pressuring their employers. Almost half of survey respondents said they work with colleagues to demand that their company take action on climate change. Two in 10 have already changed jobs or industries due to environmental concerns, and another quarter plan to do so in the future. When choosing a new job, 72 % of Gen Z and 71 % of millennials consider.

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Редактор и корректор А. А. Чернышева
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