Министерство науки и высшего образования Российской Федерации
Федеральное государственное бюджетное образовательное учреждение высшего образования
НОВОСИБИРСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

ЭКОНОМИКА, МЕНЕДЖМЕНТ И ТЕХНОЛОГИИ В ЦИФРОВУЮ ЭПОХУ

ВЫЗОВЫ, РЕШЕНИЯ И ПЕРСПЕКТИВЫ

МАТЕРИАЛЫ
Всероссийской научно-практической конференции
с международным участием

Новосибирск, Россия, 16–21 марта 2026 г.

ECONOMICS, MANAGEMENT AND TECHNOLOGIES IN THE DIGITAL ERA

CHALLENGES, SOLUTIONS AND FUTURE OUTLOOK

PROCEEDINGS VOLUME
of the International Research-to-Practice Conference

Novosibirsk, Russia, March 16–21, 2026

НОВОСИБИРСК
2026

ББК 65с51я431+74.480.46(2Рос-4Нос)+81.432.1л0-7
Э40

Составители: *В. Л. Каракчиева, Е. Г. Логинова*

Сборник подготовлен на кафедре иностранных языков технических факультетов Новосибирского государственного технического университета

Э40 **Экономика, менеджмент и технологии в цифровую эпоху: вызовы, решения и перспективы. Economics, Management and Technologies in the Digital Era: Challenges, Solutions and Future Outlook**: материалы Всероссийской научно-практической конференции с международным участием / сост. В. Л. Каракчиева, Е. Г. Логинова. – Новосибирск: Издво НГТУ, 2026. – 540 с.

ISBN 978-5-7782-5666-8

Сборник содержит материалы Международной научно-практической конференции «Экономика, управление и технологии в цифровую эпоху: вызовы, решения и перспективы» (Новосибирск, 16–21 марта 2026 г.), представленные на английском языке. Работы посвящены актуальным вопросам цифровой трансформации, искусственного интеллекта, автоматизации, бизнес-аналитики, управления, маркетинга, логистики, цифровых активов, экономической безопасности, пищевых технологий, общественного здоровья и образования.

Статьи напечатаны в авторской редакции.

ББК 65с51я431+74.480.46(2Рос-4Нос)+81.432.1л0-7

ISBN 978-5-7782-5666-8

© Коллектив авторов, 2026
© Новосибирский государственный технический университет, 2026

CONTENTS

Preface....10

AUTOMATION OF BUSINESS PROCESSES AND BUSINESS ANALYTICS IN THE ERA OF AI AND DATA ECONOMY....11

T. V. Adalinskaya. Financial sandbox as a decision-making automation tool in AI-oriented services....11

G. G. Afanasov. Evaluation of the economic impact of implementing an AI agent for commercial proposal generation in mice tourism....15

M. V. Akishin. Russian automation systems: efficiency, implementation, development....20

N. A. Amirbekova. AI-driven digital transformation of occupational safety management in Kazakhstan....25

A. A. Bobrova. Evaluating the effectiveness of virtual project teams....29

M. Byzova, *N. Demchenko*, *A. Kuzmina*. Reasons for employees' resistance to automating corporate processes and ways to motivate them....32

K. A. Chepurnova. Digital art in the era of neural networks: main directions and the problem of recognition....37

A.E. Egorkin, *I.A. Kozlov*. The dynamics of data complexity in socio-economic research....40

K. A. Ershova. Patterns in multi-attributive transactions using data mining techniques....44

S. A. Karpievich. Corporate rag system for banking regulatory compliance with strict source citation....47

L. I. Kerman. Analytical data support for spatial mass appraisal of housing....50

A. K. Kholostova. Architecture of a service for predicting the risk of developing dementia-type cognitive impairment....55

R. V. Klyosova, *A. S. Serova.* Analysis of factors affecting audio quality in videoconferencing systems....60

S.-N. Kosareva. Low-code and AI in 1C: accelerating digital business transformation....64

A. I. Kradinov, *S. E. Generozov.* Neural networks in software development....68

A. A. Kuznetsov. Analysis of architectural solutions using the example of geographic information systems....72

T. A. Lorinets, S. D. Sviridova. Readiness of the organization's employees to implement an artificial intelligence system....76

A. D. Martynov, V. V. Pechenkin. Digitalization and automation of educational processes in robotics on the example of start-up "steel dream"....81

D. D. Olisko. Designing end-to-end processes for managing company tasks....84

A. S. Serova. Automation in comparison of standard classifiers for construction works types to enable intelligent forecasting of quality control procedures....89

A. A. Surkova, G. E. Yakhyaeva. Intelligent assistant for analysing the pre-owned market for mobile devices....94

A. R. Tsukanova. A comprehensive approach to forecasting banking supervision indicators....98

I. S. Vidergold., Y. V. Orlova, E. E. Plyusnina. Citizens' perceptions of usability and trust in automated e-government services....102

A. V. Vilyan. The digital twin model of the tasks management system....106

I. M. Zakharov. Automation of technical support services using Telegram-bot and 1C....110

Zhang Xinlei. Transformation and application of artificial intelligence technology in data analysis of industrial automation systems....114

BUSINESS AND GOVERNMENT IN THE CONTEXT OF DIGITAL TRANSFORMATION....121

A. A. Alekseeva. Strategies for scientific organizations to enter global markets....121

A. T. Assylbekova. Methods for evaluating the implementation of artificial intelligence in government agencies in the context of project management: modeling and scenario forecasting....127

V. E. Bednenko, A. V. Novikov. Market size assessment for the digital service development startup....132

N. V. Degoyan, N. A. Semakina. Multifunctional centers as a form of providing public and municipal services in the context of digital transformation....136

Yelzhan Duisebay. Optimizing administrative decision-making in AI-enabled e-government: a readiness framework and international lessons....140

A. S. Goleshev. Real options and business digitalization: the relationship of concepts....146

Y. E. Goncharov. Additional share issuance as a tool for financial recovery: a case study of segezha group 150

A. A. Grigorev. Government incentives and business strategies for digitalizing oil supply chains for export 155

K. B. Kopylov. Digital logistics and export of mineral fertilizers to Africa: the role of the state and the experience of PhosAgro 158

D. A. Kostenko. Digital directions for enhancing the efficiency of a professional sports club 162

D. I. Kratkaya, I. G. Rzun. Comparative analysis of the maturity of AI transformation in the branches of the economy 167

A. V. Laktionov. Valuation methods for international telecommunications companies in the context of digital transformation 176

O. A. Makhammadjonov. Factors enhancing the international competitiveness of automotive industry organizations 180

A. V. Morgunov. Peculiarities of Russian nitrogen fertilizer exports in the context of changing global economic relations 184

Y. M. Morozova. Analysis of resource usage at the enterprise of JSC Kuzbass fuel company 189

K. N. Nausharipova. Blockchain as a tool for enhancing trust in public administration 193

Abdul Quadir Basirat Oluwatosin. Coordination mechanisms in diaspora-oriented agri-food supply chains: an entrepreneurial perspective 198

I. Yu. Platonova. Analysis of the effectiveness of an investment project: theoretical aspects and practical calculation using the example of Karachinsky Source LLC 201

D. Yu. Ponomarev, R. S. Bisultanov. Grant support in the system of innovation development institutions 204

A. V. Rafalskij, K. D. Vinnikov, N. A. Shcherbakova. Identification of factors influencing the price level of agricultural producers in the Siberian federal district 206

A. P. Rudneva. Classification of control costs in export operations 210

A. R. Sadykova, M. A. Tenenev. New business models in retail trade for business digitalization 214

V. D. Savinova, A. S. Serova. Analysis of video conferencing architectures for the implementation of synthetic video content detection modules 218

M. Shreteh, A. E. Efremova. Digital governance and economic security: bridging information gaps in conflict-affected economies (the Syrian case study) 223

V. V. Shumskaya. Effective implementation of warehouse management systems as a factor of business profitability growth 229

V. V. Sichkarev. Lean manufacturing tools for modern business in the context of digital transformation 234

A. A. Vershinskaya. Directions of digital transformation as a factor in improving the efficiency of Russian railways....238

S. A. Vozhdaeva. Innovative project's foreign trade potential....243

V.K. Zaplatinskaya, A.V. Nosanova. The impact of the introduction of a fast payment system on reducing the costs of trade organizations 248

BUSINESS ADMINISTRATION AND ENTREPRENEURSHIP 251

Y. A. Akhmadulina. Methodology for comprehensive diagnostics of the personnel adaptation system in the industrial sector: a qualitative-quantitative approach....251

D. D. Chebotar. Analysis of strengths and weaknesses of the innovation potential of the Novosibirsk Region....255

E. M. Chernova. Debtor segmentation based on payment behavior 259

I. V. Guzhentsev. Economic aspects and management approaches to the implementation of temperature-controlled cargo transportation systems 264

D. Imambekova. Risks and limitations of implementing low-code technologies in the economic sector 268

M. Kabdygaliyeva. Project management for building data-driven simulation platforms....274

M. B. Kazantsev. Modern methods of personnel management in the banking sector 280

A. R. Kharisova. Application of BI systems and AI analytics in supporting strategic decisions of a gold mining company....289

A. S. Khruchsheva. University dormitory management: current issues and challenges....294

N. V. Kulichkov, Ya. Yu. Anufrieva. Exhibition promotion management: the experience of «Russian House. Creative Regions 2025»....298

V. A. Petrenko. Public-private partnership as a driver of commercial potential in regional sports: a case study of Novosibirsk oblast....301

A. B. Petrov. Combining lean manufacturing and digitalization in SMEs: challenges and success factors....305

I. A. Samoilov. Barriers and drivers of AI adoption in Russian companies: a Jobs-to-be-Done approach....310

E. B. Shernyukova, B. A. Shakhmanova. Enhancing business processes through internal communications 317

A. V. Sogreshilin. Application of filling line automation systems in food production: security and economic aspects 323

T. V. Sokolova. Standardization in the hospitality inndustry: managerial challenges and solutions....329

V. Y. Solovov. The role of artificial intelligence and data analytics in enhancing the efficiency of a high-tech enterprise's communication strategy 334

S. E. Sprynga. Placement of a laundry business: a logistics and marketing perspective 340

P. I. Topornina. Balancing roster strategies: business models and operational efficiency in Russian volleyball clubs....345

APPLYING INFORMATION AND ANALYTICS TO BUSINESS PROCESS, FINANCE, AND ECONOMIC SECURITY....351

R. T. Abutalipova. AI-driven ESG integration for risk-adjusted financial project management in the digital economy 351

A. E. Efremova, I. Boboshozoda. Strategic design management in digital economies: business models, intellectual property, and educational imperatives for the AI era 357

A. L. Gieeva, E. A. Prikhodko. Analysis of business processes for financing the "green" transition in single-industry towns as a tool for identifying threats to economic security and money laundering schemes 365

A.V. Gordt. Assessment of the business risks of WHOOSH Holding PJSC as a factor of going concern 371

K. I. Ikonnikov, O. V. Usacheva. The concept of financial condition in the context of analysis and forecasting....375

A. V. *Kushnarenko.* System of early warning indicators on hybrid threats to the national economy of the Russian federation: selection methodology and main principles.....380

A. S. Lemak. Digital transformation regarding state regulation of organizations activities in the customs services field....386

A. A. Lyubarskii. Using a domain semantic graph to identify activities and cost drivers in ABC costing: application to aquaculture....390

E. A. Mashinistova. Addressing fraud in Russia and abroad 394

A. A. Melentyev, I. V. Baranova. Diagnosing corporate bankruptcy: methodological foundations 398

S. K. Mkrtchyan. Investigating the relationship between non-financial performance metrics and financial outcomes 404

M. A. Nazarov. Co-financing in participatory budgeting 408

E. V. Nedelkova, M. A. Vlasenko. Analysis of financial results as a tool for ensuring the economic security of an enterprise 412

V. A. Nezbudey. Specific factors affecting the performance of companies in the oil industry 416

A. A. Radich. Assessment of the level of economic security of a manufacturing enterprise 421

A. A. Radchenko, N. V. Fribus. Internal audit of the energy company's fixed assets: risk assessment based on the integration of accounting and technical data 425

V. V. Shumskaya. The impact of last-mile delivery innovations on repeat sales growth 430

A. S. Tomenko, E. A. Prikhodko. Comparative analysis of regional competitiveness and economic security indicators (a case study of Novosibirsk and Nizhny Novgorod regions) 434

L. A. Ternopolskaia. Capital: an overview of approaches to defining the concept 439

A. S. Zhaksylyk. Application of PRINCE2 in financial IT risk monitoring projects: a comparative and conceptual analysis 442

EFFECTIVE APPROACHES TO USING LOGISTICS AND MARKETING TOOLS FOR BUSINESS DEVELOPMENT 449

M. A. Bakanova, V. A. Nazarkina. Promotion of a tourist product in the internet enviroment 449

K. A. Ershova, L. I. Tolstobrova. Automation of customer interaction and booking management in catering establishments using telegram bots 455

S. A. Fedoseeva, V. A. Nazarkina. Analysis of marketing activities of companies: web analytics tools 459

Yu. Yu. Kapitsky. Implementation and design of an automated packaging and labeling line in the food industry. Productivity and reliability 466

L. I. Kerman. Algorithmic procedure for mass appraisal of residential real estate 472

Yu. P. Komarov. Competitive analysis of mobile games using the BCG matrix 477

M. M. Shakenova. Analysis of advanced research and prospective project management solutions for Kazakhstan's event industry: challenges and opportunities of digital transformation 483

D. E. Shilingovsky, M. E. Tsoy. Targeted advertising in social networks as an element of omnichannel marketing communications in the Russian automotive market 488

A. E. Sypchenko. Gigachat-powered AI agent development: key issues and hidden challenges.....492

KEY CHALLENGES IN THE DIGITAL TRANSFORMATION OF EDUCATION.....497

A. V. Adarchenko. Metaverses as an emerging space for immersive educational practices.....497

Ganzorig Gandavaa, E. N. Gvozdeva. Digital tutor in foreign language education for future railway transport engineers.....502

L.S. Dragunova, E.V. Dragunova. Digitalization and transformation of educational structures: technological potential, pedagogical limitations, and medical and biological aspects.....508

E. G. Kobeleva, A. A. Borisova. Sustainability of work capacity of older employees of educational organizations as a factor of sectoral stability under digitalization and labor shortage.....512

P. V. Molchanov. Architecture and methods of a recommendation service for university applicants which meets the requirements of the GosTech platform.....516

S. O. Pepelyaeva, E. V. Khomenko. Analysis of stakeholders of Novosibirsk State Technical University in the context of sustainable development.....521

Y. V. Pushkina, O. V. Railian. Structural changes and price segmentation in Moscow primary education market.....525

E. Z. Sidorova. Analysis of threats to the criminological security of the digital educational environment at the present stage 530

A. P. Stupnikova-Dolbnya, D. I. Stupnikov-Dolbnya. Integration of the memory module into an application for the development of human cognitive processes 536

PREFACE

The International Research-to-Practice Conference "Economics, Management and Technologies in the Digital Era: Challenges, Solutions and Future Outlook" (Novosibirsk, Russia, March 16–21, 2026) brought together young researchers to address the profound transformations driven by digitalization, artificial intelligence, and the data economy.

The conference was initiated and organized by the **Faculty of Business of Novosibirsk State Technical University**. The **Foreign Languages Department for Engineering Programs** provided organization and language facilitation, for which we express our sincere appreciation for their valuable collaboration.

This e-volume contains all papers admitted after meeting the conference requirements. The contributions explore the following key areas:

– Automation of business processes and business analytics in the era of AI and the data economy

– Business and government in the context of digital transformation

– Business administration and entrepreneurship

– Applying information and analytics to business processes, finance, and economic security

– Effective approaches to using logistics and marketing tools for business development

– Key challenges in the digital transformation of education

Together, these papers offer both theoretical insights and practical solutions to the challenges of the digital era. We hope this volume will serve as a valuable resource for scholars and professionals seeking to navigate the ongoing technological and economic shifts.

The Editors

AUTOMATION OF BUSINESS PROCESSES AND BUSINESS ANALYTICS IN THE ERA OF AI AND DATA ECONOMY

FINANCIAL SANDBOX AS A DECISION-MAKING AUTOMATION TOOL IN AI-ORIENTED SERVICES

T. V. Adalinskaya

Research advisor: E. V. Dragunova, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
teya.adalinskaya@yandex.ru

Abstract. The article examines the gap between theoretical financial literacy training and practical personal finance management skills. Based on a survey of 160 respondents, a high degree of user uncertainty was revealed. The concept of a personalized financial sandbox based on AI is proposed, which makes it possible to model financial decisions without real losses.

Keywords: financial literacy; financial behavior; goal setting; budget control; financial sandbox; artificial intelligence; personalization of financial decisions.

ФИНАНСОВАЯ ПЕСОЧНИЦА КАК ИНСТРУМЕНТ АВТОМАТИЗАЦИИ ПРИНЯТИЯ РЕШЕНИЙ В СЕРВИСАХ, ОРИЕНТИРОВАННЫХ НА ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ

Т. В. Адалинская

Аннотация. В статье рассматривается проблема разрыва между теоретическим обучением финансовой грамотности и практическими навыками управления личными финансами. На основе опроса 160 респондентов выявлена высокая степень неуверенности пользователей. Предлагается концепция персонализированной финансовой песочницы на базе ИИ, позволяющей моделировать финансовые решения без реальных потерь.

Ключевые слова: финансовая грамотность; финансовое поведение; целеполагание; контроль бюджета; финансовая песочница; искусственный интеллект; персонализация финансовых решений.

There is an opinion that the basis of financial literacy is the combination of two concepts – goal setting and control. Financial literacy is defined as a combination of awareness, knowledge, skills, attitudes, and behaviors necessary to make informed financial decisions and maintain financial well-being [1]. Goal setting presupposes that the user has a specific and clearly formulated financial goal, to which an accumulation strategy is subsequently applied. And control takes on the importance of accounting for all expenses for a certain period of time, followed by their analysis. We observe compliance with the principle of control in all banking applications, and it is worth noting that control takes on different forms and depths of study: from the classic list of transactions per month to gradation by category and month. The principle of goal setting is less common and is formulated in the form of "I want to save so much money in such a period" [2]. This is how the uncertainty in the user's financial activity manifests itself. However, we find in every application training on how to properly manage a budget and how to invest properly. A person who does not see an incentive for budgeting and investing begins to painstakingly study all kinds of financial literacy courses. He studies, but he doesn't take anything out. The problem is that he gets a lot of theory, but he doesn't understand at all how it can work in practice. This problem was highlighted in my survey of 160 respondents, in which 79.1% of participants showed a trend in uncertainty about how to manage finances, and their main problem is the lack of sufficient practical experience in investing and rational budget management.

And although there are already representatives on the market (BCS World of Investments) who have implemented a tool such as a financial sandbox, where there is a correlation between the theoretical foundations and the testing of acquired skills in practice, however, this functionality is not enough. It is not enough to tell the user based on historical data what decision to make in a particular situation affecting a financial instrument. It is necessary to personalize this experience for a specific user, which implies how the user could act in his particular situation, with his portfolio and in comparison, with the strategy proposed by artificial intelligence. This approach will increase the level of trust in artificial intelligence prompts, because it will allow you to visually assess the actions of AI in dynamics: "if I had made a decision under the influence of AI, it would have been like this, if I hadn't made it, everything would have happened differently." Also, this technology will allow a person to learn from their instruments to invest without financial losses and at the same time consolidate in practice exactly what they are most interested in [3].

Another important note about financial sandboxes: there is a lack of simulation regarding budget control. We are taught to invest, but it is not possible to invest without the ability to find stability and order in finances. It is important to teach a

person in practice to be aware of their actions and their consequences, as well as to help them learn their type of financial behavior and how it affects their well-being [4].

In 2022, a study was conducted on the results of the implementation of the Strategy for Improving Financial Literacy in the Russian Federation, which showed that thanks to the actions of the Bank of Russia and the Ministry of Finance of the Russian Federation, it was possible to achieve significant success in improving financial literacy of the population. However, there is still a problem with the formation of "sustainable models of financial behavior," namely, building long-term plans and building savings. [5] The solution to this problem can be an AI assistant that allows you to analyze the current economic situation, the user's goals and risk profile, as well as able to offer a personalized savings strategy and help monitor its implementation.

The user's task when accessing the financial sandbox for the first time is to provide input data about himself: what goals he pursues when forming savings – whether it will be a "financial cushion" or deferred funds for some purchase; how much he is risk tolerant – based on this information, the AI assistant will be able to select financial instruments; and also the amount, planning horizon, etc. After the user sends the data, the AI assistant analyzes the profile and forms a savings accumulation strategy based on these parameters. Since legislation regulates the issuance of investment recommendations, the proposed AI plan should not fall under this concept. Also, the AI assistant does not make a decision for a person, but automates the preparation of a decision through data. The user should see the causal relationships, why the AI offers this particular tool. To do this, scenario modeling has been implemented based on historical data, for example, such "stress scenarios" as the COVID-19 pandemic, the imposition of sanctions against Russia, the financial crisis, etc. with the possibility of analyzing and comparing scenarios. This makes it possible to achieve such requirements for AI as transparency, verifiability, cognitive load reduction, and ethics [6]. At the same time, the financial sandbox takes into account an important pattern – the quality of the goal-setting model for the user. At the moment, the user compares their financial solutions with those offered by artificial intelligence through the difference between the achieved financial results – independent and the proposed LLM.

At the moment, I have implemented this functionality in the form of an HTML-based MVP. The user visits the page, selects a financial goal from the suggested ones (for example, "buying a car"), the trained artificial intelligence model offers him a strategy to achieve this goal: open this deposit, purchase a fund, buy bonds, and so on. The user has a choice whether to follow this strategy or not. If he decides to follow it and strictly follows all the recommendations of the system, then he does not need

to test the work of AI through the financial sandbox, while a user who does not trust AI can make two choices: fix his decision to ignore AI and follow the future dynamics of how this affected his future situation, or use another function is to track by his decisions how his financial situation might have changed if he had clearly followed the recommendations of AI and what kind of situation he has now (without these recommendations). Additionally, the financial sandbox functionality is under development, which will provide user training on budget control. The essence of this innovation lies in the fact that a person will be able to live non-standard life situations through the choice of budget management actions in the form of a dialogue with the system. As a conclusion, the system will demonstrate the irrational choice of the user and explain what it is related to and how it can be avoided.

REFERENCES

1. Popova E. M. (2021) Finansovaya gramotnost' v epokhu tsifrovizatsii: novye vozmozhnosti i vyzovy. In: Finansovaya gramotnost' v epokhu tsifrovizatsii. Monograph. URL: https://cyberleninka.ru/article/n/finansovaya-gramotnost-v-epohu-tsifrovizatsii-novye-vozmozhnosti-i-vyzovy (accessed 10.12.2025).

2. Boiko S. V. (2023) Finansovaya gramotnost' i dostupnost' tsifrovykh finansovykh uslug: bar'ery i puti resheniya. CyberLeninka. URL: https://cyberleninka.ru/article/n/finansovaya-gramotnost-i-dostupnost-tsifrovyh-finansovyh-uslug-bariery-i-puti-resheniya (accessed 10.12.2025).

3. Sodnomova N. B. (2024) Vliyanie iskusstvennogo intellekta na finansovuyu sferu. CyberLeninka. URL: https://cyberleninka.ru/article/n/vliyanie-iskusstvennogo-intellekta-na-finansovuyu-sferu (accessed 10.12.2025).

4. Volodin V. V. (2025) Iskusstvennyi intellekt kak sredstvo formirovaniya finansovoi gramotnosti u mladshikh shkol'nikov. CyberLeninka. URL: https://cyberleninka.ru/article/n/iskusstvennyy-intellekt-kak-sredstvo-formirovaniya-finansovoy-gramotnosti-u-mladshih-shkolnikov (accessed 12.12.2025).

5. Ministry of Finance (2025) Doklad o realizatsii Strategii povysheniya finansovoi gramotnosti i formirovaniya finansovoi kul'tury do 2030 goda (po itogam 2024 goda). Moscow: Ministry of Finance. URL: https://minfin.gov.ru/ru/fingram?id_57=312691-doklad_o_realizatsii_strategii_povysheniya_finansovoi_gramotnosti_i_formirovaniya_finansovoi_kultury_do_2030_goda_po_itogam_2024_goda (accessed 15.12.2025).

6. Akuffo G. (2026) The role of artificial intelligence in enhancing financial literacy, decision-making and growth. World Journal of Advanced Research and Reviews, 29(1). URL: https://journalwjarr.com/sites/default/files/fulltext_pdf/WJARR-2026-0161.pdf (accessed 15.12.2025).

EVALUATION OF THE ECONOMIC IMPACT OF IMPLEMENTING AN AI AGENT FOR COMMERCIAL PROPOSAL GENERATION IN MICE TOURISM

G. G. Afanasov

Research advisor: Yu. S. Ezrokh, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
afanasovgerakl@gmail.com

Abstract. This study evaluates the economic impact of implementing an AI agent for commercial proposal generation in MICE tourism using the AltaiTravel case study. The research compares preparation time before and after AI implementation, calculating time savings, ROI, and productivity gains. Results show proposal preparation time decreased from 8-10 hours to 30-60 minutes (90-95% reduction), with ROI of 197% and payback period under 12 months.

Keywords: MICE tourism, AI agent, knowledge base, commercial proposal generation, time efficiency, ROI, productivity, automation.

ОЦЕНКА ЭКОНОМИЧЕСКОГО ЭФФЕКТА ВНЕДРЕНИЯ ИИ-АГЕНТА ДЛЯ ГЕНЕРАЦИИ КОММЕРЧЕСКИХ ПРЕДЛОЖЕНИЙ В MICE-ТУРИЗМЕ

Г. Г. Афанасов

Аннотация. В работе оценивается экономический эффект внедрения ИИ-агента для генерации коммерческих предложений в MICE-туризме на примере компании AltaiTravel. Проведено сравнение времени подготовки КП до и после внедрения ИИ, рассчитаны экономия времени, ROI и прирост производительности. Результаты показывают сокращение времени подготовки с 8-10 часов до 30-60 минут (90-95 %), ROI 197 % и срок окупаемости менее 12 месяцев.

Ключевые слова: MICE-туризм, ИИ-агент, база знаний, генерация коммерческих предложений, экономия времени, ROI, производительность, автоматизация.

Introduction

MICE tourism (business travel for meetings, conferences, incentives, and exhibitions) represents a high-value segment of the tourism industry characterized by complex, customized service requirements [8]. In this competitive market, the speed and quality of commercial proposal (CP) preparation directly impact business success. Traditional manual processes involve significant time investments, with managers spending hours gathering information from disparate sources [10].

Recent advances in artificial intelligence and large language models (LLMs) have created opportunities for automating routine business processes [1]. AI-powered tools can analyze requirements, retrieve relevant information, and generate structured documents with minimal human intervention. This study examines the economic implications of implementing an AI agent for commercial proposal generation at AltaiTravel, a regional MICE tour operator.

The research objectives are to: (1) quantify time savings achieved through AI automation, (2) calculate return on investment metrics, (3) assess productivity improvements, and (4) evaluate the overall economic feasibility of the solution.

Problem Statement and Case Study

Analysis of AltaiTravel's business processes revealed that the primary operational bottleneck was the manual preparation of commercial proposals. Project managers reported spending 8-10 hours on each complex proposal, involving:

- Manual data collection from multiple sources (Google Sheets price lists, Google Docs descriptions, PDF files)
- Individual customization for each client's specific requirements
- Calculation of costs, margins, and final pricing
- Formatting and preparation of presentation documents

This manual approach resulted in several negative consequences: slow response times to client inquiries, risk of calculation errors, inconsistent proposal quality, and staff burnout from repetitive tasks [9]. The agency's capacity was limited to approximately 4-5 complex proposals per manager per week. As shown in Figure 1, the manual workflow involves multiple sequential steps, while the AI-assisted approach significantly streamlines the process.

AI Agent Architecture and Implementation

The implemented solution consists of three integrated components working together to automate the proposal generation process (Figure 2).

Telegram Bot Interface serves as the primary user interaction point. Managers input structured briefs containing essential parameters: client name, dates, number of participants, budget range, activity preferences, accommodation requirements, and special requests. The bot validates inputs and initiates the generation process [4].

Knowledge Base System stores all company information in a centralized, structured format. The system includes: activity descriptions with pricing, hotel and accommodation options, transportation logistics, supplier contacts, and document templates. Data is maintained in Google Workspace (Sheets, Docs, Drive) with version control and regular updates [6].

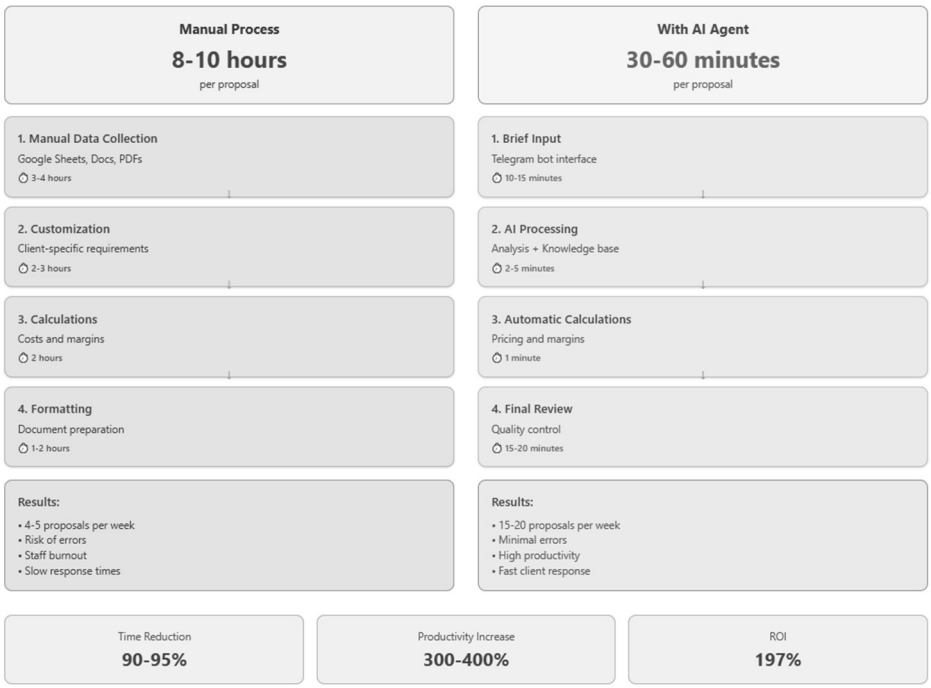


Figure 1. Comparison of manual and AI-assisted proposal generation workflows (source: the author)

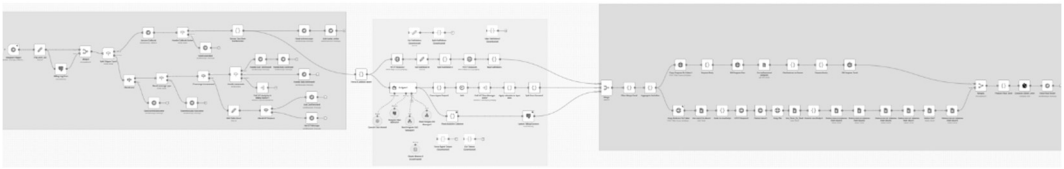


Figure 2. AI agent system architecture based on n8n (source: n8n.io, adapted by the author)

AI Processing Engine orchestrates the workflow using advanced language models. The engine analyzes client requirements, queries the knowledge base for relevant information, calculates costs and margins using embedded formulas, generates draft program documents, and creates client-ready proposals. The entire process completes in 2-5 minutes [7].

Economic Analysis and Results

The economic evaluation focused on quantifiable metrics: time savings, productivity gains, cost reductions, and return on investment. Data was collected through time-tracking analysis and comparative assessment of manual versus automated processes.

Time Efficiency Analysis

Table 1 – A comparison of key time metrics before and after AI implementation

Metric	Manual Process	With AI Agent
Proposal preparation time	8-10 hours	30-60 minutes
Proposals per manager per week	4-5	15-20
Time reduction	-	90-95%
Productivity increase	-	300-400%

The results demonstrate a 90-95% reduction in proposal preparation time. A task that previously required a full workday (8-10 hours) now completes in 30-60 minutes. This dramatic improvement enables managers to handle significantly higher volumes.

ROI Calculation

Table 2 – Return on investment analysis based on actual implementation costs and measured benefits

Metric	Value
Time saved per proposal	~8.25 hours
Annual proposals (estimated)	100
Total annual hours saved	825 hours
Equivalent labor cost saved ($18/hr)	$14,850
Implementation & maintenance cost	$5,000
Net annual benefit	$9,850
ROI	197%

The ROI is calculated using the standard formula: ROI = (Benefits - Costs) / Costs x 100%. With net benefits of $9,850 and implementation costs of $5,000, the ROI reaches 197%, indicating strong economic viability. Even with conservative estimates, the payback period is less than 12 months [2].

Additional qualitative benefits include: reduced error rates in calculations, standardized proposal quality, faster client response times, improved staff satisfaction, and enhanced competitive positioning.

Conclusion

The case study of AltaiTravel demonstrates that implementing an AI agent for commercial proposal generation delivers substantial economic benefits in MICE tourism operations. The quantitative analysis confirms:

- Time savings of 90-95 % per proposal, reducing preparation from 8-10 hours to 30-60 minutes
- Productivity increases of 300-400 %, enabling managers to handle 15-20 proposals per week instead of 4-5
- ROI of 197 % with a payback period under 12 months
- Annual cost savings of approximately $9,850 per manager

Beyond direct economic benefits, the solution provides strategic advantages: improved response times enhance competitive positioning, standardized outputs ensure consistent quality, and reduced routine workload improves staff satisfaction and retention [5].

The findings support the broader applicability of AI automation in knowledge-intensive service industries. Organizations facing similar challenges with manual document preparation and data compilation can expect comparable returns when implementing well-designed AI solutions integrated with structured knowledge bases [3].

REFERENCES

1. Artificial Intelligence in Tourism 2024 [Electronic resource] // Aiwa Solution – 2024. – URL: https://aiwasolution.ru/articles/iskusstvennyy-intellekt-v-turizme-2024/ (accessed: 18.02.2026).

2. MICE Tourism: Basic Concepts and Principles [Electronic resource] // CyberLeninka – 2024. – URL: https://cyberleninka.ru/article/n/mice-turizm-osnovnye-ponyatiya-i-ego-printsipy (accessed: 18.02.2026).

3. Revolutionize MICE & SMERF Proposals with AI Video Solutions [Electronic resource] // Hippo Video – 2024. – URL: https://www.hippovideo.io/industries/ai-video-solutions-hospitality-industry.html (accessed: 18.02.2026).

4. How Generative AI Can Revolutionize the MICE Business [Electronic resource] // LinkedIn - 2024, August. - URL: https://www.linkedin.com/pulse/how-generative-ai-can-revolutionize-mice-business-new-frontier-xkxoc (accessed: 18.02.2026).

5. Remapping travel with agentic AI [Electronic resource] // McKinsey - 2025, September. – URL: https://www.mckinsey.com/industries/travel/our-insights/remapping-travel-with-agentic-ai (accessed: 18.02.2026).

6. Launching proposals 2.0 and AI [Electronic resource] // MICE Operations – 2024. – URL: https://www.miceoperations.com/launching-proposals-and-ai (accessed: 18.02.2026).

7. MICE 5.0: Future of Neurotechnologies and AI in Business Tourism [Electronic resource] // Russpass Business – 2024. – URL: https://business.russpass.ru/mice-50-budushee-nejrotehnologij-i-iskusstvennogo-intellekta-v-industrii-delovogo-turizma (accessed: 18.02.2026).

8. AI Knowledge Base: What It Is and Why It's Crucial to AI Agents [Electronic resource] // Sendbird – 2025, September. – URL: https://sendbird.com/blog/ai-knowledge-base (accessed: 18.02.2026).

9. How AI is Impacting the MICE Industry [Electronic resource] // URAHL – 2025, October. – URL: https://urahl.com/how-ai-is-impacting-the-mice-industry (accessed: 18.02.2026).

10. AI Meets Mice: Transforming Event Planning for the Better [Electronic resource] // Vajra Events – 2024, December. – URL: https://vajraevents.com/ai-meets-mice-transforming-event-planning-for-the-better/ (accessed: 18.02.2026).

RUSSIAN AUTOMATION SYSTEMS: EFFICIENCY, IMPLEMENTATION, DEVELOPMENT

M. V. Akishin

Novosibirsk, *Novosibirsk State Technical University*
maksim.akishin.04@mail.ru

Abstract. The aim of this article is to evaluate the efficiency of Russian automation systems in the context of active import substitution and the digitalization of the economy. The article examines the results of implementing these systems in industrial and business sectors, as well as their impact on cost reduction, performance improvement, and management transparency. It also identifies key trends in market development and the practical effects of implementing domestic technologies.

Key words: automation systems, business process automation, import substitution, enterprise digitalization, technological independence, artificial intelligence, industrial automation, Russian market.

РОССИЙСКИЕ СИСТЕМЫ АВТОМАТИЗАЦИИ: ЭФФЕКТИВНОСТЬ, ВНЕДРЕНИЕ, РАЗВИТИЕ

М. В. Акишин

Аннотация. Работа посвящена оценке эффективности российских систем автоматизации в условиях активного импортозамещения и цифровизации экономики. Рассмотрены результаты внедрения решений в промышленности и бизнесе, их влияние на снижение издержек, повышение производительности

и прозрачности управления. Отражены ключевые тенденции развития рынка и практические эффекты применения отечественных технологий.

Ключевые слова: системы автоматизации, автоматизация бизнес-процессов, импортозамещение, цифровизация предприятий, технологический суверенитет, искусственный интеллект, промышленная автоматизация, российский рынок.

Automation of industrial and business processes has become a key element of the national strategy in the context of global transformation and the priority of technological independence of the Russian Federation. After Western vendors left the Russian market, domestic systems gained opportunities for rapid development. Government support and import substitution programs contribute to the successful development of Russian businesses. The research object is the Russian market of automation systems. The aim of the article is to evaluate the efficiency of implementing Russian automation systems and to analyze their development prospects. The relevance of the subject is determined by the rapid development of Russian IT systems. Research methods include the analytical method, comparative analysis, content analysis, a systems approach, as well as generalization and interpretation.

A study conducted by the audit company "Delovoy Profil" confirms the high development potential of the Russian market and identifies key trends and development paths up to 2031 [2]. Growth in the market share of domestic systems is expected in the industrial, financial, and energy sectors, reaching up to 45% by 2031. Artificial intelligence technologies, analytical tools, and robotic process automation are being actively implemented at enterprises. Digitalization particularly affects industrial, logistics, and public administration sectors. The average annual growth rate of the Russian automation systems market (9.3%) exceeds that of the American market (less than 6%) and the global average (around 6%), but remains below that of the Chinese market (approximately 11%). General trends include the development of cybersecurity, the implementation of artificial intelligence and IoT technologies, increased investment in energy-efficient technologies, personnel training, UX/UI improvement, and international cooperation with friendly countries. Below are the projected development scenarios of the Russian automation systems market. Neutral scenario: CAGR of 8.2%, with a market volume of approximately 20 billion US dollars. Features: moderate growth, localization in industry and the energy sector, and an increasing share of AI and IoT technologies. Optimistic scenario: CAGR of up to 10%, with a market volume of up to 23 billion US dollars. Features: successful development of domestic ERP, CRM, cybersecurity, and artificial intelligence technologies, as well as active implementation of hybrid technological solutions. Pessimistic scenario: CAGR of around 6%, with a market volume of up to 18 billion

US dollars. Features: slowed import substitution due to technical difficulties and a shortage of specialists, as well as continued dependence on foreign technologies.

Let us examine the market participants in more detail. 1C implemented the "1C:ERP Enterprise Management" system at the construction company TAMAK [1]. The implementation covered the entire production chain, including sales, procurement, and manufacturing business processes. As a result, operating costs decreased by 10%, and inventory levels were reduced by 15%. According to the "Technoprom 2025" forum [3], Russian developers have achieved significant results in improving business process efficiency through the introduction of digital technologies. Examples of successful cases include: BFT-Holding (Budget and Financial Technologies JSC) is a Russian vendor and developer of software products. The company has completed more than 7,000 projects and participates in 20 federal projects. It operates in 83 regions and serves more than 100 million users. The company develops MDM, BI, SRM, EAM, and LCNC solutions. Its corporate clients include Rostelecom, EL5-Energo, Sheshmaoil, and Osnova. Federal customers include the Social Fund, Rosreestr, Rostrud, Ministry of Digital Development of Russia, Ministry of Health of Russia, and Rosstat. An example of SRM system implementation for a manufacturing company resulted in faster procurement processing, fewer errors, and improved efficiency and transparency. Performance indicators include 22,000 requests per second, 650,000 processes per day, 3.2 million concurrent processes, 12,000 users, dozens of terabytes of data, and petabytes stored in S3. Transset is a Russian developer of software for business process management, including ERM, BSS/OSS, MES, and ITSM systems. Its clients include GKU TsODD, Transneft, and Russian Railways, among others. A project implemented for Russian Railways led to a 4.5-fold reduction in equipment failures, a 30% increase in productivity, a threefold improvement in response time to malfunctions, an infrastructure availability ratio of 0.99998, a 50% reduction in data collection costs, and improved managerial decision-making. Infosoft is a Russian developer of IT solutions for enterprise management, including ERP, CRM, and low-code/no-code platforms based on 1C. Its clients include Rotor JSC, MNTK Eye Microsurgery, Irkutsk Oil Company, and others. Implementation of its solutions resulted in a 19% reduction in inventories; a 15% decrease in production and material costs; an 8% reduction in product cost; shorter equipment downtime and a 22% increase in labor productivity; a 17% decrease in production defects; a 23% reduction in labor intensity across departments; improved inventory turnover and a 25% increase in output; a reduction in accounts receivable, operating, and administrative expenses by 16%; a 54% acceleration in order processing; a 21% reduction in order fulfillment time; and a 14% increase in profit. The company also implements new technologies such as IIoT, machine learning, AR/VR, Digital Twin, and artificial intelligence. The IT company KT. Team,

in its research, not only highlights improvements in companies' operational performance but also outlines the challenges and stages of implementing automation systems [4], [5]. The implementation of RPA (robotic process automation) technologies reduces task labor intensity by up to 80% and saves up to 30% of expenses. Software robots perform routine tasks 5–10 times faster than humans. BPM platforms such as ELMA and Comindware reduce process execution time by 30–60%. The implementation of CRM systems and notification systems improves customer service. In Pyaterochka, HR automation by Skillaz reduced recruitment time by 40%, increased lead-to-deal conversion by 30%, and lowered candidate acquisition costs by 38%. The implementation of ERP systems enhances management transparency, reduces errors by up to 80% through automation, accelerates budget planning fourfold, reduces inventory levels by 10–15%, and improves other operational indicators. The return on investment (ROI) of such technologies depends on system complexity: simple technologies pay back within 3–6 months, medium-sized projects within 6–12 months, and comprehensive automation within 12–24 months. Key implementation challenges include high costs, resistance to change, shortage of qualified specialists, insufficient documentation, dependence on data quality, risks related to return on investment, and technological obsolescence.

Table 1 – Steps for Implementing Automation Systems

No.	Stage	Description
1	Comprehensive business process analysis	A detailed examination of current business processes in order to identify priority areas for automation and determine baseline performance indicators
2	Selection of an appropriate automation system	Standard system. Lower cost and simplified implementation, but difficulties in adapting to the specific needs of the organization
		Custom system. Maximally adapted to the company's needs and easily scalable, but more difficult to implement due to higher cost and longer development time
3	Pilot project implementation	It is recommended to conduct initial testing of the system on a limited number of business processes in order to confirm its effectiveness
4	Employee training	Training enhances employees' competencies for effective system use and improves their professional qualifications
5	System scaling	After successful completion of the pilot project and confirmation of its effectiveness, the system is implemented across the entire enterprise

Thus, the Russian automation market is indeed competitive and capable of replacing foreign products. Domestic solutions are effective and improve management quality, transparency, and business sustainability. They demonstrate fast payback periods and high scalability. Future prospects are associated with the development of intelligent technologies, digital management ecosystems, and infrastructure expansion, making these solutions economically efficient and strategically beneficial.

REFERENCES

1. 1C Consulting (2025). Proizvodstvennaya kompaniya “TAMAK” pereshla na sovremennuyu ERP-sistemu [Production company “TAMAK” switched to a modern ERP system]. Available at: https://consulting.1c.ru/cases/217530.html (accessed 12 February 2026) (in Russian).

2. Delprof Analytics (2025). Rynok avtomatizirovannykh sistem upravleniya (ASU) v Rossii: analiz i prognoz do 2031 goda [The market of automated control systems (ACS) in Russia: analysis and forecast until 2031]. Available at: https://delprof.ru/press-center/open-analytics/rynok-avtomatizirovannykh-sistem-upravleniya-asu-v-rossii-analiz-i-prognoz-do-2031-goda/ (accessed 12 February 2026) (in Russian).

3. Forum 2025 (2025). Programma foruma “Tsifrovizatsiya i nauka: vyzovy i perspektivy” [Program of the forum “Digitalization and Science: Challenges and Prospects”]. Available at: https://forum2025.arppsoft.ru/programma/ (accessed 12 February 2026) (in Russian).

4. KT.Team (2025). Chto takoe avtomatizirovannye sistemy upravleniya: vidy, primery, preimushchestva i vnedrenie v rossiyskikh kompaniyakh [What are automated control systems: types, examples, advantages and implementation in Russian companies]. Available at: https://www.kt-team.ru/blog/automation-systems-overview-russia (accessed 12 February 2026) (in Russian).

5. KT.Team (2025). ERP-otchetnost’ dlya strategicheskogo upravleniya: otchety ERP, finansy, prodazhi, proizvodstvo, BI i drayvery rosta v Rossii [ERP reporting for strategic management: ERP reports, finance, sales, production, BI and growth drivers in Russia]. Available at: https://www.kt-team.ru/blog/erp-reporting-strategic-management-russia (accessed 12 February 2026) (in Russian).

AI-DRIVEN DIGITAL TRANSFORMATION OF OCCUPATIONAL SAFETY MANAGEMENT IN KAZAKHSTAN

N. A. Amirbekova

Research advisor: T.H. Raskaliev, PhD (Economics)

Astana IT University, Astana, Kazakhstan,
dlyarabotiucheby@gmail.com

Abstract. Occupational safety in Kazakhstan shows a persistent deterioration: workplace injuries rose from 2,033 (2020) to 2,670 (2023), and occupational disease cases nearly tripled over the same period. This paper examines how AI-driven digital transformation through machine learning, computer vision, and IoT analytics can address these systemic failures. A mixed-methods approach combining official national statistics, systematic literature review, and enterprise case analysis is applied. Findings indicate that properly implemented AI safety systems reduce incident rates by 20-40%, and a phased national integration strategy aligned with the National Occupational Safety Concept 2024-2030 is proposed.

Keywords: artificial intelligence, occupational safety, digital transformation, Kazakhstan, predictive analytics, machine learning, workplace injuries, Industry 4.0.

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ СИСТЕМЫ УПРАВЛЕНИЯ ОХРАНОЙ ТРУДА В КАЗАХСТАНЕ НА ОСНОВЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

Н. А. Амирбекова

Аннотация. Охрана труда в Казахстане демонстрирует тревожную динамику: число несчастных случаев выросло с 2 033 (2020) до 2 670 (2023), а профессиональные заболевания утроились. В статье исследуется потенциал цифровой трансформации на основе ИИ, машинного обучения, компьютерного зрения и IoT-аналитики. Результаты показывают снижение травматизма на 20-40% при надлежащем внедрении. Предлагается поэтапная стратегия интеграции ИИ в рамках Концепции безопасного труда 2024-2030.

Ключевые слова: искусственный интеллект, охрана труда, цифровая трансформация, Казахстан, предиктивная аналитика, машинное обучение, производственный травматизм, Индустрия 4.0.

Introduction

Workplace safety remains a critical challenge in Kazakhstan. Injury cases grew from 2,033 (2020) to 2,670 (2023) a 31.3% rise before declining to 2,471 in 2024. Occupational diseases nearly tripled: from 237 (2020) to 662 (2023) [1]. Kazakhstan's frequency coefficient of 0.20 per 1,000 workers is roughly 2.5 times higher than Germany (0.07) or South Korea (0.09) [2]. The National Occupational Safety Concept 2024-2030 mandates a risk-oriented, digital approach [3], yet enterprise-level AI integration remains nascent. This paper analyzes how AI-driven transformation can close Kazakhstan's safety management gap.

The application of AI to occupational safety has accelerated globally. Nath, Behzadan and Paal [4] demonstrated that convolutional neural networks (CNNs) achieve over 90% accuracy in real-time PPE compliance detection from CCTV footage. Luo et al. [5] showed deep learning models predict coal mine gas explosion risk 48 hours in advance with 84% precision. Kim et al. [6] combined wearable IoT sensors with LSTM networks to detect worker fatigue, reducing false alarms by 73% versus threshold-based approaches. Sarkar et al. [7] applied transformer-based NLP to OSHA incident logs, extracting systemic causal patterns otherwise invisible to manual review. For post-Soviet industrial contexts, Zubarev and Smirnov [8] identify institutional inertia, legacy infrastructure, and workforce resistance as dominant barriers conditions directly relevant to Kazakhstan.

Methodology

This study uses a mixed-methods design. Quantitative analysis draws on official data from the Committee on Labor, Social Protection and Migration (2020–2024) and the Bureau of National Statistics. A systematic literature review following PRISMA guidelines covered Web of Science, Scopus, and IEEE Xplore (2020–2025); 42 studies were included from an initial 214 records. Case analysis examined AI deployments at ArcelorMittal Temirtau and KazMunayGas (Kazakhstan), POSCO (South Korea), and Thyssenkrupp (Germany). A five-dimension technology readiness matrix (technical maturity, implementation cost, scalability, safety impact, regulatory alignment) was applied to rank AI technologies for prioritization.

Table 1 reveals two concurrent negative trends: cumulative injury growth of 21.5% and a 123.2% increase in occupational diseases over five years. Mining and metallurgy account for 38% of fatal accidents, followed by construction (24%) and agriculture (15%) the primary target sectors for AI intervention.

Table 1 – Occupational injury and disease dynamics in Kazakhstan (2020–2024)

Year	Injuries	Change	Occupational Diseases	Change	Frequency Coeff.
2020	2,033	–	237	–	0.23
2021	2,133	+4.9%	351	+48.1%	0.22
2022	2,449	+14.8%	657	+87.2%	0.22
2023	2,670	+9.0%	662	+0.8%	0.21
2024	2,471	−7.5%	529	−20.1%	0.20

Source: Committee on Labor, Social Protection and Migration, 2024 [1].

Table 2 – AI technology assessment matrix for occupational safety

AI Technology	Maturity	Cost (inv.)	Scalability	Safety Impact	Reg. Fit	Total /25
Predictive Analytics (ML)	4	4	5	4	4	21
NLP - Incident Analysis	4	5	5	3	4	21
Computer Vision / PPE	4	3	4	5	4	20
IoT + Wearable AI	3	3	4	4	3	17
AI-VR Safety Training	3	3	3	4	4	17
Digital Twin Systems	2	2	3	5	3	15

Note: 1=very low, 5=very high; cost score is inverted (5=lowest cost). Source: authors.

Predictive analytics and NLP rank highest (21/25 each), reflecting high maturity and scalability. Computer vision ranks second (20/25) with the highest direct safety impact. Digital twins show the greatest theoretical impact but face cost and readiness barriers in Kazakhstan's current context. Case evidence confirms these findings: ArcelorMittal Temirtau's computer vision pilot (2022) reduced PPE violations by 27% within 12 months; KazMunayGas's AI-based gas detection at Tengiz cut near-miss incidents by 31% [3]. Internationally, POSCO (South Korea) achieved a 35% reduction in lost-time injuries over three years, and Thyssenkrupp (Germany) reduced equipment failure-related injuries by 42% [2].

The persistent growth of workplace incidents through 2023 confirms that compliance-based reactive approaches are structurally insufficient. AI enables a shift to continuous, real-time, predictive safety management [9]. Technologies with the highest near-term potential predictive analytics and computer vision are also the

most accessible, requiring no frontier AI capabilities [10]. Three barriers must be addressed: (1) data infrastructure: most enterprises have not digitized safety records, limiting AI training data; (2) human capital: insufficient AI safety specialists in Kazakhstan; (3) regulatory ambiguity: no standards yet govern AI-generated risk assessments. A phased strategy is proposed: Phase 1 (2025-2026) – digitize records, pilot AI in 5-10 high-risk enterprises; Phase 2 (2027-2028) – scale pilots, develop certification standards, invest in upskilling; Phase 3 (2029–2030) – national AI safety integration and cross-sector data sharing under a unified industrial safety data hub.

Conclusion

This study demonstrates that Kazakhstan's occupational safety system faces a persistent structural challenge that traditional regulatory and compliance-based approaches have been unable to resolve. The data show a 21.5% cumulative increase in workplace injuries and a 123.2% increase in occupational diseases between 2020 and 2024, with frequency coefficients approximately 2.5 times higher than benchmark economies.

AI-driven digital transformation offers a proven pathway to addressing these challenges. Technologies including machine learning-based predictive analytics, computer vision for real-time hazard detection, IoT-integrated health monitoring, and NLP-powered incident analysis have demonstrated incident reduction rates of 20-40% in comparable industrial contexts internationally. Early Kazakhstani case evidence from ArcelorMittal Temirtau and KazMunayGas supports these findings in the local context.

The National Occupational Safety Concept 2024–2030 provides a strategic foundation, but must be supplemented with specific AI integration provisions and funding mechanisms.

Future research should focus on longitudinal evaluation of AI safety system impacts in Kazakhstan's specific industrial contexts, development of localized models trained on national incident data, and assessment of the socioeconomic return on investment of AI safety infrastructure.

REFERENCES

1. Committee on Labor, Social Protection and Migration of the Republic of Kazakhstan. Annual Report on Occupational Safety and Labor Conditions 2020–2024. Nur-Sultan, 2024. URL: https://www.enbek.gov.kz

2. International Labour Organization. World Employment and Social Outlook 2023: The Value of Essential Work. Geneva: ILO, 2023. 218 p. https://doi.org/10.54394/OQVF7543

3. Government of the Republic of Kazakhstan. National Occupational Safety Concept for 2024–2030. Resolution No. 1126, 28 December 2023. Astana, 2023. https://adilet.zan.kz/rus/docs/P2300001182/info

4. Nath N.D., Behzadan A.H., Paal S.G. Deep learning for site safety: real-time detection of personal protective equipment. Automation in Construction. 2020, vol. 112, article 103085. https://doi.org/10.1016/j.autcon.2020.103085

5. Luo X., Li H., Cao D., et al. Towards efficient and objective work sampling: recognizing workers' activities in site surveillance videos with two-stream convolutional networks. Automation in Construction. 2018, vol. 94, pp. 360–370. https://doi.org/10.1016/ j.autcon. 2018.07.011

6. Tehrani A., Yadollahzadeh-Tabari M., Zehtab-Salmasi A., & Enayatifar R. (2024). Wearable sensor-based human activity recognition system employing Bi-LSTM algorithm. *The Computer Journal*, 67(3), 961-975. https://doi.org/10.1093/comjnl/bxad035

7. Sarkar S., Raj R., Vinay S., Maiti J., Pratihar D.K. An optimization-based decision tree approach for predicting slip-trip-fall accidents at work. *Safety Science*. 2019, vol. 118, pp. 57–69. https://doi.org/10.1016/j.ssci.2019.05.009

8. Timofeeva S. S. (2024). Tsifrovizatsiya i iskusstvennyy intellekt v okhrane truda [Digitalization and artificial intelligence in occupational safety]. XXI vek. *Tekhnosfernaya bezopasnost*, 9(3), 280–295. https://doi.org/10.21285/2500-1582-2024-9-3-280-295 (in Russian).

9. Li X., Yi W., Chi H.-L., Wang X., Chan A.P.C. A critical review of virtual and augmented reality (VR/AR) applications in construction safety. *Automation in Construction*. 2018, vol. 86, pp. 150–162. https://doi.org/10.1016/j.autcon.2017.11.003

10. Fang W., Zhong B., Zhao N., Love P.E.D., Luo H., Xue J. A deep learning-based approach for mitigating falls from height with computer vision. *Advanced Engineering Informatics*. 2020, vol. 39, pp. 170–177. https://doi.org/10.1016/j.aei.2018.12.005

EVALUATING THE EFFECTIVENESS OF VIRTUAL PROJECT TEAMS

A. A. Bobrova

Research advisor: E. V. Dragunova, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
annabobrova05@yandex.ru

Abstract. The article discusses a modern approach to evaluating the effectiveness of virtual project teams. Such teams represent a form of work organization in which participants interact remotely using digital communication channels. It is proposed to expand the KPI system by including metrics that take into account the process of interaction between participants, their engagement, digital maturity, and the quality of collaboration.

Keywords: virtual team, project team, remote work, digital transformation, project management, performance metrics.

ОЦЕНКА ЭФФЕКТИВНОСТИ ВИРТУАЛЬНЫХ ПРОЕКТНЫХ КОМАНД

А. А. Боброва

Аннотация. В статье рассматривается современный подход к оценке эффективности виртуальных проектных команд. Такие команды представляют собой форму организации работы, при которой участники взаимодействуют удаленно, используя цифровые каналы связи. Предлагается расширение системы KPI за счет включения метрик, учитывающих процесс взаимодействия участников, их вовлеченность, цифровую зрелость и качество совместной работы.

Ключевые слова: виртуальная команда, проектная команда, удаленная работа, цифровая трансформация, управление проектами, метрики эффективности.

The current stage of economic development is characterized by the active introduction of digital technologies and the spread of remote forms of employment. Project activities are increasingly carried out in the format of virtual teams, whose members interact using digital communication tools [1].

Traditional key performance indicators in project management are primarily focused on evaluating the final result. These include, for example, meeting deadlines, staying within budget, and achieving goals. However, in a virtual work environment, such indicators are not enough. Therefore, there is a need to develop approaches to evaluating effectiveness that consider the specifics of virtual work.

In the context of remote interaction, the importance of such factors as the speed and quality of communication, coordination of actions, involvement of participants, and the level of their digital competence increases. Communication errors can lead to delays in completing tasks, duplication of work, and a decrease in the overall effectiveness of the team. In this regard, there is a need to move to a more comprehensive assessment system that takes into account not only the result, but also the work process, including a set of technological, organizational, and behavioral parameters [2].

In modern conditions, the evaluation of project team effectiveness is carried out using digital platforms that provide automatic data collection and analysis. Table 1 presents examples of such tools used in Russian practice.

Table 2 presents the metrics for evaluating virtual project teams. The list of key metrics for evaluating virtual project teams may vary depending on the specifics of the project, the level of digital maturity of the organization, and the tools used [3].

Thus, the development of virtual teams requires the formation of new approaches to evaluating effectiveness, based on the analysis of digital behavior of participants and the use of modern management technologies.

Table 1 – Example of digital tools

Type of tool	Examples
Project Management Corporate Systems	Bitrix24, Yandex.Tracker, Pyrus
Communication and Collaboration	VK Teams, Yandex.Telemost, Kontur
Online Boards	MyBoards, sBoard, Holst
Specialized Design Software	VR Concept

Table 2 – Metrics for Evaluating Virtual Project Teams

Metrics	How measured	Methods
Team Digital Maturity	Evaluation of tool usage, frequency of use, mastering of functions	Analysis of activity in corporate systems, internal surveys
Quality of Digital Interaction	Average response time, communication intensity, proportion of completed discussions	Analysis of messenger logs and corporate platforms, monitoring of communication activity
Coordination of Actions	Proportion of tasks completed without revisions, number of changes after approval	Project management systems, task history analysis
Online Engagement (Participation Level)	Activity in the digital environment, participation in meetings, regular interaction; share of active participants in team meetings and discussions	Activity statistics, online surveys, eNPS indicators
Individual Contribution to the Project	Volume and quality of completed tasks, meeting deadlines	Task trackers, verification systems, task reports
Virtual Team Productivity (Task Completion Speed)	Number of tasks completed during a period, average task completion time	Agile metrics, project systems analytics
Predictability of Performance	Ratio of planned and actual deadlines for task completion	Plan-fact analysis, Scrum metrics
Quality of Collaborative Work	Number of errors, task returns, rework	Quality control systems, bug trackers, code review
Participant Satisfaction	Level of satisfaction with working conditions, communication, and workload	Surveys, eNPS, inter-view

The proposed system of metrics takes into account not only the final results of project activities, but also the specifics of the interaction process in the digital environment. The practical significance of the approach lies in the possibility of its application in corporate information systems.

REFERENCES

1. Borodin G. V. (2025) Osobennosti upravleniya udalennymi IT-komandami v usloviyah cif-rovoj transformatcii [Peculiarities of managing distributed IT teams amid digital transformation]. *Ekonomika, predprinimatelstvo i pravo* [Journal of Economics, Entrepreneurship and Law], № 4. URL: https://cyberleninka.ru/article/n/osobennosti-upravleniya-udalennymi-it-komandami-v-usloviyah-tsifrovoy-transformatsii (accessed 26.02.2026).

2. Kuzovkin D. A. (2025) Podhody k otcenke i povysheniyu effektivnosti komand razrabotchikov v proektah tsifrovoy transfromatsii promyshlennosti [Approaches to evaluating and improving the effectiveness of developer teams in industrial digital transformation projects]. *Teoriya i praktika sovremennoj nauki* [Theory and practice of modern science], №11 (125). URL: https://cyberleninka.ru/article/n/podhody-k-otsenke-i-povysheniyu-effektivnosti-komand-razrabotchikov-v-proektah-tsifrovoy-transformatsii-promyshlennosti (accessed 26.02.2026).

3. Bobunov A. Y., Grepan V. N., Sheinman V., Goncharov V. I. (2025). Metriki proizvoditelnosti raspredelennyh IT-komand: adaptaciya tradicionnyh pokazatelej dlya gibridnoj i udalennoj raboty [Performance metrics for distributed IT teams: adapting traditional metrics for hybrid and remote work]. *International Journal of Open Information Technologies*, № 2. URL: https:// cyberleninka.ru/article/n/metriki-proizvoditelnosti-raspredelennyh-it-komand-adaptatsiya-traditsionnyh-pokazateley-dlya-gibridnoy-i-udalennoy-raboty (accessed 26.02.2026).

REASONS FOR EMPLOYEES' RESISTANCE TO AUTOMATING CORPORATE PROCESSES AND WAYS TO MOTIVATE THEM

M. Byzova, N. Demchenko, A. Kuzmina

Research advisor: E. V. Dragunova, Cand. Sc. (Econ.)

Novosibirsk State Technical University, *Novosibirsk*,
m_byzovaa@mail.ru

Abstract. The article examines the issue of employee resistance to the automation of corporate processes at Russian enterprises and identifies the key causes of this phenomenon associated with the human factor. Based on the results of a conducted survey, practical recommendations are proposed to minimize resistance and ensure the successful implementation of digital solutions.

Keywords: employee resistance, automation, digital transformation, employee motivation, human factor, professional training, organizational behavior.

ПРИЧИНЫ СОПРОТИВЛЕНИЯ СОТРУДНИКОВ АВТОМАТИЗАЦИИ КОРПОРАТИВНЫХ ПРОЦЕССОВ И СПОСОБЫ ИХ МОТИВАЦИИ

М. Бызова, Н. Демченко, А. Кузьмина

Аннотация. В статье исследуется проблема сопротивления сотрудников автоматизации корпоративных процессов на российских предприятиях и определяются основные причины данного явления, обусловленные человеческим фактором. На основе результатов проведенного анкетирования предлагаются практические рекомендации по минимизации сопротивления и успешному внедрению цифровых решений.

Ключевые слова: сопротивление сотрудников, автоматизация, цифровая трансформация, мотивация сотрудников, человеческий фактор, профессиональное обучение, организационное поведение.

In the modern business environment, digitalization and automation have become important drivers of organizational development. According to the annual HR-Meter survey, 61% of companies identify automation and robotics as key trends. Research conducted by the Moscow School of Management Skolkovo shows that the implementation of analytical tools for decision-making accelerates management processes and improves their quality. International studies also indicate that companies that rely on objective data tend to demonstrate higher profitability than those that rely primarily on intuition [1].

However, in Russia, the digital transformation of small and medium-sized enterprises faces a significant barrier related to the human factor. Empirical data suggest that the main challenges are not technological, but organizational and behavioral. For example, 53% of companies report a lack of necessary competencies among employees, and 45% indicate resistance to organizational change [2, 3].

To better understand this issue, a pilot survey was conducted among employees of Russian companies from different sectors. The results made it possible to identify several common reasons for resistance to new technologies. One of the main factors is professional insecurity: employees may fear that they lack the skills required to use new tools effectively. This concern can negatively affect their confidence and professional identity. In addition, the automation of routine tasks is sometimes perceived as a potential threat to job stability, as employees may associate technological change with possible staff reductions.

Another important factor is the disruption of established work processes. Even if a new system is objectively more efficient, it requires retraining and changes in habitual work practices, which can lead to dissatisfaction and stress [2, 4].

Understanding these factors is essential for developing effective management strategies. Instead of relying on formal pressure, organizations should focus on employee engagement and support. Investment in training programs can reduce insecurity by providing employees with the necessary knowledge and opportunities to practice before the official implementation of new systems. It is also advisable to prepare middle managers to act as mentors during the transition period [2].

Equal access to training for employees in different regions and branches is particularly important. If training opportunities are concentrated only in central offices, this may increase resistance in other locations. Therefore, organizations should combine online and in-person formats to ensure broader access to professional development [4].

Finally, it is important to promote a shared digital culture within the organization. Informational seminars, discussions of industry trends, and the presentation of successful implementation cases can help employees better understand the purpose and benefits of digital transformation. When employees recognize the broader goals of change, their level of acceptance may increase [3].

In this context, overcoming resistance should be viewed not as a single action, but as a continuous process of working with human capital. Digital transformation is more likely to be successful when organizations pay equal attention to technological implementation and employee development.

To identify the main reasons for employee resistance to digitalization, a preliminary survey was conducted among employees of Russian companies operating in various sectors. For a comprehensive analysis of the factors influencing resistance, charts and diagrams were prepared based on the survey data and combined into a single dashboard for clearer presentation.

The survey involved employees from different industries and age groups. The majority of respondents were under 25 years old (46,67%) and between 26 and 35 years old (17,14%), while the smallest group consisted of employees over 55 years old (4,76%) (Figure 1).

The graph illustrates respondents' attitudes toward the automation of tasks and business processes, depending on their industry and company size, shows that employees in the food service sector demonstrated the highest level of openness to change (4,8). High levels were also observed in the government (4,7) and finance and banking sectors (4,6). This may be explained by the large number of routine tasks in these sectors, which employees would prefer to automate in order to reduce errors and increase work efficiency.

The analysis by company size revealed an inverse relationship. The highest level of readiness for automation was recorded in small organizations (4,6), where

processes are generally more flexible and decisions are made more quickly. In medium-sized and large companies, the level of employee enthusiasm decreases (4,4), which may be associated with natural resistance to large-scale changes. The lowest indicator was observed in micro-business (4,1), possibly due to limited resources for implementation and training.

The analysis of motivational factors shows that for employees under 25 and those aged 26–35, the most significant incentive is structured training and technical support (19% and 17%), as well as bonuses and raises (18% and 17%). For the group of employees from 36 to 45 years old, such factors as bonuses and raises (24%) and job protection and corporate-funded upskilling (20%) can be distinguished. For employees aged 46–55, a job protection and corporate-funded upskilling (30%) is particularly important, along with structured training and technical support and personal benefits (18%). In the group over 55 years old, almost all factors are equally important, but the main one is additional bonuses (33%). Therefore, the approach to motivation should be comprehensive and consider the expectations of different age groups.

The analysis of the main causes of resistance to automation identified three key concerns common to all age groups. The dominant factor is fear of the usability concerns of the implemented systems (from 14% to 32% of respondents), which is especially pronounced among older employees due to lower confidence in their digital competencies. The second most significant concern is lack of implementation support (13-21%), indicating weaknesses in change management practices. The third factor is fear of losing job (11-23%), reflecting employees' anxiety about their professional relevance. In addition, negative prior experience (4-14%) has an impact, especially among the older generation.

Automation success depends on managing the human factor, not just technology: job security, training, and personal communication [4].

Implementation requires a planned sequence addressing both technical and human aspects. First, define problems and select an appropriate system, then identify departments to begin implementation. For organization-wide automation, a gradual process allows timely response to difficulties [3, 4].

Alongside technical planning, address organizational and behavioral aspects. Managers should discuss adaptation plans, identify resistance causes, and develop motivation and training programs. Focus groups of innovation-positive employees can support colleagues during transition [2, 3].

Develop a structured system with clear stages and deadlines, avoiding one-time measures. Provide detailed instructions to reduce uncertainty and minimize errors [4].

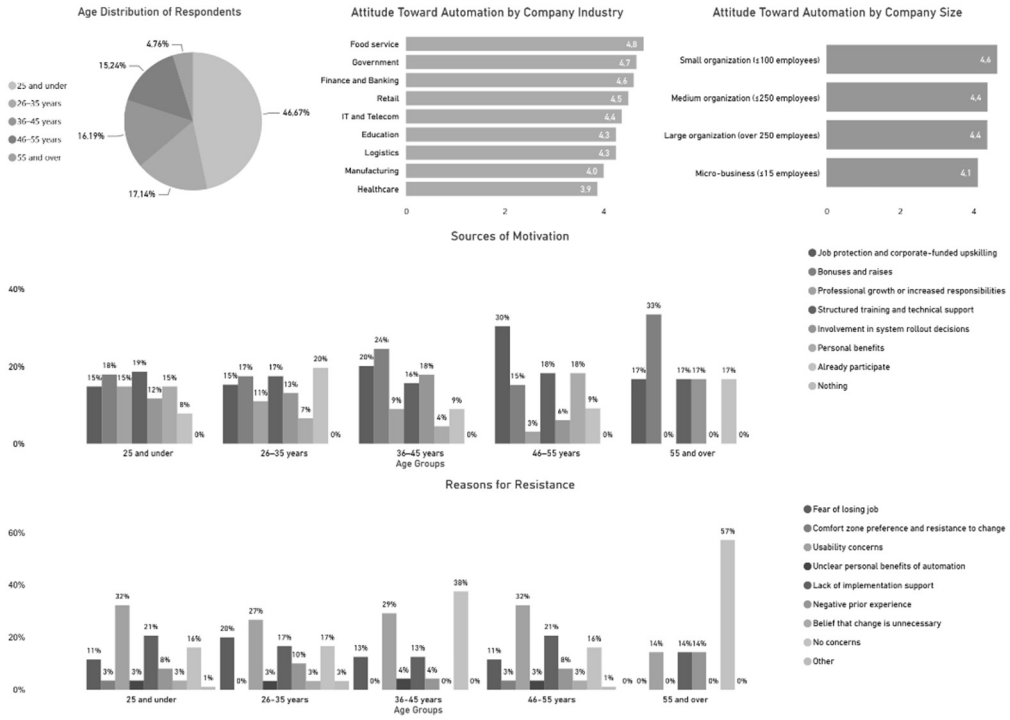


Figure 1. Employee attitudes toward automation

Source: authors.

Continuously collect and analyze employee feedback throughout implementation to adjust decisions and improve strategy. This comprehensive approach increases automation success and reduces resistance [3, 4].

REFERENCES

1. Bugasova Ekaterina Vladislavovna, Shichkin Igor Alekseevich Sovremennyye tendentsii tsifrovizatsii protsessov upravleniya personalom [Modern trends in digitalization of personnel management processes] (in Russian)// Journal of Monetary Economics and Management. 2024. № 8. URL: https://cyberleninka.ru/article/n/sovremennye-tendentsii-tsifrovizatsii-protsessov-upravleniya-personalom (date of access: 24.02.2026).

2. Chunhua Xiao The Reason and Coping Measures of Employees' Resistance to Information System / Chunhua Xiao [Электронный ресурс] // Scientific Research : [сайт]. — URL: https://www.scirp.org/journal/paperinformation?paperid=75032 (date of access: 26.02.2026).

3. Alena Valtonen, Mira Holopainen Mitigating employee resistance and achieving well-being in digital transformation / Alena Valtonen, Mira Holopainen [Электронный ресурс] //

ScienceDirect : [сайт]. — URL: https://www.sciencedirect.com/org/science/article/pii/S0959384524000022#app1 (date of access: 26.02.2026).

4. Senjuti Goswami Managing employee change resistance to Business Process Improvement (BPI) in the manufacturing sectors in Singapore / Senjuti Goswami [Электронный ресурс] // ResearchGate : [сайт]. — URL: https://www.researchgate.net/publication/346993667_Managing_employee_change_resistance_to_Business_Process_Improvement_BPI_in_the_manufacturing_sectors_in_Singapore (date of access: 26.02.2026).

DIGITAL ART IN THE ERA OF NEURAL NETWORKS: MAIN DIRECTIONS AND THE PROBLEM OF RECOGNITION

K. A. Chepurnova

Research advisor: E. V. Dragunova, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
ksen.chepurnova@yandex.ru

Abstract. The article examines the main types of digital art. The influence of modern technologies, including artificial intelligence, on the development of artistic creativity is being investigated. The purpose of the work is to give an overview of the directions of digital art and check how difficult it is for ordinary people to distinguish the work of a neural network from the work of a person.

Keywords: digital art, neural networks, computer graphics, generative art, artificial intelligence, digital painting.

ЦИФРОВОЕ ИСКУССТВО В ЭПОХУ НЕЙРОСЕТЕЙ: ОСНОВНЫЕ НАПРАВЛЕНИЯ И ПРОБЛЕМА РАСПОЗНАВАНИЯ

К. А. Чепурнова

Аннотация. В статье рассматриваются основные виды цифрового искусства. Исследуется влияние современных технологий, включая искусственный интеллект, на развитие художественного творчества. Цель работы – дать обзор направлений цифрового искусства и проверить, насколько сложно обычным людям отличить работу нейросети от работы человека.

Ключевые слова: цифровое искусство, нейросети, компьютерная графика, генеративное искусство, искусственный интеллект, цифровая живопись.

Digital art is creativity created using computer technology. It appeared in the middle of the 20th century, but active development has been taking place over the past few years, thanks to the development of the Internet and artificial intelligence. Today, digital art surrounds us everywhere: in video games, commercials, movies, social media and even museums [2]. The relevance of the topic is due to the fact that technology is changing very quickly. Neural networks can now create pictures, music and even entire videos in seconds. This raises many questions: can such creativity be considered art? Who is the author – person or program? And most importantly – how to distinguish the work of a person from the work of a machine? The purpose of this work is to study the main types of digital art and find out if ordinary people can recognize who created the picture – an artist or a neural network [1].

Digital art is a wide area that includes many different directions, each of which has its own characteristics. The most common type is digital painting and two-dimensional graphics, when the artist draws on a computer using a graphic tablet and special programs. The result looks like a regular picture, but is created entirely in digital format and is often used for illustrations in books, for games and films, and for website design. Another important area is 3D modeling and animation, where specialists create voluminous objects and characters in complex programs. Such models then come to life in video games, cartoons and movies, which requires the authors to know not only art, but also technical skills [2].

A separate place is occupied by generative art and AI art, where part of the work is done by a computer. The artist sets the rules, algorithm or text request, and the program creates the image on its own. The most famous tools in this area are Midjourney, DALL-E and Kandinsky, but there is still debate about the authorship of such works. There is also a direction of interactive installations and virtual reality, where the viewer does not just look, but becomes part of the work. Examples are immersive exhibitions, virtual and augmented reality, which are often created by entire teams of artists and programmers. We must not forget about digital music created with the help of computer programs and synthesizers, as well as digital stage art, where theater and performances use video projections and virtual scenery. All these directions show how technology expands the boundaries of creativity and allows you to create new forms of art.

The emergence of generative neural networks in recent years has significantly changed the world of digital creativity. Now anyone can create a beautiful picture by simply writing a text prompt, which offers huge advantages in accessibility and speed. Ideas can be tested and implemented in minutes; it is easy to try different styles and approaches. However, along with the possibilities come serious problems associated with authorship and uniqueness. Many AI works look similar, the artist's

individual style is lost, it becomes difficult to tell where a person's work ends and artificial intelligence begins. This creates risks for professional artists, as customers may prefer a cheaper and faster version from the neural network [3].

In addition, there is a question of trust in images, especially in advertising, where it is important to understand the origin of the content. Despite all the difficulties, neural networks are becoming a powerful tool in the hands of artists. It is important to find a balance between the use of technology and the preservation of human participation so that art does not turn into generation. The future of digital art depends on how successfully new tools can be integrated without losing the value of the author's intention [1].

To test how difficult it is to distinguish AI art from human art, I conducted an online social survey. The study involved 20 people, among whom were students of various specialties and people with no experience in the industry. The survey included 15 questions aimed at identifying preferences and attitudes towards technology. Particular attention was paid to the practical part, where participants were asked to look at six images and determine their authorship. The images were selected so that they were of a similar quality and style: three were created by a neural network, three by artists. This approach made it possible to compare the theoretical analysis of the market with the real opinion of people, as well as to identify the level of their awareness of the possibilities of artificial intelligence.

The survey results revealed several important patterns regarding attitudes towards digital art. Only 45% of participants correctly identified authorship of all six images, whereas 25% erred on one or two occasions and 10% failed to identify authorship on either occasion. It shows that the line between human and machine creativity is really becoming blurred and it's hard for the average person to see the difference.

Of particular interest is the analysis of responses to one specific image created by a neural network. Only 10% of the participants correctly determined that this work was created by artificial intelligence, while 90% were sure that it was painted by the artist. This result indicates the high quality of modern generative models.

At the same time, 60% of respondents answered that they have a negative attitude towards the creation of art using artificial intelligence. 45% of participants would like to learn how to create images using neural networks themselves, which indicates a high interest in learning. Most participants believe that authors should definitely indicate that the image was created by a neural network. These data confirm that technology has reached a high level, and the line between human and machine creativity continues to blur.

Digital art is a dynamic and diverse field that continues to evolve with technology. Major areas such as 3D modeling, generative art and interactive installations open

up new possibilities for creativity. The advent of neural networks has made the creation of digital art more accessible, but has raised new questions about authorship, uniqueness and trust.

REFERENCES

1. Kathanova J. F. et al. (2024) Vliyaniye tsifrovykh tekhnologi na iskusstvo [The impact of digital technology on art]. Internet-zhurnal Prepodavatel XXI vek [Internet journal Teacher], (2-1). URL: https://cyberleninka.ru/article/n/vliyanie-tsifrovyh-tehnologiy-na-iskusstvo (accessed 23.02.2026).

2. Lugovoy A. A., Potolokova M.O. et al. (2025) Zarozhdeniye tsifrovogo iskusstva na primerakh izobrazitelnogo, muzykalnogo i stsenicheskogo iskusstv [The emergence of digital art in the fields of visual, musical, and performing arts]. Internet-zhurnal KANT: Sotsialnyye i gumanitarnyye nauki [Internet journal KANT: Social science & Humanities], 1(21). URL: https://cyberleninka.ru/article/n/zarozhdenie-tsifrovogo-iskusstva-na-primerah-izobrazitelnogo-muzykalnogo-i-stsenicheskogo-iskusstv (accessed 23.02.2026).

3. Chzhiyun Y. et al. (2025) Innovatsii v tsifrovom iskusstve: sochetaniye tekhnologii i iskusstva [Innovation in Digital Art: Combining Technology and Art]. Internet-zhurnal Vestnik Kemerovskogo gosudarstvennogo universiteta kultury i iskusstv [Internet journal Bulletin of the Kemerovo State University of Culture and Arts], (71). URL: https://cyberleninka.ru/article/n/innovatsii-v-tsifrovom-iskusstve-sochetanie-tehnologii-i-iskusstva (accessed 23.02.2026).

THE DYNAMICS OF DATA COMPLEXITY IN SOCIO-ECONOMIC RESEARCH

A.E. Egorkin, I.A. Kozlov

Research advisor: D.S. Smirnov, Cand. Sc. (Econ.)

Moscow, National Research Nuclear University MEPhI,
egorkin.2004@mail.ru

Abstract. A method for calculating an integral data complexity coefficient is proposed, incorporating multifactorial research, methodological complexity, and technological tools. Analysis of 1985–2026 publications reveals a steady positive trend, confirming the progressive complication of research processes. These findings support developing specialized approaches to data organization in the socio-economic sphere.

Key words: complexity coefficient, socio-economic research, data analysis, methodology, heterogeneous data, complexity dynamics.

ДИНАМИКА СЛОЖНОСТИ ИСПОЛЬЗОВАНИЯ ДАННЫХ В СОЦИАЛЬНО-ЭКОНОМИЧЕСКИХ ИССЛЕДОВАНИЯХ

А. Е. Егоркин, И. А. Козлов

Аннотация. В работе предложена методика расчета интегрального коэффициента сложности использования данных, включающего три компонента: многофакторность, методологическую и технологическую сложность. На основе выборки публикаций 1985–2026 гг. выявлена устойчивая положительная динамика коэффициента, подтверждающая усложнение исследовательских процессов. Результаты обосновывают развитие специализированных подходов к организации данных в социально-экономической сфере.

Ключевые слова: коэффициент сложности, социально-экономические исследования, анализ данных, методология, гетерогенные данные, динамика сложности.

Contemporary socio-economic science is characterized by a transition from the analysis of a limited set of macroeconomic indicators to comprehensive interdisciplinary research. Data on demographic processes, cultural values, institutional features, and environmental factors are increasingly being incorporated into scientific discourse [1][3]. Parallel to the expansion of the subject field, information processing methods are also becoming more complex: classical regression models are supplemented by panel data analysis, composite indices, GIS modeling, and machine learning algorithms [2][4].

On the one hand, this trend opens up new opportunities for obtaining reliable conclusions, but on the other hand, it raises a problem that requires separate study: how to quantitatively assess the increasing complexity of the process of using data in research? The answer to this question will not only allow us to record the current state of scientific practice, but also to predict further directions for the development of information processing tools.

The purpose of this work is to quantitatively assess the dynamics of the complexity of data use in socio-economic research based on a developed integral coefficient.

To solve this problem, an integral complexity coefficient K was developed, which characterizes the level of complexity of working with data in each specific study. The coefficient is calculated as the arithmetic mean of three components:

$$K_i = \frac{F_i + M_i + T_i}{3};$$

F_i – the coefficient of multifactoriality of the study, reflecting the number of subject areas (domains) involved in the article; M_i - the coefficient of methodological

complexity, characterizing the level of analytical and statistical methods used. The value is assigned according to the developed scale: 0.2 - qualitative analysis and descriptive statistics; 0.4 - linear regression and basic econometrics; 0.6 - panel data and multidimensional analysis; 0.8 - composite indices and latent models; 1.0 - machine learning and neural network methods; T_i - technological complexity coefficient reflecting the use of specialized software and information tools. The scale includes: 0.2 - manual processing; 0.4 - standard statistical packages; 0.6 - specialized analytical libraries; 0.8 - GIS systems and integrated platforms; 1.0 - Big Data tools and automated analysis systems, ML tools.

The proposed methodology allows the qualitative characteristics of the research process to be converted into quantitative values, ensuring the comparability of works from different years and subject areas.

For the analysis, a sample of 39 scientific publications covering the period from 1985 to 2026 was formed. The sample included works that were representative of their time and reflected the main trends in socio-economic analytics. For each publication, the values of the coefficients of multifactoriality of the research, methodological and technological complexity, as well as the final complexity coefficient were calculated on the basis of expert analysis.

The results of the calculations are presented in Figure 1, where each point corresponds to a separate publication, and the trend line is constructed using the least squares method.

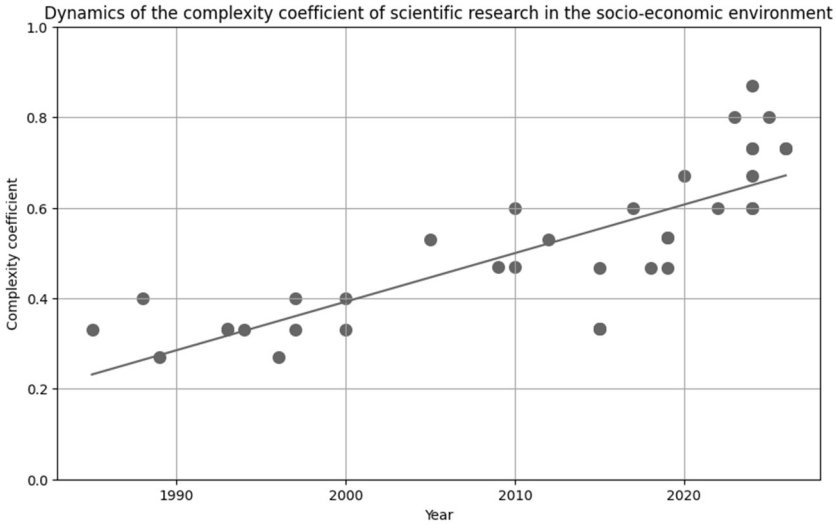


Figure 1. Dynamics of the coefficient of complexity of data use in studies of the socio-economic environment

There is a marked positive trend in the complexity coefficient over the entire time interval under consideration. While in the 1980s and 1990s the average values of the coefficient ranged from 0.2 to 0.4, in the works of 2020-2026 this indicator regularly exceeds 0.7.

The multifactoriality coefficient has increased due to the inclusion of cultural, institutional, and environmental data in the analysis, which previously remained outside the scope of quantitative research.

The methodological complexity coefficient has grown due to the transition from simple correlations to panel data and composite indices, and in recent years to machine learning methods [1][2].

The technological complexity coefficient shows the most dynamic growth, reflecting the transition from manual processing to specialized software and Big Data platforms.

The identified dynamics are important for understanding current trends in socio-economic research.

In this context, the complexity coefficient is a quantitative reflection of the real requirements for researcher competencies and available data infrastructure.

REFERENCES

1. Abhishek Sheetal, Shilpa Madan, Rui Ling Lee, Krishna Savani. What values best distinguish the world's cultures? The machine learning-based cultural values inventory // PNAS Nexus. 2025. No. 4.

2. Galluccio Carla, Giambona Francesca. Cultural heritage and economic development: measuring sustainability over time // Socio-Economic Planning Sciences. 2024. No. 95. P. 101998.

3. Gilli Martino, Calcaterra Matteo, Emmerling Johannes, Granella Francesco. Climate change impacts on the within-country income distributions // Journal of Environmental Economics and Management. 2024. No. 127. P. 103012.

4. Roch-Dupré David, Aracil Elisa, Calvo-Bascones Pablo. Monitoring socioeconomic readiness for the demographic transition: Introducing the Senior Economy Tracker // Structural Change and Economic Dynamics. 2024. No. 71. P. 430–443.

PATTERNS IN MULTI-ATTRIBUTIVE TRANSACTIONS USING DATA MINING TECHNIQUES

K. A. Ershova

Language adviser: L. I. Tolstobrova

Novosibirsk, *Novosibirsk State Technical University*,
kanvalybamba4@gmail.com ; ershovacclara@gmail.com

Abstract. The article examines the analysis of multiattributive retail transactions using data mining methods. The Apriori algorithm is used to identify common sets and associative rules reflecting the behavior of joint purchases. The data set includes 578 real transactions containing 97 unique products. As a result of the analysis, 41 associative rules with increased values of confidence and lift indicators were selected. The results of the study demonstrate that associative rule analysis methods can be effectively applied to analyze sparse transactional data and support practical management decisions.

Keywords: data mining, associative rules, Apriori algorithm, transactional data, pattern detection, digital economy.

ВЫЯВЛЕНИЕ ПАТТЕРНОВ В МУЛЬТИАТРИБУТИВНЫХ ТРАНЗАКЦИЯХ С ИСПОЛЬЗОВАНИЕМ МЕТОДОВ ИНТЕЛЛЕКТУАЛЬНОГО АНАЛИЗА ДАННЫХ

К. А. Ершова

Аннотация. В статье рассматривается анализ мультиатрибутивных розничных транзакций с использованием методов интеллектуального анализа данных. Для выявления частых наборов и ассоциативных правил, отражающих поведение совместных покупок, применяется алгоритм Apriori. Набор данных включает 578 реальных транзакций, содержащих 97 уникальных товаров. В результате анализа было выделено 41 ассоциативное правило с повышенными значениями показателей confidence и lift. Полученные результаты демонстрируют, что методы анализа ассоциативных правил могут эффективно применяться для анализа разреженных транзакционных данных и поддержки практических управленческих решений.

Ключевые слова: интеллектуальный анализ данных, ассоциативные правила, алгоритм Apriori, транзакционные данные, выявление паттернов, цифровая экономика.

Introduction

Transactional data is widely used in modern business intelligence, especially in the retail and service industries. Such data reflects the purchasing behavior of customers and can be used to identify sustainable patterns of joint purchase of goods. One of the common approaches to analyzing transactional data is the analysis of associative rules which allows us to identify dependencies between goods purchased together.

Despite the active development of complex machine learning models, associative rules remain relevant due to their simplicity and interpretability. The results of such an analysis are easily explained and can be directly used in practice, for example, when building recommendation systems or optimizing the assortment. This makes the methods of analyzing associative rules especially in demand for small and medium-sized enterprises that do not always have a well-developed analytical infrastructure.

The purpose of this study is to identify statistically significant patterns of joint purchases in multiattributive sales transactions using the Apriori algorithm, as well as to evaluate its applicability to the analysis of real transactional data.

Methodology

The study is based on a dataset containing 578 real retail transactions. Each transaction represents a set of purchased items. In total, there are 97 unique products in the data. To apply data mining methods, transactions were converted to a binary format in which each product is represented by a binary feature reflecting its presence or absence in the transaction.

After grouping the goods by transaction IDs, binary encoding was performed using the transaction encoding approach which is widely used in machine learning pipelines. As a result, the data was presented as a sparse binary matrix:

$$X \in \{0,1\}^{(\mathrm{N}\times\mathrm{M})}$$

where N is the number of transactions and M is the number of goods.

To extract frequent sets, an Apriori algorithm was used, based on the principle of antimonotonicity, according to which if a certain set of goods is frequent, then all its subsets are also frequent. Set support is calculated using the formula:

$$support(A) = \frac{|\{t \in T: A \subseteq t\}|}{N},$$

where T is the set of all transactions.

Associative rules of the type A→ were evaluated using the confidence and lift metrics. The confidence metric reflects the probability of acquiring a set if there is a

set A, and the lift metric shows how much this probability differs from a random joint appearance. The minimum support threshold was set at 0.01. Additionally, confidence ≥ 0.2 and lift ≥ 1.1 limits were set.

Results and Discussion

As a result of applying the Apriori algorithm, 224 associative rules were obtained. After applying the set thresholds for the confidence and lift metrics, 41 rules were selected for further analysis. The distribution of confidence and lift values shows that most of the generated rules are characterized by low confidence which explains the significant reduction in the final set of rules after filtering.

The strongest rules correspond to stable and logically interpretable patterns of purchasing behavior. Many of them are related to frequently purchased beverages which is typical for retail transactional data. At the same time, less obvious combinations of goods were identified, indicating the presence of non-trivial associative dependencies.

From the point of view of data analysis, associative rules can be considered as an interpretable model describing the dependencies between goods in transactional data. Frequent sets can also be used as additional features in the tasks of forecasting demand and building recommendation systems. Modern research suggests combining classical methods of associative rule analysis with neural network and autoencoder models to improve the quality of pattern detection in sparse datasets.

Conclusion

The results of the study show that the analysis of associative rules remains an effective method of analyzing multiattributive transactional data. The Apriori algorithm allows you to identify significant patterns of joint purchases even when working with relatively small datasets. The obtained associative rules can be used in practice to optimize the assortment, develop recommendation systems and analyze consumer behavior. In the future, research may focus on using more scalable algorithms such as FP-Growth, as well as analyzing sequential and time-based purchase patterns.

REFERENCES

1. Díaz-García, J. A., Ruiz-Cortés, A., Martín-Díaz, O. (2022). A survey on the use of association rules mining techniques in textual social media. *Artificial Intelligence Review*, 55, 4681–4720.

2. Mansyrova, Sh. Z. (2024). Primenenie intellektual'nogo analiza dannykh v proizvodstve [Application of data mining in manufacturing]. *Aktual'nye issledovaniia* [Current Research]. (in Russian).

3. Berteloot, T., Khoury, R., Durand, A. (2023). Association rules mining with auto-encoders. *arXiv preprint*.

4. Al Shehabi, S., Baba, A. (2021). MARC: Mining association rules from datasets using clustering models. *arXiv preprint*.

CORPORATE RAG SYSTEM FOR BANKING REGULATORY COMPLIANCE WITH STRICT SOURCE CITATION

S. A. Karpievich

Research advisor: G.E. Yakhyaeva, Cand. Sc. (Phys.-Math.)

Novosibirsk, Novosibirsk State University,
s.karpievich@g.nsu.ru

Abstract. This paper presents the architecture and deployment of a Retrieval-Augmented Generation (RAG) system for regulatory document analysis in a Russian commercial bank. The architecture combines a Weaviate vector store with hybrid search (HNSW + BM25), fine-tuned bge-m3 embeddings, a bge-reranker-v2-m3-en-ru cross-encoder, and a locally deployed Qwen2.5-7B-Instruct LLM adapted via LoRA. Strict source attribution and post-validation eliminate hallucinations.

Keywords: retrieval-augmented generation, vector search, Weaviate, fine-tuning, source attribution, banking compliance, large language model, reranking.

КОРПОРАТИВНАЯ RAG-СИСТЕМА ДЛЯ БАНКОВСКОГО РЕГУЛЯТОРНОГО КОМПЛАЕНСА СО СТРОГИМ ЦИТИРОВАНИЕМ ИСТОЧНИКОВ

С. А. Карпиевич

Аннотация. В работе представлена архитектура и внедрение системы генерации с дополненным извлечением (RAG) для анализа нормативных документов в российском коммерческом банке. Архитектура объединяет векторное хранилище Weaviate с гибридным поиском (HNSW + BM25), дообученные эмбеддинги bge-m3, кросс-энкодер bge-reranker-v2-m3-en-ru и локально развёрнутую LLM Qwen2.5-7B-Instruct, адаптированную методом LoRA. Строгая атрибуция источников и пост-валидация исключают галлюцинации.

Ключевые слова: генерация с дополненным извлечением, векторный поиск, Weaviate, дообучение, атрибуция источников, банковский комплаенс, большая языковая модель, реранкинг.

Introduction

Financial institutions in Russia operate under a constantly evolving regulatory framework of the Central Bank of Russia (CBR). Legal departments and compliance divisions daily process tens of thousands of pages of CBR regulatory acts (Federal Laws 115-FZ, 152-FZ on Personal Data), internal policies, procedural instructions, and methodological templates. Traditional lexical search systems (Confluence, SharePoint) fail to handle the semantic complexity of legal terminology, resulting in prolonged document retrieval times, heavy reliance on senior experts for routine inquiries, and elevated compliance risks due to the use of outdated document versions.

Retrieval-Augmented Generation (RAG) has established itself as a promising approach that combines information retrieval with generative language models to produce grounded answers with source citations. However, deploying RAG in a banking environment poses unique challenges: data must remain within a closed security perimeter, responses must contain precise references to regulatory provisions, and the system must ensure access control and document versioning. This paper describes the architecture and implementation of an enterprise-grade RAG system that addresses these challenges through hybrid search, fine-tuned multilingual models, and strict hallucination control.

System Architecture and Search Pipeline

The proposed system architecture consists of four main components: data ingestion and chunking, hybrid search with metadata filtering, cross-encoder reranking, and controlled answer generation with post-validation.

The document corpus comprises approximately 9,500 documents collected from CBR regulatory acts, internal bank policies (Confluence, SharePoint), methodological guides, and compliance bulletins. The ETL pipeline extracts text using pdfminer.six with OCR fallback (Tesseract) for scanned documents, python-docx for Word files, and HTML parsers for Confluence pages. Documents undergo deduplication and normalization of legal references into canonical markers. Texts are split using RecursiveCharacterSplitter with chunk overlap and heading-based breaks (H1–H3), preserving metadata.

The retrieval layer is built on Weaviate with an HNSW index for dense vector search and an inverted BM25 index with a Russian-language analyzer for lexical matching. Vectorization is performed by the bge-m3 model, fine-tuned via SFT on query–passage pairs derived from internal legal queries and annotated by domain experts [1]. Hybrid search combines dense and BM25 retrieval results using Reciprocal Rank Fusion, retrieving 200 candidates.

The top-200 candidates are reranked by the multilingual cross-encoder bge-reranker-v2-m3-en-ru, fine-tuned on internal query–passage pairs with hard negatives from adjacent sections and outdated document revisions [1]. The final top-5 passages are forwarded to the generation stage. The retrieval–reranking pipeline achieves a p95 latency of under 350 ms.

Answer Generation

Answer generation is performed by a locally deployed Qwen2.5-7B-Instruct model [3], adapted to the formal business style via LoRA on an instruction–response dataset [2]. The prompt template enforces a strict "context-only answer" policy: the model is required to cite at least one source from the provided context. When the confidence level falls below a threshold, the system returns a clarifying query or a direct link to relevant documents instead of generating an unreliable answer.

The hallucination prevention pipeline includes four post-validation stages. The system supports two output formats: a structured text format for lawyers and a JSON format for programmatic integration into corporate portals and compliance bots. Inference parameters are optimized for deterministic, citation-rich responses. The average generation latency is 1.4 seconds (p95).

The system is integrated into the bank's internal web portal and into Confluence via a chat interface plugin. All experiments were tracked in MLflow, covering embedding, reranking, and generation model versions. The offline evaluation system reports Recall@5 = 0.91, Precision@1 = 0.86.

Conclusion

In this study, a Retrieval-Augmented Generation (RAG) system was designed for analyzing the regulatory framework of a Russian commercial bank. Its deployment significantly improved the operational efficiency of the bank's legal department and compliance divisions. The average document analysis time was reduced from 20–40 minutes to 7–10 minutes per query. The share of escalated requests to the legal department decreased by 37%, allowing experts to focus on complex cases. Strict source attribution eliminated cases of using outdated regulatory revisions, reducing compliance risks.

The combination of fine-tuned multilingual models (bge-m3 for embeddings, bge-reranker-v2-m3-en-ru for reranking), a locally deployed Qwen2.5-7B-Instruct LLM with LoRA adaptation, and a multi-stage post-validation pipeline has proven effective for building a hallucination-free RAG system within a closed banking perimeter. Future work includes extending the system to support interdepartmental knowledge sharing and integrating real-time regulatory update monitoring.

REFERENCES

1. Chen, J., Xiao, S., Zhang, P. et al. (2024) BGE M3-Embedding: Multi-Lingual, Multi-Functionality, Multi-Granularity Text Embeddings Through Self-Knowledge Distillation. arXiv preprint arXiv:2402.03216.

2. Hu, E. J., Shen, Y., Wallis, P. et al. (2022) LoRA: Low-Rank Adaptation of Large Language Models. Proceedings of ICLR 2022.

3. Qwen Team (2024) Qwen2.5: A Party of Foundation Models. arXiv preprint arXiv:2412.15115.

ANALYTICAL DATA SUPPORT FOR SPATIAL MASS APPRAISAL OF HOUSING

L. I. Kerman

Research advisor: M. E. Tsoy, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
kermanlev@mail.ru

Abstract. Spatial models in mass housing appraisal place stricter requirements on primary data because price formation must be explained using apartment attributes, the georeferenced location of the building, and measurable characteristics of the surrounding urban environment [1,2]. This paper presents an organizational framework for acquiring and preparing data from open web sources and proposes a four-layer data model that combines an urban cartographic base, a buildings layer, a listings layer, and an infrastructure (points-of-interest) layer. The paper describes how data from real-estate listing aggregators and geoinformation directories can be transformed into a unified structure and linked through building coordinates, yielding a reproducible dataset suitable for spatial modeling of housing values [2,5]. The practical feasibility of the proposed approach is illustrated by an automated data-collection and appraisal workflow deployed for the city of Novosibirsk [9].

Keywords: mass appraisal, spatial econometrics, primary listing data, web data acquisition, geospatial data integration, spatial models.

АНАЛИТИЧЕСКОЕ ОБЕСПЕЧЕНИЕ ПРОСТРАНСТВЕННОЙ МАССОВОЙ ОЦЕНКИ ЖИЛЬЯ

Л. И. Керман

Аннотация. Пространственные модели в массовой оценке жилья предъявляют повышенные требования к первичным данным, поскольку формирование цены должно быть объяснено с учётом характеристик квартиры, координатной привязки дома и измеримых характеристик окружающей городской среды [1,2]. В работе представлена организационная схема получения и подготовки данных из открытых веб-источников и предложена четырёхслойная модель данных, объединяющая базовый городской картографический слой, слой зданий, слой объявлений и слой инфраструктуры (точек интереса). В работе описано, каким образом данные из агрегаторов объявлений и геоинформационных справочников могут быть приведены к единой структуре и связаны через координаты зданий, что обеспечивает воспроизводимость набора данных и его пригодность для пространственного моделирования стоимости жилья [2,5]. Практическая реализуемость предложенного подхода проиллюстрирована автоматизированным контуром сбора данных и оценки, развернутым для города Новосибирска [9].

Ключевые слова: массовая оценка, пространственная эконометрика, первичные данные объявлений, веб-сбор данных, интеграция геоданных, пространственные модели.

Introduction

Spatial models are increasingly used in mass housing appraisal because housing prices typically exhibit spatial dependence and because the influence of structural and locational factors can vary across urban space [1, 2]. In the hedonic tradition, the observed price is interpreted as the outcome of implicit valuation of attributes, which motivates the explicit measurement of both property characteristics and locational conditions [3]. In practice, a spatial appraisal dataset must therefore include (i) a dataset of listings with property characteristics and publication attributes and (ii) an independent representation of spatial context, including building coordinates and amenity accessibility measures derived from urban infrastructure data (for example, distances to the nearest facility and counts within a specified radius) [4,6]. Regular access to detailed transaction data is often restricted; consequently, open web sources become an important input for research and prototyping in mass appraisal, provided that data collection and preparation follow a reproducible organizational design. The Novosibirsk deployment provides an empirical example of such an automated model operating with open web sources in a Russian urban context [9].

The objective of this study is to describe an organizational model of analytical data support that enables the acquisition of primary data and its preparation in a form suitable for spatial modeling of real-estate prices [1, 2].

Data sources

The dataset is formed from open sources that serve distinct functions. The urban cartographic base is provided by geoinformation sources—most commonly OpenStreetMap—and is used as the spatial backbone (street network and basic elements of urban structure). Primary observations on the supply side of the market and information about buildings are extracted from listing aggregators, including Cian, Etazhi, and Domclick. Coordinates and points of interest are obtained from geoinformation directories such as 2GIS and Yandex Maps. The logic of dataset formation and the direction of data flows between sources and layers are shown in Figure 1.

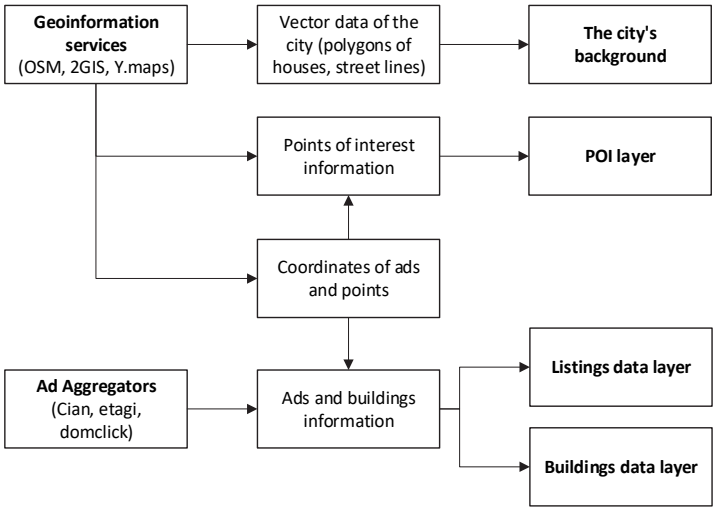


Figure 1. Data sources and data-flow scheme for forming the analytical dataset

For spatial mass appraisal tasks, the base dataset is organized into four interrelated layers. The first layer represents the urban cartographic base derived from OSM. The second layer contains buildings and residential complexes and plays a reference role by storing address information and coordinates of the real-estate object. The third layer contains listings, where the unit of observation is a listing representing an apartment and the state of supply at a specific point in time [4]. The fourth layer contains points of interest used to compute amenity accessibility

measures (for example, nearest-distance and local-density measures) that are subsequently assigned to listings via building coordinates [6]. This layering aligns the observational unit (a listing) with the spatial linkage unit (a building or residential complex), which is necessary for spatial econometric interpretation and for consistent construction of locational variables [2]. The dataset structure and the linkage logic between layers are presented in Figure 2.

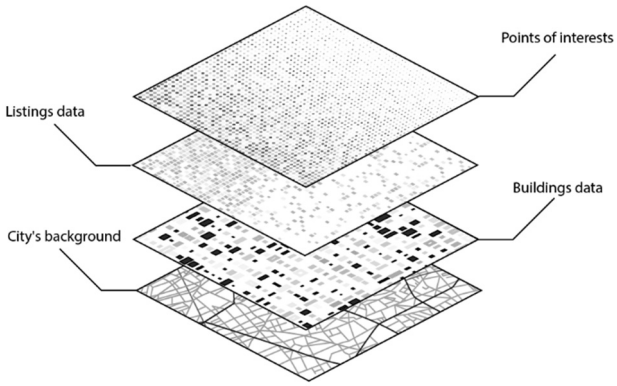


Figure 2. Four-layer data model for spatial mass appraisal:
OSM base, buildings, listings, and points of interest.

Data acquisition is carried out according to predefined scenarios. Each scenario is assigned to a specific source and defines the sequence of operations, the set of fields to be extracted, the storage format, and the checks to be performed. Scenarios are launched on a schedule. For each run, the selection parameters, execution time, number of retrieved records, and completion status are recorded; in case of failure, the run is repeated and the cause is logged. This scenario-based organization supports reproducibility and comparability across collection cycles, which is essential in mass appraisal workflows that rely on repeated updates and systematic evaluation [5].

Listing acquisition is organized by reproducing the user's interaction logic with a source: a search request is formed, a list of listings is retrieved, and information is extracted sequentially from listing detail pages. In practice, the website interface receives the source data as machine-readable responses during search and when opening detail pages. The program captures these responses, extracts the substantive payload, and converts it into a tabular form. As output, two linked tables are produced: a listings table containing apartment characteristics and publication attributes, and a buildings table containing address attributes and coordinates.

This decomposition reflects the difference in data levels: the observation pertains to an apartment and a publication, while spatial linkage and amenity accessibility measures are defined at the building or residential-complex level.

Points of interest are obtained from geoinformation directories by categories of urban objects. For each category, records with coordinates and attributes are formed. Amenity accessibility measures are then computed for the coordinate of a building or residential complex and subsequently assigned to the listings linked to that coordinate. In a minimal configuration, the measures include distances to the nearest objects in selected categories and density measures within a specified neighborhood. The category set typically includes transport, education, healthcare, retail and business infrastructure, and recreational areas, and is determined by interpretability and data stability requirements [6].

After primary extraction, the data are transformed into a unified structure. For each source, a correspondence table is applied to map source fields into a common set of listing and building attributes. At this stage, units of measurement and categories are standardized, data types are harmonized, and stable identifiers are formed. Quality checks are then performed, including completeness of key fields, coordinate validity, admissible ranges for price and area, and integrity of the listing-to-building linkage. The results of acquisition and processing are stored in a database in two representations: a raw layer that preserves data close to the source format together with service attributes describing time and source, and a prepared layer that contains unified fields, quality-check results, deduplication results, and assigned amenity accessibility measures.

Conclusion

This paper substantiates the need to treat analytical data support as an independent component of spatial mass appraisal of housing. The practical applicability of spatial models depends on the availability of a regularly updated primary dataset aligned through georeferencing [1, 2]. We propose a four-layer data model—an urban cartographic base (OpenStreetMap), a buildings layer with coordinates, a listings layer as the observational unit, and a points-of-interest layer (2GIS, Yandex Maps) used to derive amenity accessibility measures. An organizational scheme for dataset formation is described based on scenario-driven collection from listing aggregators (Cian, Etazhi, Domclick) and geoinformation directories, followed by transformation into a unified structure and systematic quality control. The resulting reproducible data foundation supports spatial modeling of housing values and map-based analysis of estimated spatial patterns [2, 5]. The Novosibirsk case provides an empirical reference for implementing such an automated model in practice [9].

REFERENCES

1. Anselin L. Spatial Econometrics: Methods and Models. – Vol. 4. – Dordrecht: Springer Netherlands, 1988.
2. LeSage J., Pace R. K. Introduction to Spatial Econometrics. – Boca Raton: Chapman and Hall/CRC, 2009.
3. Rosen S. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition // Journal of Political Economy. – 1974. – Vol. 82, No. 1. – P. 34–55. – DOI 10.1086/260169.
4. Dubin R. A. Predicting house prices using multiple listings data // The Journal of Real Estate Finance and Economics. — 1998. — Vol. 17, No. 1. — P. 35–59. — DOI 10.1023/A:1007751112669.
5. Kauko T., D'Amato M. Mass Appraisal Methods: An International Perspective for Property Valuers. – Chichester, West Sussex: Wiley-Blackwell, 2008..
6. Cohen J. P., Coughlin C. C. Spatial hedonic models of airport noise, proximity, and housing prices // Journal of Regional Science. — 2008. — Vol. 48, No. 5. — P. 859–878. — DOI 10.1111/j.1467-9787.2008.00569.x.
7. Brunsdon C., Fotheringham A. S., Charlton M. E. Geographically Weighted Regression: A Method for Exploring Spatial Nonstationarity // Geographical Analysis. – 1996. – Vol. 28, No. 4. – P. 281–298. – DOI 10.1111/j.1538-4632.1996.tb00936.x.
8. Elhorst J. P. Spatial Econometrics. – Berlin; Heidelberg: Springer, 2014.
9. Kerman L. I. Avtomatizirovannye sistemy otsenki nedvizhimosti: mezhdunarodnyi opyt i vozmozhnosti primeneniya v Rossii (in Russian) [Automated Real Estate Valuation Systems: International Experience and Opportunities for Application in Russia]. In: Zakharova E. V. (ed.) *Nauka. Tekhnologii. Innovatsii. Collection of Scientific Papers*: *in 9 parts*. Novosibirsk: NSTU Publishing House; 2026. Part 4. ISBN 978-5-7782-5568-5.

ARCHITECTURE OF A SERVICE FOR PREDICTING THE RISK OF DEVELOPING DEMENTIA-TYPE COGNITIVE IMPAIRMENT

A. K. Kholostova

Research advisor: D. S. Smirnov, Cand. Sc. (Econ.)

Moscow, National Research Nuclear University MEPhI,
airsha2004@gmail.com

Abstract. This article provides a critical analysis of five leading foreign clinical decision support systems (CDSS) for the early diagnosis of dementia-type cognitive disorders. Four systemic barriers of existing solutions were identified: reliance on unavailable invasive biomarkers, neglect of the high prevalence of vascular pathology (68.3% in patients with MCI), lack of integration of local neuropsychological methods, and non-compliance with physician appointment time standards (15–20 min).

A conceptual service architecture is proposed based on routinely available data — medical history, local tests, and hippocampal morphometry — providing an interpretable risk assessment with minimal interference in the physician's workflow.

Keywords: pre-dementia cognitive disorders, information-analytical system, risk prediction, neuropsychological testing, hippocampal morphometry, service architecture, vascular pathology.

АРХИТЕКТУРА СЕРВИСА ПРОГНОЗИРОВАНИЯ РИСКА РАЗВИТИЯ КОГНИТИВНЫХ НАРУШЕНИЙ ДЕМЕНТНОГО ТИПА

А. К. Холостова

Аннотация. В работе рассматривается проблема адаптации зарубежных систем поддержки клинических решений для ранней диагностики когнитивных нарушений к условиям российской амбулаторной практики. Выявлены четыре системных барьера существующих решений: зависимость от недоступных инвазивных биомаркеров, игнорирование высокой распространённости сосудистой патологии (68.3% у пациентов с ЛКС), отсутствие интеграции локальных нейропсихологических методик и несоответствие нормативам времени приёма врача (15–20 мин). Предложена концептуальная архитектура сервиса на основе рутинно доступных данных — анамнеза, локальных тестов и морфометрии гиппокампа — обеспечивающая интерпретируемую оценку риска с минимальным вмешательством в рабочий процесс врача.

Ключевые слова: додементные когнитивные расстройства, информационно-аналитическая система, риск прогнозирования, нейропсихологическое тестирование, морфометрия гиппокампа, архитектура сервиса, сосудистая патология.

Cognitive impairments preceding clinically manifest dementia pose a serious challenge to the healthcare system amidst an aging population. According to the WHO, over 55 million people worldwide live with dementia [6]. The pathological process in Alzheimer's disease begins developing 10–15 years before the onset of pronounced symptoms, passing through the stages of Subjective Cognitive Decline (SCD) and Mild Cognitive Impairment (MCI) [2]. Intervention at these stages can halve the severity of future cognitive impairments [5], highlighting the importance of early diagnosis.

However, early detection of pre-dementia conditions in Russian outpatient practice faces systemic barriers. Invasive methods (lumbar puncture) and expensive examinations (amyloid PET) are practically unavailable: less than 5% of patients with

SCD/MCI undergo these examinations [3]. A neurologist spends an average of 15–20 minutes per appointment, which is insufficient for comprehensive cognitive screening.

A systematic analysis of five leading international solutions revealed fundamental limitations to their application in the Russian Federation (Table 1). PredictAD (Finland) demonstrates high diagnostic accuracy (AUC 0.88–0.92) but requires the mandatory use of amyloid PET and CSF analysis—methods practically unavailable in Russian polyclinics [3]. The time required to work with the system (40–60 minutes) exceeds the physician appointment standard by 2–3 times. CADi2 (Japan/Germany) ensures rapid application (<5 minutes) but ignores regional characteristics of the Russian population: in patients with MCI, arterial hypertension occurs twice as often (68.3% vs. 32.7% in ADNI data) [3]. The system is also limited to using only the MoCA scale, whereas in the RF, local tests are routinely used: "12 words", Benton test, "clock drawing". According to the study by Koberskaya et al. (2021), the Benton test demonstrates statistically significant differences between patient groups with SCD and MCI ($p \leq 0.014$), while the MMSE scale does not reveal significant differences ($p > 0.05$) [4]. QDEMS (USA) and NeuroCLIP (Canada) integrate MRI data but require specialized equipment. Dementia Risk Score (UK) uses only demographic data, achieving moderate accuracy (AUC 0.71), which is insufficient for early diagnosis [1].

Table 1. Comparative analysis of existing CDSS for early diagnosis of cognitive impairment

System	*Country*	*Data type*	*Accuracy (AUC)*	*Processing time*
PredictAD	Finland	MRI, PET, CSF, tests	0.88–0.92	40–60 min
CADi2	Japan/Germany	Clinical + MoCA	0.79–0.82	<5 min
QDEMS	United States	MRI + clinical	0.85	15–20 min
NeuroCLIP	Canada	MRI + report text	0.87	25–30 min
Dementia Risk Score	United Kingdom	Demographics, medical history	0.71	<2 min

The analysis revealed four systemic barriers of existing solutions:

1. Reliance on unavailable biomarkers. Most models are trained on data from the ADNI project, where amyloid PET and CSF analysis are mandatory components [1]. These methods are practically not used in Russian outpatient clinics.

2. Neglect of regional population characteristics. The high prevalence of vascular pathology among Russian patients requires adaptation of predictive models, which foreign systems do not provide.

3. Lack of integration of Russian neuropsychological methods. None of the existing systems provide for the input of results from local tests (Benton test, "12 words"), despite their proven effectiveness at early stages [4].

4. Non-compliance with organizational conditions of physician workflow. The time required to interact with these systems exceeds the physician appointment standard (15–20 minutes) by 2–3 times.

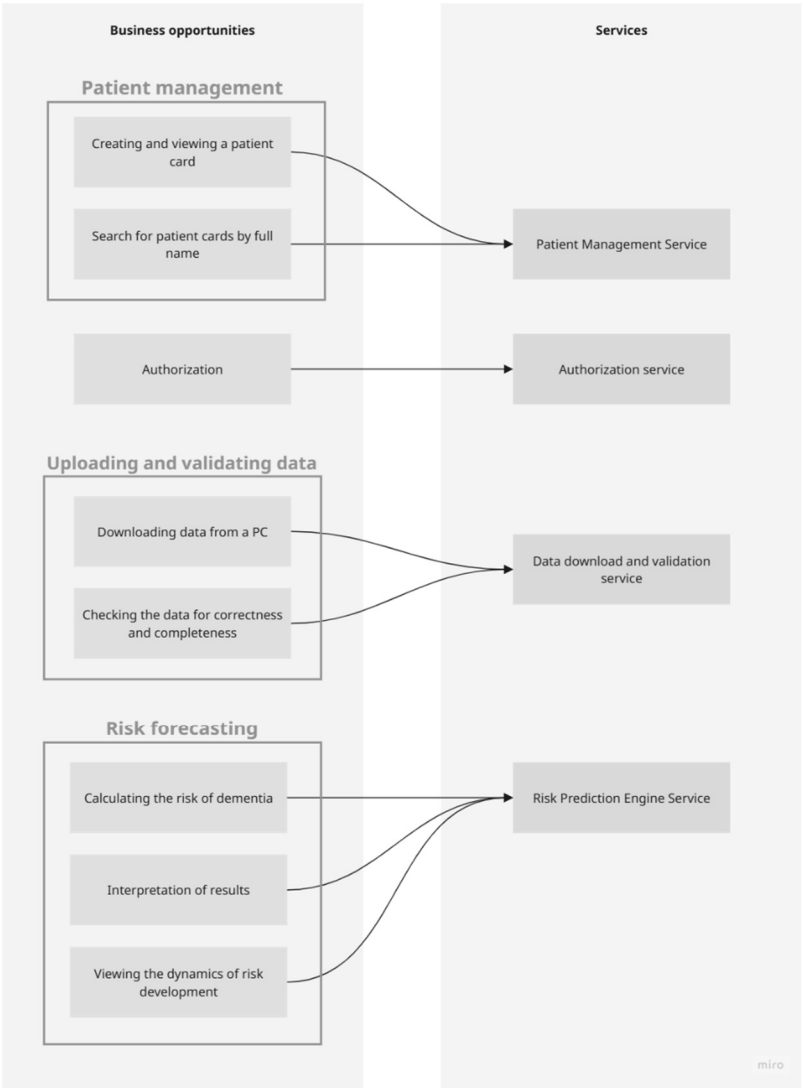


Figure 1. Conceptual architecture of the information and analytical system for predicting the risk of cognitive disorders

Based on the identified limitations, a conceptual architecture of the information and analytical system (Fig. 1) has been proposed, focused on the conditions of Russian outpatient practice. The architecture includes three functional blocks:

1. Patient management — creation and viewing of cards, search by name.

2. Integration of clinical data — import of anamnestic information (age, gender, education, vascular diseases), results of local neuropsychological tests, and morphometric indicators of hippocampal MRI. The rejection of mandatory invasive biomarkers ensures practical applicability.

3. Interpretable risk calculation — based on ensemble machine learning methods, a quantitative risk assessment (0–100 points) is formed, highlighting the key factors that contributed most to the prognosis.

The proposed approach has three advantages over existing solutions: (1) practical applicability through the use of only routinely available data; (2) regional adaptation considering the high prevalence of vascular pathology; (3) minimal interference with the physician's workflow.

Thus, the analysis showed that existing foreign clinical decision support systems have fundamental limitations when applied in Russian outpatient practice. The proposed conceptual architecture of the information-analytical system eliminates the identified barriers through adaptation to local conditions — data availability, population characteristics, and organizational constraints. Future work includes implementation of prototype modules for data integration and risk calculation, as well as model validation on a retrospective sample of Russian patients.

REFERENCES

1. Albright J. Forecasting the progression of Alzheimer's disease using neural networks and a novel preprocessing algorithm. Alzheimers Dement (N Y). 2019;5:483–491.

2. Jack C.R., Knopman D.S., Jagust W.J., et al. Tracking pathophysiological processes in Alzheimer's disease: an updated hypothetical model of dynamic biomarkers. Lancet Neurol. 2013;12(2):207–216.

3. Koberskaya N.N., Mkhitaryan E.A., Lokshina A.B., Grishina D.A. Dodementnye kognitivnye rasstroystva [Predementia cognitive disorders] Russ J Geriatr Med. 2022;1(9):48–57. (in Russian).

4. Koberskaya N.N., Ostroumova O.D., Perepelov V.A., Smirnov D.S. Influence of genetic and comorbid emotional-affective factors on pre-mild cognitive decline in middle-aged patients. Neurol Neuropsychiatry Psychosom. 2021;13(4):66–74.

5. Reisberg B., Shulman M.B., Torossian C., Leng L., Zhu W. Outcome over seven years of healthy adults with and without subjective cognitive impairment. Alzheimers Dement. 2010;6(1):11–24.

6. World Health Organization. Global action plan on the public health response to dementia 2017–2025. Geneva: WHO; 2021.

ANALYSIS OF FACTORS AFFECTING AUDIO QUALITY IN VIDEOCONFERENCING SYSTEMS

R. V. Klyosova, A. S. Serova

Moscow, National Research Nuclear University MEPhI,
regina.klyosova@yandex.ru

Abstract. The paper presents a formalized model of the audio path of a videoconferencing system in the form of a composition of operators that take into account acoustic, hardware-induced, codec, and network distortions. The influence of model parameters on objective and subjective speech quality metrics is analyzed. A comparison of the main types of interference with the sensitivity of MOS, PESQ, and POLQA metrics is performed.

Keywords: videoconferencing, audio signal, acoustic interference, audio path, mathematical model, speech quality assessment.

АНАЛИЗ ФАКТОРОВ, ВЛИЯЮЩИХ НА КАЧЕСТВО АУДИОСВЯЗИ В СИСТЕМАХ ВИДЕОКОНФЕРЕНЦСВЯЗИ

Р. В. Клёсова, А. С. Серова

Аннотация. В работе представлена формализованная модель аудиотракта системы видеоконференцсвязи в виде композиции операторов, учитывающих акустические, аппаратно-цифровые, кодековые и сетевые искажения. Проведён анализ влияния параметров модели на объективные и субъективные метрики качества речи. Выполнено сопоставление основных типов помех с чувствительностью показателей MOS, PESQ и POLQA.

Ключевые слова: видеоконференцсвязь, аудиосигнал, акустические помехи, аудиотракт, математическая модель, оценка качества речи.

Videoconferencing (VC) is an essential tool for professional and educational interaction. For speech transmission, the audio channel plays a key role in determining the speech intelligibility and perceptual naturalness. Speech quality in telecommunications systems is assessed using standardized methods of the International Telecommunication Union (ITU-T), including recommendations P.800, P.862, and P. 863, which define subjective and objective assessment methods [7-9]. The availability of formalized metrics allows audio signal degradation to be considered as a measurable engineering problem.

In real-world operating conditions, characterized by the use of home environments, built-in microphones, and unstable network connections, the quality of audio communication remains inconsistent. Signal degradation arises from a complex interplay of acoustic, hardware-related and digital factors [2-6]. This necessitates formalized modeling of interference followed by an assessment of its impact on objective quality metrics.

Distortions occur at successive stages of the audio path. Acoustic interference includes reverberation caused by sound wave reflections [4], acoustic echo and feedback caused by the signal from the speaker being picked up again by the microphone [3], and additive background noise that reduces the signal-to-noise ratio [5].

At the capture and analog-to-digital conversion stage, hardware distortions occur, including microphone thermal noise, clipping when the preamplifier is overloaded, and quantization noise determined by the signal representation bit depth [1].

After digital processing and encoding, distortions associated with bitrate constraints and compression algorithm characteristics may arise, leading to a loss of spectral detail and the appearance of artifacts [1].

At the network transmission stage, channel parameter instability causes increased latency, jitter, and packet loss. Latency exceeding 150 ms disrupts the natural pace of dialogue, and packet loss leads to interruptions in the speech stream [2].

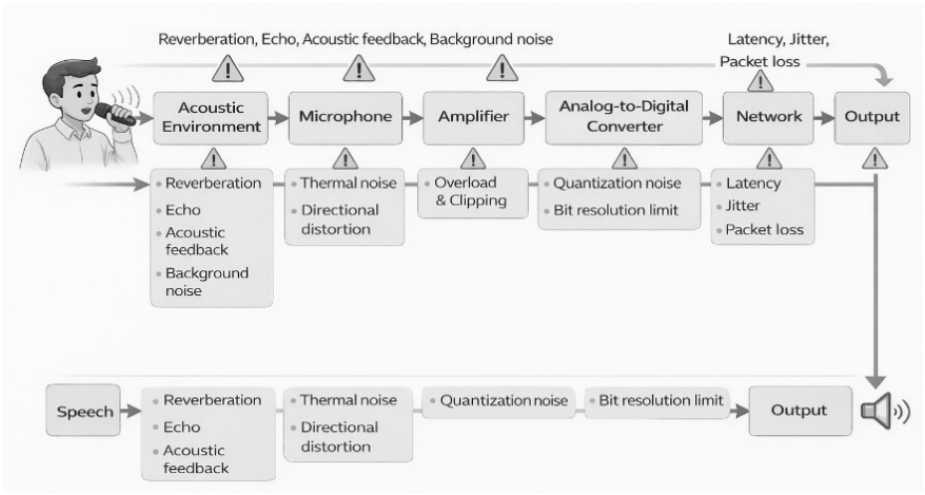


Figure 1. Block diagram of the audio path of a videoconferencing system with localization of distortion sources

To formalize the end-to-end processing of the speech signal of a videoconferencing system, we introduce a mapping that connects the input signal s(t) and the output

signal of the playback device $\hat{s}(t)$. We represent the audio path as a sequence of transformations acting on the signal and including the acoustic environment, capture, conversion, processing, encoding, and network transmission. In signal and system theory, such a representation is naturally given by a composition of operators describing the cascade structure of the path [10]:

$$\hat{s}(t) = (P°D°N°C°F°Q°G)((s * h)(t) + n_a(t)),$$

where $(s * h)(t)+n_a(t)$ - describes the signal at the input of the capture path; $h(t)$ - impulse response of the acoustic environment; $n_a(t)$ - additive acoustic noise.

Operators G, Q, F, C, N, D, P specify, respectively, the analog capture path, analog-to-digital conversion, digital preprocessing, encoding, network transmission, decoding, and playback.

Standardized metrics from the International Telecommunication Union (ITU-T) are used to quantitatively assess the impact of these distortions on perceived speech quality. The subjective MOS (Mean Opinion Score) metric reflects the average speech quality rating by a group of listeners on a five-point scale and is used as a benchmark for validation [7]. The objective PESQ (Perceptual Evaluation of Speech Quality) metric is based on comparing the distorted signal with the reference signal and is designed to evaluate narrowband speech [8]. The POLQA (Perceptual Objective Listening Quality Assessment) metric is an extension of PESQ and appropriately accounts for broadband speech and nonlinear distortions [9]. From a mathematical point of view, each metric is a functional [11]

$$Q = \Phi(s(t), \hat{s}(t)) \text{ , where}$$

s(t) is the reference signal; $\hat{s}(t)$ is the signal after passing through the audio path.

Thus, changes in model parameters directly affect the quality metric value.

The influence of the parameters of the mathematical model of the audio path on the values of objective and subjective speech quality metrics was evaluated. Background noise and reverberation were selected as representative factors for the main acoustic distortions, clipping as a typical nonlinearity of the capture path, bitrate reduction as a codec factor, and packet loss as a key network factor.

The analysis showed that the sensitivity of objective and subjective speech quality metrics varies significantly depending on the physical nature of the distortions. The most pronounced decrease in metrics is observed in the case of nonlinear and temporal distortions, such as clipping and packet loss, as they lead to irreversible disruption of the spectral and temporal structure of the signal. Additive noise and reverberation mainly affect intelligibility and naturalness of sound, with PESQ and POLQA metrics showing varying degrees of sensitivity to spectral and broadband signal changes.

Table 1 – Sensitivity of metrics to distortions

Distortion type	Main parameter	Impact on MOS	Impact on PESQ	Impact on POLQA
Background noise	Signal-to-noise ratio (SNR)	Intelligibility loss	High sensitivity	High sensitivity
Reverberation	Reverberation time	Naturalness loss	Medium sensitivity	High sensitivity
Clipping	Clipping level	Timbre distortion	Strong degradation	Strong degradation
Low bitrate	Bitrate	Detail loss	Moderate degradation	Severe degradation
Packet loss	Loss rate	Integrity disruption	Sensitive to interruptions	Sensitive to temporal distortions

A mathematical model of the audio path in the form of a composition of operators enables formalization of the contribution of each processing stage to the final signal degradation. The parameterization of acoustic, hardware, codec, and network distortions enables comparison of the physical characteristics of the path with changes in quality metric values. This approach allows us to move from a descriptive classification of interference to a structured analysis of its impact on perceived speech quality.

The results confirm that ensuring acceptable audio quality in videoconferencing systems requires prioritized control of parameters related to nonlinear and network distortions, while simultaneously reducing the level of acoustic noise at the signal capture stage. The presented model and systematization of degradation factors can be used in the development and optimization of speech processing algorithms in Russian videoconferencing platforms.

REFERENCES

1. Analog Devices. Basics of Embedded Audio Processing. Embedded Media Processing. 2005. URL: https://www.analog.com/media/en/dsp-documentation/embedded-media-processing/embedded-media-processing-chapter5.pdf.

2. Bezukladnikov I.I. et al. Upravlenie kachestvom servisov v gorodskikh mul'tiservisnykh setyakh [Management of service quality in urban multiservice networks]. Perm: Izdatel'stvo Permskogo natsional'nogo issledovatel'skogo politekhnicheskogo universiteta, 2014. 218 p. (in Russian).

3. Bol'shaya rossiyskaya entsiklopediya. Ekho [Echo]. URL: https://old.bigenc.ru/physics/text/4918133 (in Russian).
4. Bol'shaya rossiyskaya entsiklopediya. Reverbatsiya [Reverberation]. URL: https://old.bigenc.ru/physics/text/3500988 (in Russian).
5. Bol'shaya rossiyskaya entsiklopediya. Shum akusticheskiy [Acoustic noise]. URL: https://old.bigenc.ru/physics/text/4923415 (in Russian).
6. Bol'shaya rossiyskaya entsiklopediya. Zvuk [Sound]. URL: https://old.bigenc.ru/physics/text/1990754 (in Russian).
7. ITU-T. Recommendation P.800.1. Mean opinion score (MOS) terminology. 2016. URL: https://www.itu.int/rec/t-rec-p.800.1.
8. ITU-T. Recommendation P.862. Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs. 2001. URL: https://www.itu.int/rec/t-rec-p.862.
9. ITU-T. Recommendation P.863. Perceptual Objective Listening Quality Analysis (POLQA). 2018. URL: https://www.itu.int/rec/t-rec-p.863.
10. Sergienko A.B. Tsifrovaya obrabotka signalov [Digital signal processing]. SPb.: Piter, 2011. (in Russian).
11. Shakhtarin B.I. Teoriya peredachi signalov [Theory of signal transmission]. M.: Goryachaya liniya – Telekom. (in Russian)

LOW-CODE AND AI IN 1C: ACCELERATING DIGITAL BUSINESS TRANSFORMATION

S.-N. Kosareva

Research advisor: E. V. Dragunova, Cand. Sc. (Econ.)

Moscow, Moscow Physical Technical Institute, Novosibirsk, Novosibirsk State Technical University, nickoleta@kosareeva.ru

Abstract. This article explores the key role of the synergy of low-code tools and intelligent services in accelerating the digital transformation of modern business. In the context of an ever-changing data economy and increasing demands for flexibility and speed of adaptation, traditional approaches to development are becoming ineffective. The article analyzes how the low-code approach is implemented in the 1C platform. The company significantly reduces the time required to develop and implement solutions, while ensuring high adaptability to changing business processes.

Keywords: low-code, 1C Enterprise, artificial intelligence, business processes, automation.

LOW-CODE И AI В 1С: УСКОРЯЕМ ЦИФРОВУЮ ТРАНСФОРМАЦИЮ БИЗНЕСА

С.-Н. Косарева

Аннотация Данная статья исследует ключевую роль синергии low-code инструментов и интеллектуальных сервисов в ускорении цифровой трансформации современного бизнеса. В условиях постоянно меняющейся data-экономики и возрастающих требований к гибкости и скорости адаптации, традиционные подходы к разработке становятся неэффективными. В статье анализируется, как low-code подход, реализуемый в платформе 1С:Предприятие, позволяет значительно сократить сроки разработки и внедрения решений, обеспечивая при этом высокую адаптивность к изменяющимся бизнес-процессам.

Ключевые слова: low-code, 1С:Предприятие, искусственный интеллект, бизнес-процессы, автоматизация.

In the last decade, there has been a cult of automation – any self-respecting company analyzes its activities and tries in every possible way to improve them: reduce costs, increase profits, and generally change financial performance. Automation of business processes frees employees from routine work, reduces the impact of the human factor, and is also easily replicated to other departments without requiring staff growth.

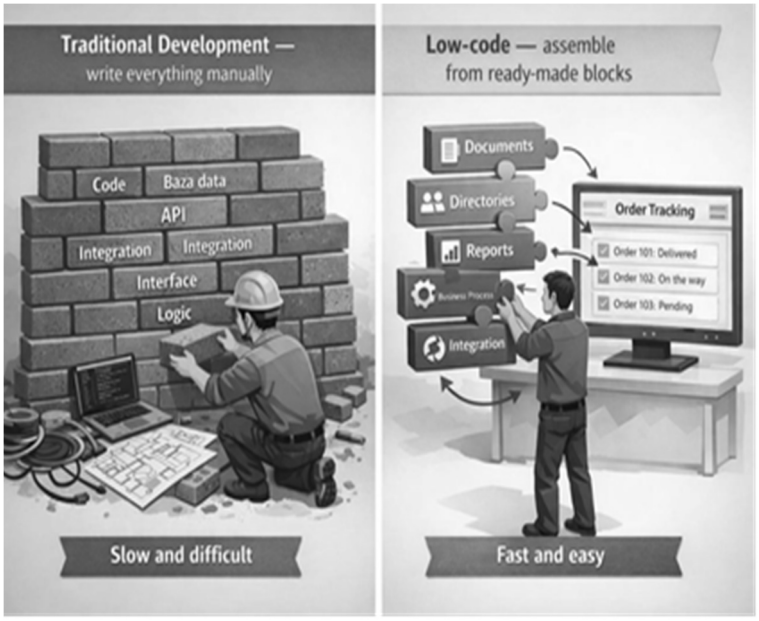
In addition, one should not forget that modern business exists in conditions of constant and rapid changes (this includes market conditions, legislation and, of course, customer needs). Therefore, we certainly need tools that will allow us to quickly adapt systems to new tasks.

However, thanks to the emerging trend towards automation, a large number of companies have been born that modernize your processes for you. Such firms should be treated with caution, as there is a risk of falling for the tricks of the "shoemaker without boots." It is difficult to trust people who have not been able to automate their own business processes, but at the same time I offer my services to others in this difficult matter.

Meanwhile, in addition to small one-day companies, there are practically monopolists on the market who have proven the effectiveness of their automation methods over many years of work. Many of these approaches do not even require serious knowledge in development and programming, since they use low-code platforms. Companies provide an opportunity to assemble the right product from "cubes" that will be a good business assistant.

Low-code is not just a tool, but a strategy that transfers the power of digitalization from IT departments into the hands of those who specialize directly in business processes.

Unlike traditional low-code development, systems make it possible to assemble a finished product many times faster, they can attract not only developers, but also analysts who understand the process better, and most importantly for modern business, it is easier to make changes and create prototypes in such systems. Figure 1 clearly shows the difference between traditional development and low-code.



Source: *created by the author using a neural network chatgpt.com*

However, unfortunately, the low-code platform alone is not enough in the modern world to solve business problems. Artificial intelligence (AI) has come to the rescue, which has not just become a trend, but a fundamental driver of business innovation.

The use of AI brings companies a number of definite advantages, including automation of routine monotonous operations. Integration of AI services with the 1C platform: Enterprise 8 is qualitatively changing the way it interacts with data, shifting it from simple storage to an active decision-making tool.

- AI can extract information from scanned documents, which helps reduce the likelihood of manual input errors.;
- AI models can predict future events based on historical data accumulated in 1C;
- Based on the analysis of customer behavior and preferences, AI can offer personalized products or services, increasing cross-sales and customer loyalty;

- AI can analyze incoming text, which can be used to classify support requests, determine the tone of a review, generate summaries of long texts, and so on.

In this way, intelligent systems become an integral part of modern business infrastructure, allowing not only to automate business processes, but also to create new values.

Low-code platforms can be particularly valuable in the context of integration with intelligent services. The key idea is that the low-code approach allows you to significantly accelerate the implementation and integration of ready-made AI services into existing business processes that are already automated based on 1C.

The 1C platform already has built-in tools for data mining. The subsystem "Data Analysis and forecasting" provides basic capabilities for applying machine learning algorithms to data stored in the 1C information database. 1C also makes it possible to interact with python scripts (which are the de facto standard for development in the field of Data Science and machine learning). This approach provides maximum flexibility for embedding complex models that are developed in Python into 1C functionality, ensuring seamless execution of complex tasks.

For example, Low-code systems allow you to quickly develop a user interface in 1C, where the purchasing manager can see the demand forecast. This forecast will be based on an ML model trained on historical sales data from 1C, as well as on external factors (seasonality, marketing campaigns), called through an HTTP service or Python integration.

Thus, the synergy of low-code capabilities and flexible intelligent services helps companies not only automate current processes, but also intellectualize them with unprecedented speed and adaptability, providing a real competitive advantage in the market.

Looking to the future indisputably points to a further strengthening of the trend towards simplification and intellectualization of the IT landscape. Companies that invest in the development and application of low-code approaches combined with artificial intelligence capabilities are laying the foundation for their sustainability, efficiency and leadership in the future.

REFERENCES

1. Iskusstvennyy intellekt i prediktivnaya analitika //otraslevye i spetsializirovannye resheniya 1S:Predpriyatie [Artificial intelligence and predictive analytics // Industry and specialized solutions 1C:Enterprise] : sayt. – URL: https://cio-navigator.ru/low-code-digital-transformation/ (data obrashcheniya: 26.02.2026). (in Russian).

2. Low-code v detal'yakh: obzor instrumentov, kotorye uskoryayut tsifrovuyu transformatsiyu // CIO-NAVIGATOR : sayt. – URL: https://cio-navigator.ru/low-code-digital-

transformation/ (data obrashcheniya: 26.02.2026). [Low-code in detail: an overview of tools that accelerate digital transformation] // CIO-NAVIGATOR : website. – URL: https://cio-navigator.ru/low-code-digital-transformation/ (accessed: 26.02.2026). (in Russian).

3. Low-code revolyutsiya 2026: kak platformy stali meynstrimom i chto zhdet v 2026 [Low-code revolution 2026: how platforms became mainstream and what awaits in 2026] // OOO «Tsentr vnedreniya dokumentooborota» : sayt. – URL: https://centrvd.ru/blog/low-code-revolyuciya-2026 (data obrashcheniya: 26.02.2026). (in Russian).

NEURAL NETWORKS IN SOFTWARE DEVELOPMENT

A. I. Kradinov, S. E. Generozov

Novosibirsk, *Novosibirsk State Technical University*,
kradinatoly05@gmail.com, cgenerozov@gmail.com

Abstract. The article compares the results of international and Russian studies on the implementation of generative AI in software development. The scale of application of AI assistants and their impact on productivity, code quality, and documentation automation are demonstrated. The limitations associated with trust in generation and data security are also considered, including Russian specifics: the development of local models and the trend toward low-code/no-code solutions.

Keywords: AI, neural networks, generative AI, AI implementation, development, AI assistants, domestic AI, code generation.

НЕЙРОННЫЕ СЕТИ В РАЗРАБОТКЕ ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ

А. И. Крадинов, С. Е. Генерозов

Аннотация. В статье сопоставляются результаты международных и российских исследований о внедрении генеративного ИИ в разработку программного обеспечения. Показаны масштабы применения ИИ-ассистентов и их влияние на продуктивность, качество кода и автоматизацию документации. Также рассмотрены ограничения, связанные с доверием к генерации и безопасностью данных, в том числе российская специфика: развитие локальных моделей и тренд low-code/no-code.

Ключевые слова: ИИ, нейросети, генеративный ИИ, внедрение ИИ, разработка, ИИ-ассистенты, отечественный ИИ, генерация кода.

Over the past several years, generative artificial intelligence has evolved from an experimental technology designed to generate plausible text into a working tool used by specialists in software development. At present, it is applied not only for code

generation and the creation of accompanying documentation, but also for more complex tasks, such as supporting decision-making in the process of designing the architecture of software applications.

However, the introduction of artificial intelligence may have contradictory consequences. Along with increased productivity and the automation of routine processes, risks related to the quality and security of generated code fragments arise. Even with the maximum integration of generative models, companies still require sufficiently competent staff to perform a thorough verification of the obtained results.

This article compares the results of international and Russian studies on the implementation of generative artificial intelligence in the software development process and summarizes the current trends in this field.

In 2025, Google and the analytical publication Techreviewer published large-scale studies on the current situation regarding AI assistants in software development. According to these analytics, the adoption of AI among companies reached 97% compared to 91% in 2024, and 90% of respondents from a broad sample reported that they already use neural networks in their work [3, 4].

The main reason for the widespread implementation of AI is the increase in productivity: over 80% of specialists noted this as a positive result of integrating neural networks into their work. Also, 83% of companies report productivity growth, and almost a quarter report a radical acceleration of work. Approximately two-thirds of the respondents generate code using AI, and 67% use it for automatic documentation. In addition, 59% of developers claim an improvement in code quality [3, 4].

Despite the obvious advantages, the global market faces a number of challenges. According to 47.5% of respondents, the main issues are trust in AI and data security. For this reason, the share of companies relying on external AI solutions decreased to 17% by 2025, while 59% of organizations have already hired or trained in-house AI specialists to develop and maintain local AI systems [3].

Meanwhile, the Russian market demonstrates its ability to rapidly and effectively adapt to the integration of generative artificial intelligence into the workflow. More than 90% of technical directors in Russia believe that the level of development and adoption of AI in the country is above average, while the time spent using AI in software development in Russia increased more than tenfold between 2023 and 2024 [1]. At the same time, 71% of Russian IT companies openly report using AI in business processes [5].

The Russian IT sector is also actively following the course of import substitution and maintaining mutually beneficial relations with partners from friendly countries. Domestic large language models have been actively developing on the market for several years, including YandexGPT and GigaChat, which are capable of competing

seriously with Western analogues. In addition, national AI plugins are being developed — specialized software for writing program code, such as Source Code Assistant from Yandex and GigaCode from Sber [1].

Among the main advantages of local models, 42% of respondents mention the availability of documentation in Russian, while another 40% emphasize reduced dependence on foreign providers. In total, 49% of respondents express a positive attitude toward domestic platforms, whereas only 8% evaluate them negatively [7].

It is also important to note a pronounced trend in the Russian market toward the transition to low-code and no-code platforms created with the help of AI technologies. At present, the capitalization of this segment amounts to $37.39 billion [2].

At the same time, programmers demonstrate a contradictory attitude toward AI. On the one hand, 62% of Russian programmers evaluate their level of trust in AI as high. On the other hand, 30% of programmers worldwide do not trust work performed by AI. In Russia, the situation is similar: 70% of specialists are dissatisfied with the quality of generated code. More than one third of respondents report correcting AI-generated code in almost every case. Nevertheless, the volume of generation remains significant — for example, 8% of the entire codebase of MTS services is fully generated by AI [1, 4].

When selecting tools, 70% of programmers prefer not to experiment and use only one AI tool, while 23% prefer to work with two or more models simultaneously. Among Java developers, 48% use AI tools (35% of them prefer ChatGPT). The AI assistant market is highly competitive, and provider companies continuously compete with each other by releasing increasingly advanced versions of their models. As a result, 50% of companies already using AI assistants are considering testing another platform or are ready to switch to one within a year [1, 7].

The industry is actively adapting to new realities. Even at the present moment, 79% of novice software developers are learning to use neural networks in code generation. However, fears of the complete replacement of humans by coding agents appear to be exaggerated: only 6% of IT specialists believe that artificial intelligence will be able to fully automate development tasks, while 61% believe that automation will be partial and will affect only routine and typical processes. According to 80% of respondents, the changes will affect junior developers most strongly; in particular, tasks of testers and data analysts are expected to be automated first [7].

It should also be emphasized that the field of artificial intelligence in software development is currently experiencing a stage of rapid growth. Over the past six years, the length of tasks that generative models can autonomously solve with a success probability of at least 50% has doubled approximately every seven months. If the current growth in efficiency is extrapolated, AI systems may become capable of autonomously performing tasks within the next few years that currently require

several weeks of work by specialists. The extremely rapid development of coding agents leads to a situation in which research on this topic quickly loses relevance, and studies published even half a year earlier may become outdated: tasks that were unsolvable for AI at the time of publication may already be solved with minimal human involvement [6].

Based on the long-term trend of rapid growth in the productivity of generative models in software development tasks, as well as the widespread integration of coding agents into the workflow of the IT sector, it can be concluded that the use of AI in software creation is becoming an increasingly ordinary part of the development process, significantly increasing both the speed and quality of development. At the same time, AI should not be considered an independent and complete replacement for developers. It is more appropriate to treat it as a tool capable of transforming software development for the better, since human resources currently spent on routine work can be redirected toward more productive and valuable activities.

REFERENCES

1. 22-e ezhegodnoe issledovanie industrii razrabotki programmnogo obespecheniia (PO) v Rossii [22nd Annual Study of the software development industry in Russia] (2025). *NP «RUSSOFT»* [*NP "RUSSOFT"*]. URL: https://russoft.org/analytics/22-e-ezhegodnoe-issledovanie-russoft-2025-industriya-programmnogo-obespecheniya-v-rossii/ (accessed 05.03.2026). (in Russian).

2. 5 kliuchevykh IT-trendov 2026 goda: ot II-agentov i Zero Trust do suverennykh oblakov [5 key IT trends of 2026: from AI agents and Zero Trust to sovereign clouds] (2026). *Khabr* : *blog kompanii Selectel* [*Habr* : *Selectel company blog*]. URL: https://habr.com/ru/companies/selectel/articles/993000/ (accessed 05.03.2026). (in Russian).

3. AI in Software Development 2025: From Exploration to Accountability. A Global Survey Analysis (2025). *Techreviewer*. URL: https://techreviewer.co/blog/ai-in-software-development-2025-from-exploration-to-accountability-a-global-survey-analysis (accessed 05.03.2026).

4. Announcing the 2025 DORA Report: State of AI-assisted Software Development (2025). *Google Cloud Blog*. URL: https://cloud.google.com/blog/products/ai-machine-learning/announcing-the-2025-dora-report (accessed 05.03.2026).

5. Iskusstvennyi intellekt v Rossii – 2025: trendy i perspektivy [Artificial intelligence in Russia – 2025: trends and prospects] (2025). *Yandex*. URL: https://yandex.ru/company/news/08-12-2025-01 (accessed 05.03.2026). (in Russian).

6. Kwa, T., West, B., Becker, J. et al. (2025) Measuring AI Ability to Complete Long Tasks. *METR*. URL: https://metr.org/blog/2025-03-19-measuring-ai-ability-to-complete-long-tasks/ (accessed 05.03.2026).

7. Yandex B2B Tech, ITMO. (2025) Iskusstvennyi intellekt v razrabotke: trendy i real'noe primenenie [Artificial intelligence in development: trends and real application]. *Yandex Cloud*. URL: https://yandex.cloud/ru/blog/devtools-research-2025(accessed 05.03.2026). (in Russian).

ANALYSIS OF ARCHITECTURAL SOLUTIONS USING THE EXAMPLE OF GEOGRAPHIC INFORMATION SYSTEMS

A. A. Kuznetsov

Research advisor: D.S. Smirnov, Cand. Sc. (Econ.)

Moscow, National Research Nuclear University "MEPhI",
ababaan365@gmail.com

Abstract. Geoinformation web systems play a key role in analyzing the socio-economic development of territories and improving the efficiency of interaction between business and government. A comparative analysis of geo-platforms made it possible to identify the main requirements for an effective system: flexible geovisualization, interactive dashboards, and data filtering that ensure transparency and prompt decision-making.

Keywords: digital transformation, GIS, benchmarking, public administration, business analytics, design, Arctic zone.

АНАЛИЗ АРХИТЕКТУРНЫХ РЕШЕНИЙ НА ПРИМЕРЕ ГЕОИНФОРМАЦИОННЫХ СИСТЕМ

А. А. Кузнецов

Аннотация. Геоинформационные веб-системы играют ключевую роль в анализе социально-экономического развития территорий и повышении эффективности взаимодействия бизнеса и государства. Сравнительный анализ геоплатформ позволил выявить основные требования к эффективной системе: гибкая геовизуализация, интерактивные дашборды и фильтрация данных, обеспечивающие прозрачность и оперативность принятия решений.

Ключевые слова: цифровая трансформация, ГИС, бенчмаркинг, государственное управление, бизнес-аналитика, проектирование, Арктическая зона.

The digital transformation of the economy and public administration in the Russian Federation requires new tools for data collection and analysis, especially in strategically important regions such as the Arctic zone (AZRF), where the interests of the state and business intersect. The Ministry for the Development of the Far East and Arctic identifies priority settlements for regular monitoring [2, 3]. Businesses need transparent information about the socio-economic climate, infrastructure, and energy supply. The development of an information and reference web system is seen as a tool for reconciling the interests of the state and business.

Based on an analysis of five reference digital platforms, architectural and functional solutions have been identified that ensure effective interaction between official data providers and analytics consumers [5].

The OECD Local Data Platform is considered a benchmark for parametric spatial-statistical analytics systems. This platform implements mechanisms for filtering territories by ranges of quantitative indicators, multi-layer visualization using vector tiles, and tools for comparative analysis of regions. Together, these solutions ensure high interface performance and effective support for territorial development benchmarking tasks.

The European Urban Data Platform (a European Commission project) demonstrates an example of the implementation of a predictive and analytical approach to territorial development management. The system integrates scenario models of spatial development, supports time series analysis through an interactive timeline, and provides programmatic access to data via API. This allows the platform to be used not only as a visualization tool, but also as an element of strategic planning and cross-system integration.

The Digital Atlas of Australia (an Australian Government initiative) is an example of a centralized interagency spatial data infrastructure. The atlas implements a single point of access to distributed government information resources, uses unified data publication standards, provides a role-based access control model, and supports semantically enhanced search. This approach reduces the fragmentation of information resources and improves the consistency of official data between agencies.

The DCRA Open Data portal (Alaska Department of Natural Resources) is characterized by a high degree of detail on remote and sparsely populated areas. The resource contains information on infrastructure, budget parameters, and natural risks of settlements, and integrates climatic and environmental spatial layers. This provides the opportunity for a comprehensive assessment of infrastructure and natural constraints when making management and investment decisions.

The PolicyMap platform is considered a benchmark for applied socio- economic geospatial analytics focused on supporting management and investment decisions at the local level. The system aggregates state, municipal, and commercial data into a single spatial model, supports the creation of thematic indexes (housing market, demographics, income, infrastructure), user filtering tools, report generation, and export of analytical samples. An architecturally significant feature is its focus on scenario analysis of territories based on user tasks: the platform allows the formation of analytical layers and reports without the need for specialized GIS competencies. This approach increases the accessibility of spatial analytics for businesses and government agencies and demonstrates an effective model for transforming disparate statistical sets into an applied decision-making tool.

The analysis of negative cases is no less important, as it allows architectural limitations and bottlenecks that can negate the value of the information system to be identified.

The National Census Atlas (RDM) project demonstrates the problem of inefficient geometry handling: the lack of generalization when scaling leads to the loading of detailed statistical blocks even at the national level, which overloads the browser and reduces performance. The lack of analytical panels also limits the practical value of the system, turning it into a static map. This case confirms the need for a hierarchical structure of spatial data, where the detail of the geometry is linked to the scale of display.

The LG Inform portal (UK), on the other hand, highlights the problem of the lack of spatial context: the system does not have a cartographic interface, and analytics are presented in separate dashboards with limited visualization and filtering. The weak connectivity of the datasets makes comprehensive analysis difficult, which reduces the platform's usefulness for tasks that require consideration of geographical factors.

The Statistical Atlas of the United States illustrates the shortcomings of the user experience: rigid hierarchical navigation without free scaling and panning, the lack of correct color coding for several indicators, and the presence of many inconsistent dashboards complicate the user's work. The case study highlights the importance of intuitive navigation and correct color coding.

GeoSearch Canada demonstrates a disregard for basic interactivity standards: some of the geodata is presented in static formats (e.g., PDF), the interactive map takes up minimal space, and the data is fragmented. The lack of analytics and visual coding turns the resource into a file archive rather than a decision-making tool, which contradicts the principles of digital transformation.

The conducted analysis makes it possible to formulate the key architectural principles of the designed information and reference system, classifying it as an instrumental geo-analytical platform for the Russian Arctic Zone, oriented toward addressing government and business tasks [4].

First, the system should be hybrid in nature, combining geovisualization and analytical data processing. To prevent problems, the cartographic subsystem should be built on a hierarchical principle with geometry generalization depending on the scale.

Secondly, it is necessary to provide a single point of access to data and analytics. Unlike the architecture of the Statistical Atlas of the United States, it is proposed that analytical panels be integrated directly into the mapping interface. When selecting a region or settlement, the user should receive a single dynamic dashboard with key

indicators: demographics, transport accessibility, social infrastructure, and energy supply.

Third, the system should support flexible filtering and comparative analysis of territories, allowing for the formation of samples by aggregate, which is important both for business investment analysis and for monitoring socio-economic indicators by the state.

Thus, the digital transformation of territorial management involves a transition from disparate statistical resources to a unified geo-analytical platform. Benchmark analysis shows that its effectiveness is determined not by the volume of data, but by the sophistication of interfaces and user interaction. Avoiding geometric overload, loss of spatial context, and unintuitive navigation creates the basis for a system capable of linking strategic state goals with practical tasks for the development of the Arctic zone and providing users with up-to-date and structured information for decision-making [1, 3, 4, 5].

REFERENCES

1. Dankin, M. A., Zamyatina, N. Yu. A Special Territory: Why Standard Spatial Development Mechanisms Do Not Work in the Arctic. 2022.

2. Ministry of Economic Development of the Russian Federation. Unified List of Core Settlements of the Russian Federation [Electronic resource]: approved by the Government of the Russian Federation. 2024. Available at: https://www.economy.gov.ru/material/directions/regionalnoe_razvitie/strategistrateg_planirovanie_prostranstvennogo_razvitiya/edinyy_perechen_opornyo_naselennyh_punktov/ (accessed: February 23, 2026).

3. Russian Federation. Order of the Government of the Russian Federation. Strategy for the Spatial Development of the Russian Federation up to 2030 with a Forecast up to 2036: approved by Order No. 4146-r of December 28, 2024. Collected Legislation of the Russian Federation, 2024.

4. Alekseev, A. A., et al. Digital Platforms in the Economy: Essence, Models, Russian Practice: monograph. Edited by E. I. Piskulova; Russian Foreign Trade Academy of the Ministry of Economic Development of the Russian Federation. Moscow: RFTA, 2022. 342 p. ISBN 978-5-9547-0215-6.

5. Shcherbakov, S. M. Methodology for Analyzing the Functional Completeness of Distributed Information Systems: specialty 05.25.05 “Information Systems and Processes”. Abstract of the dissertation for the degree of Candidate of Technical Sciences. Voronezh State Technical University. Voronezh, 2020. 24 p.

READINESS OF THE ORGANIZATION'S EMPLOYEES TO IMPLEMENT AN ARTIFICIAL INTELLIGENCE SYSTEM

T. A. Lorinets, S. D. Sviridova

Novosibirsk State Technical University, Novosibirsk,
lorinecz@yandex.ru

Abstract. The article uses Russia as an example to examine the barriers to the implementation of AI in companies. It shows that while AI offers economic benefits, progress is hindered by regulatory risks, security concerns, and, most importantly, a lack of expertise. The article identifies employee resistance and a shortage of skills as key obstacles to digital transformation. It emphasizes the need for systematic training to effectively integrate AI.

Keywords: Artificial Intelligence (AI) adoption / implementation, Personnel shortage / Skills gap, Employee resistance to change, Digital transformation, Regulatory regulation and security, Economic efficiency / effect, Staff training and support.

ОЦЕНКА УСПЕШНОСТИ ВНЕДРЕНИЯ ИИ: ИССЛЕДОВАНИЕ ЭФФЕКТИВНОСТИ ПЕРСОНАЛА

Т. А. Лоринец, С. Д. Свиридова

Аннотация. В статье на примере России рассмотрены барьеры внедрения ИИ в компаниях. Показано, что при экономической выгоде от ИИ прогресс тормозят регуляторные риски, проблемы безопасности и, главное, дефицит компетенций. Ключевыми препятствиями цифровой трансформации названы сопротивление сотрудников и нехватка навыков. Обоснована необходимость системного обучения персонала для эффективной интеграции ИИ.

Ключевые слова: Дефицит кадров / Нехватка компетенций, сопротивление сотрудников, цифровая трансформация, регуляторное регулирование и безопасность, обучение и поддержка персонала.

The dynamics of the spread of artificial intelligence technologies can be considered using the example of ChatGPT: within two years, its weekly audience exceeded 300 million users. Interest in AI is demonstrated not only by private users, but also by the corporate sector — over 90% of Fortune 500 companies have already integrated relevant solutions into their activities [1]. The pace of AI adoption surpasses the speed of a number of previous technological innovations: for example, it took about ten years to achieve a comparable level of Internet coverage.

However, the development of AI is accompanied by a number of limitations. Key constraints include issues of regulatory regulation and security, which in the current context are more often seen as barriers rather than as opportunities for development [1]. Managers and employees express concern about the risks of data leakage and the likelihood of incorrect results. In addition, the economic effectiveness of AI implementation is often lower than expected: almost half of the relevant projects do not go beyond the development stage and do not provide the planned effect [1].

The greatest concern about the use of AI in professional activities is noted among employees of the public sector, as well as enterprises in the aerospace and defense industries. Thus, only 20% of public sector employees expect a significant impact of AI on their daily work in the coming year. At the same time, estimates in the media industry and telecommunications sector are more optimistic: 65% and 67% of employees, respectively, predict noticeable changes [1].

Global trends are also reflected in Russian practice. In the context of the accelerated digital transformation of the economy, the largest domestic companies are modernizing business processes through the introduction of AI. According to a study by Rostelecom PJSC, more than 76% of Russian enterprises are already using AI solutions (Fig. 1), while the economic effect for companies that have implemented such projects ranges from 0.1 to 1% of revenue (50-500 million rubles) [2].

Despite this, the technological area under consideration is characterized by an insufficient degree of maturity, which makes it difficult to formalize and document financial results. Currently, only 18% of Russian organizations have officially recorded indicators of the economic efficiency of AI implementation [2]. The specifics of the domestic situation are shown in Figure 1.

A significant limitation is the shortage of personnel. With a high demand for basic AI competencies, 87% of employees report a lack of relevant skills, and 39.1% of companies consider this factor as the main barrier to digitalization [3]. 49.9% of organizations report an acute shortage of qualified AI specialists; the combined shortage of IT and AI personnel in Russia (30-35%) exceeds the global average.

The gap between the needs of the business and the level of competence of the staff is actively discussed in the professional community. Managers are ready to invest in AI technologies, but they face a lack of specialists who are able to apply them to solve applied problems [3]. One of the reasons for the personnel shortage may be the resistance of employees to the development and use of new tools in their work practice.

Resistance to change, which is typical for about a third of Russian companies, increases in the absence of systematic communication on the part of management. According to the Cloud Security Alliance, the human factor accounts for 70-80% of

failures in the implementation of AI projects. The example of the King studio (Microsoft) is illustrative, where the demand of managers for the constant use of AI caused a negative reaction from the staff.

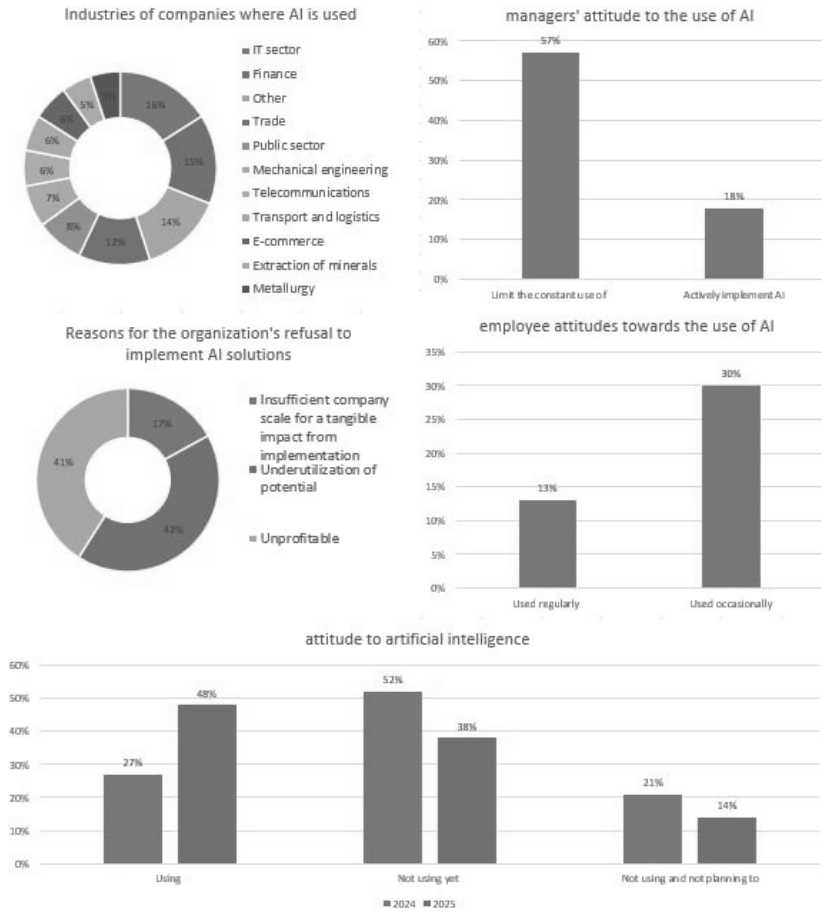


Figure 1. Statistics dashboard

Source: authors.

A key source of resistance is the lack of organizational support: only 29% of employees receive full-fledged training in working with AI. The main concern for 75% of employees is the risk of dismissal due to automation, which is compounded by the limited availability of educational programs [4].

At the same time, only 4% of employed Russians believe that the lack of AI competencies will make it impossible to find employment. According to 37% of respondents, the possession of neural network tools can be considered as an additional

advantage, while 44% believe that employers are more focused on other professional qualities and experience.

Thus, overcoming the tension associated with the introduction of AI involves complex work with staff. The key condition for reducing resistance is the systematic support of specialists and the organization of training aimed at developing practical skills in using AI technologies [4].

To confirm the conclusions, a survey of the target audience was conducted. The survey included questions about respondents' awareness of AI technologies, their attitudes towards automation, perceived barriers to implementation, accessibility of educational programs, and self-assessment of readiness to use new tools in professional activities.

The results showed that 34% of the participants consider AI competencies as a significant advantage in finding employment, and 11% believe that their absence will make it much more difficult to find a job. The main concerns include the likelihood of incorrect responses being generated, information security and privacy risks, and the threat of job cuts.

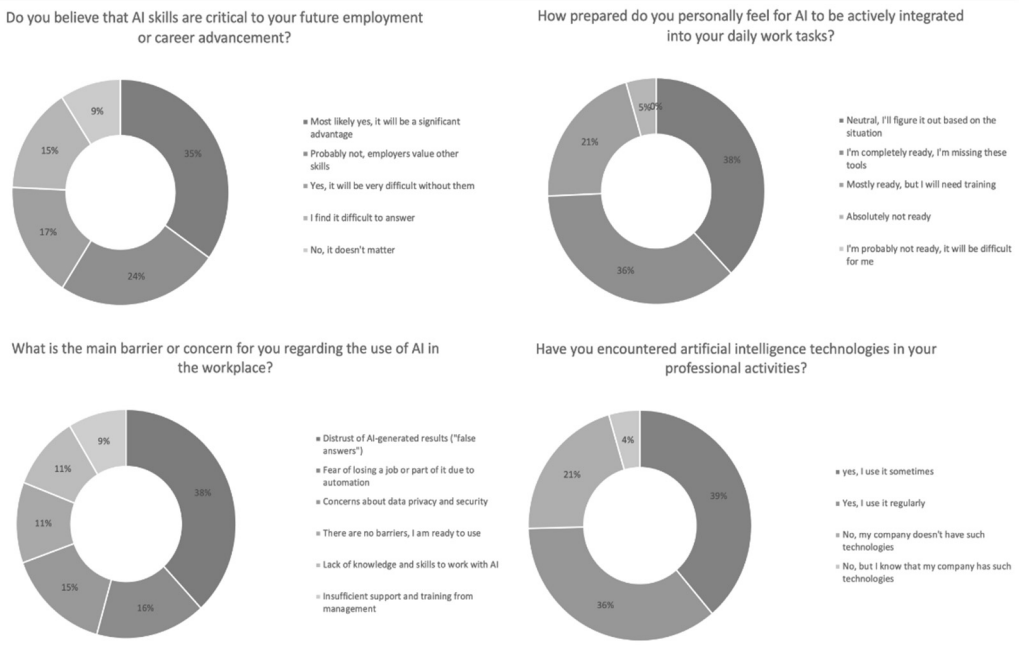


Figure 2. Results of the survey «Attitude towards the use of Artificial Intelligence in work»

Source: authors.

The data obtained confirm that the personnel factor is the central obstacle to the large-scale implementation of AI. The concerns of employees are mainly related to the risk of loss of employment, security threats and unreliability of the results of the algorithms. Therefore, the successful integration of AI into business processes requires priority attention to the development of staff competencies and the creation of conditions for their adaptation to new technological realities.

REFERENCES

1. Savunov V. Sverkhvozmozhnosti na rabochem meste: Kak sotrudniki raskryvayut ves' potentsial II. Chast' 2 [Workplace Superpowers: How Employees Unlock the Full Potential of AI. Part 2] (in Russian) / Savunov V. [Электронный ресурс] // scrumtrek.ru : [сайт]. — URL: https://scrumtrek.ru/blog/ai/16036/kak-sotrudniki-raskryvayut-potentsial-ii-part-2/ (accessed 24.02.2026).

2. Kucherenko S. A., Zaruba D. S. Vnedrenie tekhnologii iskusstvennogo intellekta kak instrumenta vnutrennego kontrolya v organizatsii [Implementation of artificial intelligence technology as a tool for internal control in an organization] (in Russian) // Regional and Sectoral Economics. 2024. No. S1. URL: https://cyberleninka.ru/article/n/vnedrenie-tehnologii-iskusstvennogo-intellekta-kak-instrumenta-vnutrennego-kontrolya-v-organizatsii (accessed 24.02.2026).

3. Lyubko E. 87% sotrudnikov ne gotovy rabotat' s II: kak biznesu zakryt' razryv [87% of employees aren't ready to work with AI: How businesses can close the gap] (in Russian) / Lyubko E. [Электронный ресурс] // companies.rbc.ru : [сайт]. — URL: https://companies.rbc.ru/news/TGxC1q0yt7/87-sotrudnikov-ne-gotovyi-rabotat-s-ii-kak-biznesu-zakryit-razryiv/ (accessed 24.02.2026).

4. Pshinnik K. Pochemu sotrudniki kompaniy soprotivlyayutsya II, i chto s etim delat' [Why Employees Resist AI, and What to Do About It] (in Russian) / — URL: https://companies.rbc.ru/news/flgLC23VcV/pochemu-sotrudniki-kompanij-soprotivlyayutsya-ii-i-chto-s-etim-delat/ (accessed 24.02.2026).

DIGITALIZATION AND AUTOMATION OF EDUCATIONAL PROCESSES IN ROBOTICS ON THE EXAMPLE OF START-UP "STEEL DREAM"

A. D. Martynov, V. V. Pechenkin

Research advisor: E. V. Dragunova, Cand. Sc. (Econ.)

Novosibirsk State Technical University, *Novosibirsk*,
aleksm0008@mail.ru

Abstract. The article discusses the approach to automation of training robot programming within the framework of "Steel Dream" startup. Description of the design of an IT tool based on the core of Google Blockly, solving the problem of "methodological gap" between visual and textual code. The architecture of a hybrid environment is presented, allowing to optimize the cognitive load of students and ensure technological sovereignty of the educational sector.

Keywords: business process automation, EdTech, robotics, Google Blockly, digital transformation of education, visual programming.

ЦИФРОВИЗАЦИЯ И АВТОМАТИЗАЦИЯ ОБРАЗОВАТЕЛЬНЫХ ПРОЦЕССОВ В РОБОТОТЕХНИКЕ НА ПРИМЕРЕ СТАРТАПА «STEEL DREAM»

А. Д. Мартынов, В. В. Печенкин

Аннотация. В статье рассматривается подход к автоматизации обучения программированию роботов в рамках стартапа «Steel Dream». Описано проектирование ИТ-инструмента на базе ядра Google Blockly, решающего проблему «методического разрыва» между визуальным и текстовым кодом. Представлена архитектура гибридной среды, позволяющая оптимизировать когнитивную нагрузку учащихся и обеспечить технологический суверенитет образовательного сектора.

Ключевые слова: Автоматизация бизнес-процессов, EdTech, робототехника, Google Blockly, цифровая трансформация образования, визуальное программирование.

In the modern digital economy, automation of educational trajectories is becoming a key training factor for high-tech industries. The "Steel Dream" (SD) project is a response to the current challenges in the field of EdTech robotics: high cost of imported solutions and difficulty for students to transit from playing mechanics to real engineering activities.

The central objective of the study is to automate the process of learning syntax of programming languages (Python/C++) through the creation of a specialized web application. The problem of "methodical break", when a student loses motivation in switching from blocks to text code, is solved by the implementation of hybrid IT architecture. [3]

System IT core: automation of logic translation.

Google Blockly is chosen as the technological foundation. The choice is based on the need to create a cross-platform, open and flexible custom tool. Automation in this context is implemented through the two-way "VPL-to-Text" bridge. [1]

As part of the "Steel Dream" project, the Blockly core has been adapted in three directions, whose composition is presented in Figure 1:

1. Problem-oriented language design: create unique visual descriptors that automate the typical commands of the robot "Willy".

2. Development of low-level code generators: A JavaScript software module in real time converts high-level block logic into executable code for Arduino microcontrollers.

3. Cloud storage integration: automate the process of saving and verifying student projects.

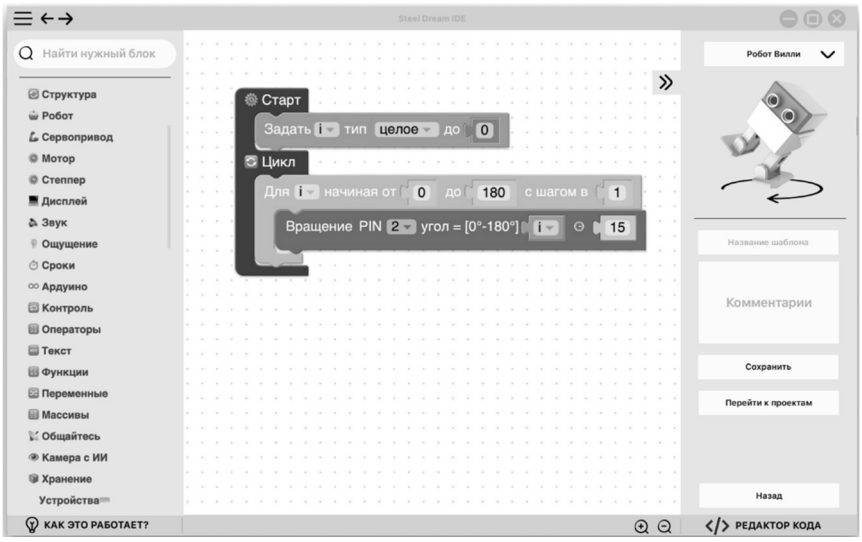


Figure 1. Key system components

Implementation of the developed web application allows automation of error control in early stages. Unlike traditional text environments, where a student spends 40-60% of their time correcting syntax errors, the "Steel Dream" hybrid environment shifts its emphasis to algorithmic. [2.5]

Main automation effects:

- Lowering the cognitive barrier: The system automatically forms the correct steps and code structure (which is critical for Python), allowing the student to focus on the business logic of device control.
- Visual matching: Parallel display of blocks and generated text creates an "interactive textbook" effect, where each action in the visual interface is instantly reflected in the code (figure 2).
- Scalability: A web-based approach allows you to automate classroom deployments without the need for complex software installation on client machines.

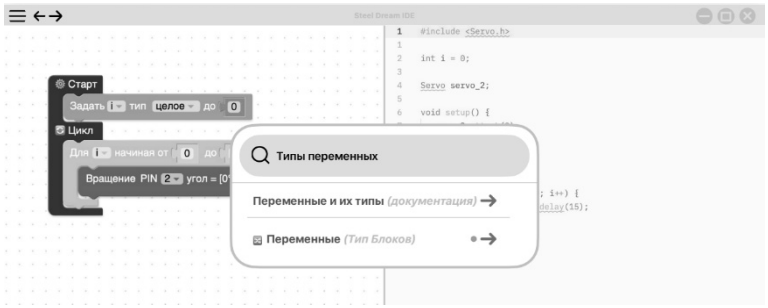


Figure 2. The principle of two-way visualization

Economic and organizational aspects of the startup.

In terms of business process management, creating your own software platform reduces the startup's transaction costs for purchasing foreign software licenses. This enables the generation of an affordable offer for public and private educational institutions in import substitution programs. [4]

The development and implementation of a web application based on Google Blockly in the "Steel Dream" ecosystem allows to automate the transition from the initial level of training to professional programming. The software and hardware complex not only solves the technical problem of controlling a robot, but also acts as a knowledge management tool in the context of the digital transformation of education. This confirms the potential of a start-up as a viable business model capable of providing quality training for future IT specialists.

REFERENCES

1. Fomkina E. S., Kukartsev V. V. Visual programming language Google Blockly// Actual problems of aviation and astronautics. 2013. 9. URL: https://cyberleninka.ru/article/n/vizualnyy-yazyk-programmirovaniya-google-blockly (Application date: 08.02.2026)

2. Fedorychev L. A., Bukunova O. V. Transition from Block to Text Programming in the Training of Schoolchildren in General and Additional Education Systems// MISC. 2022. 11

(125). URL: https://cyberleninka.ru/article/n/perehod-ot-blochnogo-k-tekstovomu-programmirovaniyu-pri-obuchenii-shkolnikov-v-sistemah-obschego-i-dopolnitelnogo-obrazovaniya (Application date: 12.02.2026)

3. Belokonova S. S., Plotnikova M. S. Application of Visual Tools in Learning Programming// Vestnik of the Taganrog Institute named after A. P. Chekhov. 2024. URL: https://cyberleninka.ru/article/n/primenie-vizualnyh-sredstv-v-obuchenii-programmirovaniyu (Application date: 10.02.2026)

4. Yakutin A. M., Koryagin S. V. Designing and Developing an Application for Visual Programming// E-Scio. 2022. 2 (65). URL: https://cyberleninka.ru/article/n/proektirovanie-i-razrabotka-prilozheniya-dlya-vizualnogo-programmirovaniya (Application date: 16.02.2026).

5. Morvinov D. A., Litvinov Y. V. Comparison of educational environments for visual programming of robots// KIO. 2016. 3. URL: https://cyberleninka.ru/article/n/sravnenie-obrazovatelnyh-sred-vizualnogo-programmirovaniya-robotov (Date of application: 14.02.2026)

DESIGNING END-TO-END PROCESSES FOR MANAGING COMPANY TASKS

D. D. Olisko

Research advisor: I. G. Rzun, Cand. Sc. (Phys.-Math.)

Novorossiysk, Novorossiysk Branch of the Financial University under the Government of the Russian Federation,
Dariaolisko2006@gmail.com

Abstract. The article discusses the design of end-to-end task management processes in a company using an information system. The current workflow is analyzed, its limitations are identified, and the "AS-IS" process is modeled. An optimized "TO-BE" process is developed using BPMN and a Use Case diagram. The results show that automation of task allocation and control reduces coordination time and improves process transparency.

Keywords: task management, business processes, BPMN, information system, automation, BABOK

ПРОЕКТИРОВАНИЕ СКВОЗНЫХ ПРОЦЕССОВ УПРАВЛЕНИЯ ЗАДАЧАМИ КОМПАНИИ

Д. Д. Олисько

Аннотация. В статье рассматривается проектирование сквозных процессов управления задачами в компании с использованием информационной системы. Анализируется текущий рабочий процесс, выявляются его ограничения и моделируется процесс "КАК ЕСТЬ". С использованием BPMN и диаграммы вариантов использования разработан оптимизированный процесс "КАК НАДО". Результаты показывают, что автоматизация распределения задач и контроля сокращает время согласования и повышает прозрачность процесса.

Ключевые слова: управление задачами, бизнес-процессы, BPMN, информационная система, автоматизация, BABOK.

Effective organization of tasks inside a company is one of the key conditions for achieving strategic objectives, maintaining stable productivity, and ensuring coordinated work across departments. When a business expands and its processes become more complicated, traditional management tools such as verbal instructions, spreadsheets, or simple checklists no longer provide sufficient control. These approaches often require excessive coordination efforts, offer limited visibility of ongoing activities, and increase the probability of human error, which ultimately reduces overall organizational performance [1]. This study aims to evaluate how information systems can be used to redesign task management and create a more integrated and efficient workflow. To accomplish this goal, several steps were carried out: examining existing management practices, identifying problematic stages and bottlenecks, modeling the current state of the process "AS IS", developing an improved version "TO BE", and assessing the outcomes after the introduction of an information system [2].

Task management usually combines several interrelated functions, including goal definition, work planning, distribution of resources, monitoring of progress, and coordination between departments. Such activities are typical for product development, marketing initiatives, internal organizational projects, and service delivery. In most organizations, these processes involve three primary roles: the project manager, the process coordinator, and the task performers. The project manager is responsible for strategic planning and overall supervision. The coordinator provides operational support and tracks deadlines and resources at the departmental level, while performers execute specific assignments and report results. Applying the principles described in the BABOK Guide makes it possible to clearly define responsibilities, structure workflows, and formalize interactions among participants, which is essential when preparing processes for further automation [3].

The analysis of the existing "AS IS" process shows that task allocation is largely manual. Employees typically rely on spreadsheets, email communication, and verbal instructions. As a consequence, information becomes fragmented, progress is difficult to track, and additional time is spent on coordination. Limited transparency and delayed communication increase the likelihood of errors and missed deadlines [1].

To better understand the workflow, a BPMN model was created. It reflects the participation of three roles – project manager, coordinator, and performer – and illustrates the sequence of actions: setting objectives, planning tasks, assigning responsibilities, completing the work, and documenting the results. Some operations occur simultaneously, which requires continuous synchronization between participants (Figure 1).

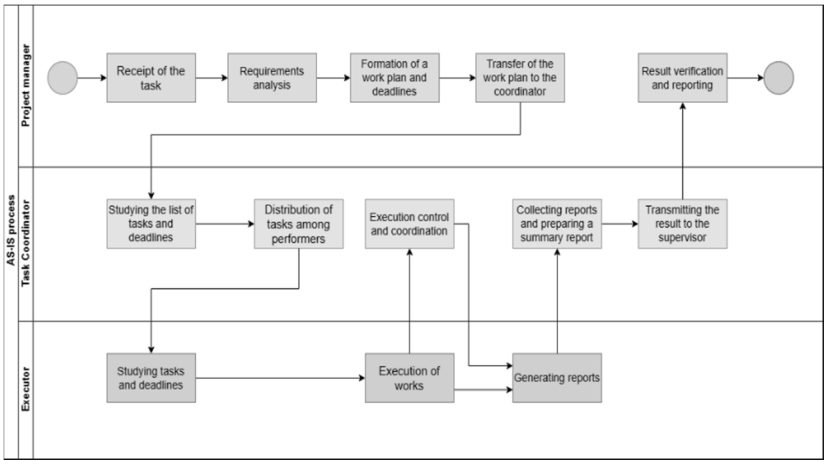


Figure 1. BPMN model of the current task management process (AS-IS)

A closer examination of the AS IS model reveals several weaknesses. Task monitoring depends heavily on manual control, communication between roles is not always timely, and there is no centralized system that provides a clear overview of task status. These factors complicate management and slow down parallel activities. Using BABOK-based approaches helps organize roles and responsibilities in a more systematic way, highlight critical problem areas, and determine which stages should be automated first. This analysis creates a foundation for designing an information system aimed at improving efficiency and reducing coordination costs [4].

The proposed "TO BE" model introduces an information system that automates the distribution of tasks, synchronizes actions between participants, and provides centralized real-time monitoring. In this environment, the project manager prepares task plans and assigns them through the system, receiving automatic notifications

about progress and potential issues. The coordinator supervises resources and deadlines, while performers update task statuses and communicate problems using integrated tools. Such digital interaction reduces the need for manual communication and simplifies information exchange [5].

To demonstrate the future workflow, an updated BPMN diagram was developed. It shows how the information system supports task assignment, performance tracking, delay alerts, reporting, and collaboration between roles (Figure 2).

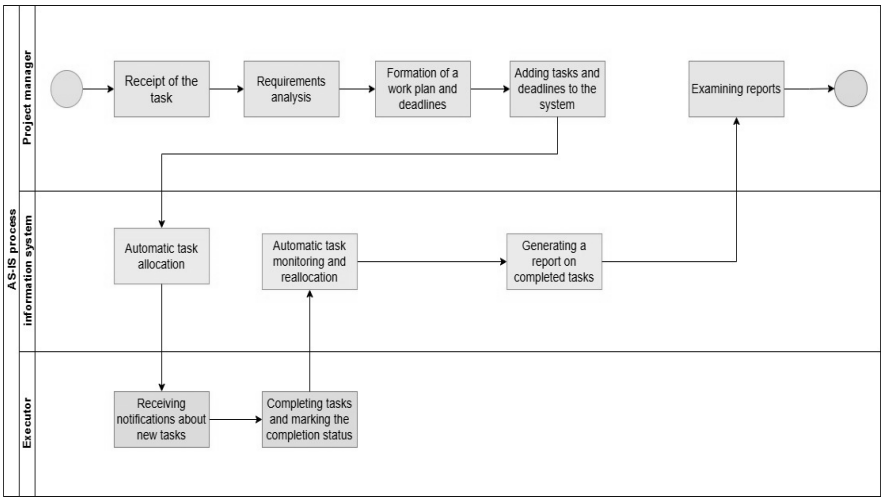


Figure 2. Optimized BPMN model of task management (TO-BE)

After the implementation of the system, noticeable improvements were recorded. A comparison of indicators before and after deployment indicates that the time required for task coordination decreased by approximately 25-30%. The number of execution errors was reduced, and delays in parallel operations occurred less frequently. Access to up-to-date information allowed managers and coordinators to respond faster and make more informed decisions, which also helped lower the workload on employees [7].

In addition, the level of organizational risk decreased due to better transparency, automated reminders about overdue tasks, and continuous monitoring of task completion. Along with measurable improvements, qualitative benefits were observed as well. Cooperation between departments became more consistent, responsibilities were clearer, and conflicts related to task distribution were minimized. Overall, both the speed and accuracy of information processing improved within the unified digital environment [8].

In conclusion, the introduction of an information system proved to be an effective solution for improving corporate task management. The TO BE model demonstrates

that automation, greater transparency, and structured control significantly enhance workflow reliability and performance while reducing the risk of mistakes. The application of the BABOK methodology helped formalize roles and processes, identify critical points, and establish a solid basis for further system development, including support for larger and more complex organizational projects.

REFERENCES

1. Project Management Institute (2022) Task Management in Organizations: Best Practices and Challenges. Available at: https://www.pmi.org/learning/library/task-management-organizations-best-practices-12549 (accessed 10.02.2026).

2. International Institute of Business Analysis (2015) A Guide to the Business Analysis Body of Knowledge (BABOK Guide). Version 3. Toronto: IIBA. Available at: https://www.iiba.org/babok-guide/ (accessed 10.02.2026).

3. Lee, H., Kim, S. (2019) Information Systems for Event Coordination and Control. Journal of Event Management, 5(2), 102–110. Available at:https://www.researchgate.net/publication/333456789_Information_Systems_for_Event_Coordination_and_Control(accessed 10.02.2026).

4. Andersson, J., Svensson, P. (2021) Business Process Mapping and Analysis for Corporate Task Management. International Journal of Business Process Integration and Management, 12(3), 45–60. Available at: https://www.inderscience.com/info/inarticle.php?artid=112345 (accessed 10.02.2026).

5. Ng, B.-Y., Kankanhalli, A. (2012) Information Systems for Large-Scale Task Management: A Case Study. Pacific Asia Journal of the Association for Information Systems, 4(3). Available at: https://pajais.isworld.org/article/view/12345 (accessed 10.02.2026).

6. Ramesh, K., Sujatha, D., Ramesh, L. (2023) Business Process Automation in Corporate Task Planning. Journal of Event Technology, 7(2), 45–58. Available at: https://www.journalofeventtech.com/article/2023-07 (accessed 10.02.2026).

7. Ng, B.-Y., Kankanhalli, A. (2014) Evaluation of Information Systems in Corporate Task Management. Pacific Asia Journal of the Association for Information Systems, 5(1), 33–50. Available at: https://pajais.isworld.org/article/view/23456 (accessed 10.02.2026).

8. Johnson, R., Williams, K. (2022) Business Process Improvement and Automation in Corporate Planning. Cham: Springer. Available at: https://link.springer.com/book/10.1007/978-3-030-95000-0 (accessed 10.02.2026).

AUTOMATION IN COMPARISON OF STANDARD CLASSIFIERS FOR CONSTRUCTION WORKS TYPES TO ENABLE INTELLIGENT FORECASTING OF QUALITY CONTROL PROCEDURES

A. S. Serova

Research advisor: D.S. Smirnov, Cand. Sc. (Econ.)

Moscow, National Research Nuclear University MEPhI,
as.serova@mail.ru

Abstract. The paper considers the problem of automating construction quality control based on formalizing the comparison of classifiers of construction and installation works and control procedures. The inobjectivity of mappings between classifications is demonstrated, and their lexical comparison is shown to be impractical. A deterministic model for forming control plan is proposed based on the technological properties of works.

Keywords: construction control, classification mapping, process classification, control procedures, semantic interpretation, deterministic planning.

АВТОМАТИЗАЦИЯ СОПОСТАВЛЕНИЯ НОРМАТИВНЫХ КЛАССИФИКАТОРОВ ВИДОВ СТРОИТЕЛЬНО-МОНТАЖНЫХ РАБОТ ДЛЯ ИНТЕЛЛЕКТУАЛЬНОГО ПРОГНОЗИРОВАНИЯ ПРОЦЕДУР СТРОИТЕЛЬНОГО КОНТРОЛЯ

А. С. Серова

Аннотация. В работе рассматривается задача автоматизации строительного контроля на основе формализации сопоставления классификаторов видов строительно-монтажных работ и контрольных процедур. Показана необъективность отображений между классификациями и обоснована невозможность их лексического сопоставления. Предложена детерминированная модель формирования планов контрольных мероприятий на основе технологических свойств работ.

Ключевые слова: строительный контроль, сопоставление, классификация процессов, процедуры контроля, семантическая интерпретация, детерминированное планирование.

Modern construction quality control systems have become an integral part of ensuring the safety and quality of capital construction projects. Restrictions related to unstructured data in executive documentation (ED) are becoming particularly

relevant. Primary information about completed construction and installation works (CIW) is recorded by engineers in general work logs in natural language using professional vocabulary and slang, which creates a semantic gap between actual performance and regulatory requirements. Russian legislation establishes strict classifiers of types of work in accordance with GOST R 72041-2025 and control procedures in SP 543.1325800.2024 [3, 8]. To structure construction information in accordance with Order No. 344/pr of the Ministry of Construction of Russian Federation and GOST R 70108-2022, the use of XML schemas for work logs is mandatory for the formation of ED in electronic form [6, 2]. However, there is no automated mechanism for matching arbitrary text records with these classifiers.

Contemporary research in the field of construction automation focuses on hardware parameter recording, information model analysis, and natural language processing. Analysis of the actual names of construction and installation works formed during the construction process shows their high lexical variability and practical uniqueness within individual projects. Such data is characterized by significant sparsity and the absence of repetitive stable formulations. Formally high indicators of the strength of the connection between categories are not accompanied by statistical significance. Comparing the names of works with normative classifiers based solely on lexical or frequency analysis is not applicable. This justifies the need to move to semantic interpretation and formalized normative representation [5].

The classification of types of construction and installation works ensures the standardization of accounting, planning, and control processes, thereby reducing discrepancies between technical verification and financial reporting. GOST R 72041-2025 introduces a faceted hierarchy of codes. The “Process” facet predominates in the classification, as it is the defining feature of the technological essence of the operation [1]. With its help, it is possible to compare the type of construction and installation work with the regulated requirements of construction control in accordance with SP 543.1325800.2024. The classification according to GOST is intended for cost estimates and reporting, and is used by budgeters and customers to link time, labor, and material resource standards to specific technological operations.

SP 543.1325800.2024 contains a hierarchical classification of types of work subject to control, aimed at construction control engineers to determine the list of mandatory verification measures based on technological principles. The lowest level of this classification links each operation to a set of input, operational, acceptance, and geodetic controls, as these procedures are regulated as inclusive list of checks to ensure quality [2]. Automated forecasting of this set minimizes subjectivity of selection and ensures compliance with regulatory requirements at all levels of construction process.

Classifications GOST R 72041-2025 and SP 543.1325800.2024 serve different purposes and should exist in parallel. Manually comparing them by subject is time-consuming, as it requires expert analysis. A comparison of the structures of the classifiers showed that the top-level groupings correspond. The major categories of work according to GOST R 72041-2025 are reflected in the sections of SP 543.1325800.2024, where aggregated descriptions of work combine several detailed GOST codes into unified control requirements. The analysis of relationships revealed three types of correspondence in code series: one-to-one, one-to-many, and multiple relationships. Geodetic control requires a separate feature of technological impact on the geometry of the object, since in SP it is highlighted as an end-to-end procedure that is not strictly tied to a single operation. Thus, the identification of the "Process" facet according to GOST provides an initial selection of the control profile, but differences in the detail of the descriptions preclude simple lexical comparison.

Formalizing classification differences requires introducing sets of construction control operations S according to SP 543.1325800.2024 and work codes G according to GOST R 72041-2025. The mapping $F{:}S\to G$ is surjective, i.e., each code $g \in G$ corresponds to at least one operation $s \in S$.

The inverse mapping $F^{-1}{:}G\to 2^S$ is multivalued. $|F^{-1}(g)| > 1$ for 30% of codes g, since on average there are 3–5 SP operations per GOST code. The subset $S_0 \subset S$ for 5–10% of SP tasks does not have a one-to-one correspondence with GOST classifier positions without context, which mathematically proves the inobjectivity of F and the loss of information when switching between classifiers.

Algorithm that generates control plans from SP 543.1325800.2024 profiles, reducing the task to semantic identification in heterogeneous environments [7]. Prediction involves verifying the applicability of procedures to an operation according to the strict ontological reasoning of SP. Semantic recognition of the text in the general work log identifies the type of operation through the detailed faceted classification of GOST R 72041-2025. It serves as the starting point for automation, as it unifies all possible types of work for comparison with the aggregated requirements of SP 543.1325800.2024. Knowing the GOST code, the algorithm deterministically generates a list of control procedures, avoiding ambiguities in the SP's own operations.

To formalize control procedures, we will introduce a vector of technological properties for each type of work in accordance with GOST R 72041-2025. For $g_i \in G$ the components of the vector will be binary predicates that take the value 0 or 1 and characterize the technological features of the work [4]:

$$v_w(g_i) = \langle P_m, P_{hid}, P_{geo} \rangle,$$

where P_m – determines the need for input control of materials; P_{hid} – records the presence of hidden work; P_{geo} – establishes the requirement for geodetic control when changing the geometry of the object.

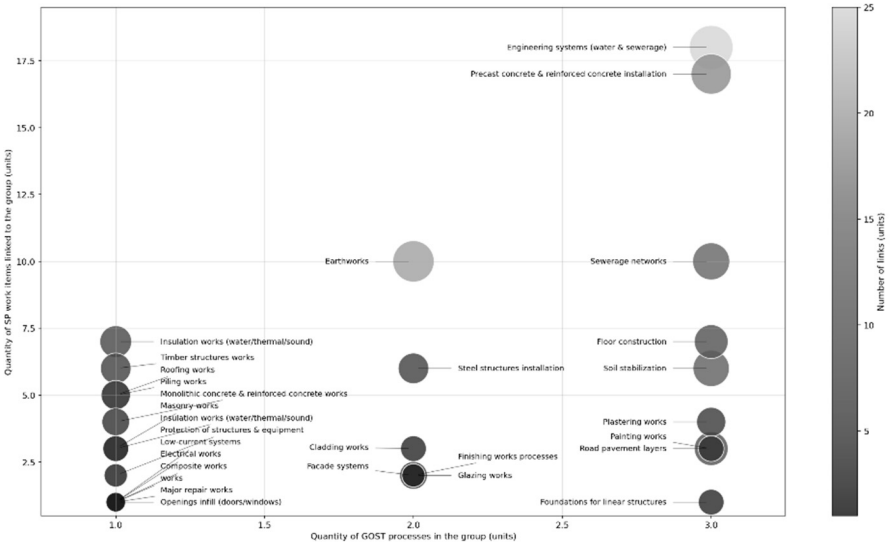


Figure 1. Bubble chart showing the coverage of the GOST work classification system with respect to the SP classification

Based on the vector of technological properties, a vector of control procedures is formed:

$$v_c(g_i) = \langle C_{in}, C_{op}, C_{geo} \rangle,$$

where C_{in} – input control, initiated when materials are introduced into the structure; C_{op} – operational control, mandatory for hidden works that are inaccessible for verification at the next stage of construction; C_{geo} – geodetic control, required when forming new spatial boundaries of the object.

Acceptance control C_{acc} is not included in the vector, as it is mandatory for all completed stages of work, regardless of technological characteristics.

The relationship between vectors $v_w(g_i)$ and $v_c(g_i)$ is defined by a deterministic mapping $\Psi: G \to 2\Pi$, where $\Pi = \{C_{in}, C_{op}, C_{geo}, C_{acc}\}$ is the set of control procedures.

Procedure C_x is included in the plan when $P_x(g_i)=1$ by implication $C_x \in Plan(g_i) \Leftrightarrow P_x(g_i)=1$. The control plan for operation g_i is defined as:

$$Plan(g_i) = \{C_{in} \ / \ (P_m(g_i)=1)\} \cup \{C_{op} \ / \ (P_{hid}(g_i)=1)\} \cup \{C_{geo} \ / \ (P_{geo}(g_i)=1)\} \cup \{C_{acc}\}.$$

This approach provides a deterministic assignment of procedures based on the technological characteristics of the work.

The study justifies the formalization comparability of GOST R 72041-2025 and SP 543.1325800.2024 classifiers for automation of construction quality control business process. The mathematical description of suboptimal mapping $F: S \to G$ and deterministic

model $\Psi: G \rightarrow 2^{\Pi}$ eliminates manual expert analysis, ensuring seamless integration of technical verification with financial reporting in forms KS-2 and KS-3 [1].

The developed algorithm converts unstructured text records of general work logs into structured control action plans, minimizing subjectivity and administrative burden. In the data economy, formalization creates a unified knowledge base for intelligent systems capable of processing streaming executive documentation in real time.

The application of the model in corporate construction information systems will ensure transition from reactive document management to predictive quality management, increasing technological reliability of facilities and reducing risks of the non-compliance with regulatory requirements by eliminating human factor in selection of construction control procedures.

REFERENCES

1. Album of standardized forms of primary accounting documentation for recording work in capital construction and repair and construction work: approved by Resolution of the State Statistics Committee of Russia No. 100 dated November 11, 1999 [Electronic resource]. – ConsultantPlus: legal information system. – URL: https://www.consultant.ru/document/cons_doc_LAW_26303/ (accessed on 12.01.2026).

2. GOST R 70108–2022. Executive documentation. Formation and maintenance in electronic form: national standard of the Russian Federation: approved and put into effect by order of the Federal Agency for Technical Regulation and Metrology dated 19.05.2022 No. 337-st: introduced on 19.05.2022. – Moscow: Russian Institute for Standardization, 2022.

3. GOST R 72041–2025. Classification of construction works. General provisions: approved and put into effect by order of the Federal Agency for Technical Regulation and Metrology dated April 29, 2025, No. 373-st: introduced on August 1, 2025. – Moscow: Russian Institute for Standardization, 2025.

4. Igoshin, V. I. Mathematical Logic and Theory of Algorithms: A Textbook for Students of Higher Educational Institutions / V. I. Igoshin. – 2nd ed., revised. – Moscow: Publishing Center "Academy," 2008. – 448 p.

5. Information Resources and Search Engines: Textbook / N. V. Maksimov, O. L. Golitsyna, G. V. Tikhomirov, P. B. Khramtsov. – Moscow: MEPhI, 2008. – 400 p.

6. On the approval of the composition and procedure for maintaining executive documentation during the construction, reconstruction, and major repair of capital construction projects: Order of the Ministry of Construction and Housing and Utilities of the Russian Federation dated May 16, 2023, No. 344/pr: registered with the Ministry of Justice of Russia on May 31, 2023, No. 73652 // Official Internet portal of legal information. – 2023. – June 2. – No. 0001202306020006.

7. Serova, A. S. Justification of the need to apply machine learning methods and large language models in the task of classifying construction and installation works / A. S. Serova;

scientific supervisor D. S. Smirnov // Collection of reports from the International Scientific and Technical Conference of Young Scientists at V. G. Shukhov Belgorod State Technological University (Belgorod, May 29–30, 2025). – Belgorod: V. G. Shukhov Belgorod State Technological University, 2025. – pp. 335–340.

8. SP 543.1325800.2024. Construction control during the construction, reconstruction, and major repair of capital construction projects: set of rules: approved by Order of the Ministry of Construction and Housing and Utilities of the Russian Federation No. 950/pr dated December 27, 2024: introduced on January 28, 2025. – Moscow: Ministry of Construction and Housing and Utilities of the Russian Federation, 2024.

INTELLIGENT ASSISTANT FOR ANALYSING THE PRE-OWNED MARKET FOR MOBILE DEVICES

A. A. Surkova, G. E. Yakhyaeva

Novosibirsk, Novosibirsk State University,
a.surkova@g.nsu.ru

Abstract. This paper presents an intelligent system for estimating the cost of pre-owned mobile devices, implementing a hybrid approach to automated analysis. The system combines a data collection pipeline from trading platforms, regression-based cost forecasting, and explainable analysis of results through integration with a large language model and a knowledge graph. Based on a comparative analysis of four models (linear, Ridge, Lasso, and polynomial regression), a second-degree polynomial model was selected as the final model, providing a coefficient of determination $R^2 = 0.75$, an average absolute error MAE = 2,444 rubles, and outperforming linear analogues by 18%. A microservice architecture with a mobile Android client is proposed, including a dialogue subsystem based on LLM and interactive visualization of the graph of device characteristics dependencies. The system has been tested on real data from trading platform advertisements and is ready for implementation in trade-in services.

Keywords: pre-owned smartphone regression analysis, large language models, LLM, knowledge graph, data wrangling, explainable AI.

ИНТЕЛЛЕКТУАЛЬНЫЙ ПОМОЩНИК ПО АНАЛИЗУ ВТОРИЧНОГО РЫНКА МОБИЛЬНЫХ УСТРОЙСТВ

А. А. Суркова, Г. Э. Яхъяева

Аннотация. В работе представлена интеллектуальная система оценки рыночной стоимости подержанных мобильных устройств, реализующая гибридный подход к автоматизированному анализу. Система объединяет конвейер сбора данных с торговых площадок, регрессионное прогнозирование цены и объяснимый анализ результатов посредством интеграции с большой языковой моделью и графовой базой знаний. По итогам сравнительного анализа четырех моделей (линейная, Ridge, Lasso и полиномиальная регрессия) в качестве итоговой выбрана полиномиальная модель второй степени, обеспечивающая коэффициент детерминации $R^2 = 0.75$, среднюю абсолютную ошибку MAE = 2 444 руб. и превосходящая линейные аналоги на 18 %. Предложена микросервисная архитектура с мобильным Android-клиентом, включающая диалоговую подсистему на базе LLM и интерактивную визуализацию графа зависимостей характеристик устройства. Система протестирована на реальных данных объявлений торговых площадок и готова к внедрению в сервисы trade-in.

Ключевые слова: вторичный рынок смартфонов, регрессионный анализ, большие языковые модели, LLM, графовые базы данных, data wrangling, explainable AI.

Introduction

The global market for pre-owned mobile devices has shown steady positive growth in recent years. According to analytical reports by IDC and Counterpoint Research [1], global sales of refurbished smartphones reached 282 million devices in 2023, with experts predicting growth to 400 million by 2026. The Russian market is following global trends: every year, sales of pre-owned mobile devices grow more than fourfold compared to the previous period.

At the same time, participants in the pre-owned market experience significant difficulties in assessing the value of devices before publishing them on online platforms. The methods used in practice are mainly expert in nature and are largely determined by subjective perceptions, which reduces the reliability of the results and makes it difficult to explain them.

The goal of this work is to create an intelligent assistant that provides the functionality of automatic assessment of the market value of pre-owned mobile devices and explainable results based on current data from trading platforms.

The scientific novelty of the research lies in the development of a hybrid approach that combines regression analysis methods, knowledge graph, and LLMs within a single platform.

Data collection and preparation subsystem

To create the database of advertisements on which the regression model is based, an automated data collection pipeline was developed to collect data from Russian online marketplaces.

Data preparation involved several stages. In the first stage, structured characteristics were extracted from the text descriptions of the advertisements: model, RAM and ROM capacity, condition of the body and screen, completeness of the package, and overall condition of the device. Next, the features were normalized: categorical features were encoded using one-hot encoding, and numerical features were Z-standardized.

Regression modeling of cost

Four regression models were trained to predict the cost of a device based on its technical characteristics. The training sample includes six features: device condition, screen condition, body condition, manufacturer, ROM capacity (GB), and RAM capacity (GB). The target variable is the cost of the device (in rubles).

The data was divided into training and test samples in a ratio of 80 to 20. The stability of the results was verified by five-fold cross-validation. The quality of the models was evaluated using two metrics: MAE (Mean Absolute Error) and R^2 (coefficient of determination) See Table 1.

Table 1 – Results of regression model training.

Model	R^2 (test)	MAE (test), rub.	CV R^2 (5 folds)	CV MAE (5 folds), rub.
Linear	0.6339	2 968	0.6362 ± 0.0337	3 025 ± 120
Ridge (a = 1.0)	0.6339	2 968	0.6362 ± 0.0337	3 025 ± 120
Lasso (a = 100.0)	0.6319	2 964	0.6353 ± 0.0352	3 020 ± 121
Polynomial (deg=2)	0.7487	2 444	0.7664 ± 0.0440	2 434 ± 39

All three linear models (classical, Ridge, and Lasso) [2] showed similar results: $R^2 \approx 0.63$ and MAE≈2,966 rubles. These indicators can be explained by the fact that linear models cannot capture nonlinear dependencies between features. It is worth noting that the cross-validation results practically coincide with the test results (CV $R^2=0.636$), which indicates the absence of overfitting. The second-degree polynomial model showed a qualitatively better result: the coefficient of determination increased to 0.7487 (+0.115), and the MAE decreased to 2,444 rubles. The MAE between folds for the polynomial model is three times lower (±39 rubles vs. ±120 rubles), which indicates a more stable generalization. Based on the above facts, the polynomial model was chosen as the final model for the system.

Implementation of the dialogue system

One of the distinctive features of the system is its integration with LLM, which allows users to obtain information about the device and its characteristics in the form of a dialogue by asking questions in text form. The LLM service always returns a two-component structure: an explanation in natural language and a set of triplets – a structured representation of information in the form of a graph describing the relationships between various device characteristics. To improve the user experience, a function has been implemented to automatically initiate a dialogue after device diagnostics are complete: when the dialogue screen is opened, the system checks whether the history contains at least one message, and if the history is empty and the first report has already been generated, the system automatically sends the question "Describe my device in terms of its market value." This approach ensures a smooth transition from the diagnostics stage to the dialogue stage and solves the "blank slate" problem - the user does not need to formulate the first question themselves.

In addition to displaying the chat with LLM, the system visualizes the second block of the server's response - a knowledge graph about the device. The nodes of the graph are entities (device characteristics, components, indicators), and the edges are the relationships between them.

Architecture of the intelligent assistant

The system is implemented in accordance with the principles of microservice architecture, which allows individual components to be scaled independently and ensures high fault tolerance.

The server part includes four microservices: a service gateway, a cost analysis service, a graph knowledge base, and an LLM module.

The client application for the Android platform implements automated testing of twelve hardware parameters of the device, including processor performance, battery status, and the operability of sensors and network modules.

Research results

A comparative analysis of four regression models showed that the polynomial model for regression analysis produces the best results for working with features describing the state of mobile devices, outperforming linear analogues by 18% in terms of MAE metrics. The LLM-based dialogue subsystem provides meaningful text explanations and structured triplets, while the visualization component allows for a clear representation of the graph of device characteristics dependencies. At the same time, it is important to note the limitations of the system: the quality of predictions significantly depends on the completeness and accuracy of the source data in the

advertisements, and the current version does not provide for automatic analysis of visual defects. Further development directions include the integration of multimodal language models for computer vision and the construction of predictive models of price trends.

Conclusion

During the research, an intelligent assistant was developed [3] for analyzing the pre-owned market for mobile devices, combining regression analysis, a graph knowledge base, and LLM within a unified microservice architecture. The LLM-based dialogue system generates text explanations and structured graph representations, while the visualization component provides a clear display of the relationships between device characteristics. The system's functionality has been tested on real data from marketplace listings and on physical devices, confirming its readiness for implementation in trade-in services.

REFERENCES

1. Rynok poderzhannykh i vosstanovlennykh smartfonov [The used and refurbished smartphone market] Available at: https://www.tadviser.ru/index.php/Статья:Рынок_поддержанных_и_восстановленных_смартфонов (accessed 09.12.2025).

2. Gujarati D. Basic Econometrics. - 5th ed. - New York: McGraw-Hill, 2021. - 942 p.

3. Surkova A. A. (2025) Razrabotka programnogo kompleksa po avtomatizirovannomy analizy stoimosti b/u mobilnih ustroistv [Development of a software package for automated analysis of the cost of used mobile devices]. Materiali X Megdunarodnoi konferncii “Znaniya-Ontologii-Teorii” [Proceedings of the X International Conference "Knowledge - Ontologies - Theories"], Novosibirsk, October 20-24, p. 371. (in Russian).

A COMPREHENSIVE APPROACH TO FORECASTING BANKING SUPERVISION INDICATORS

A. R. Tsukanova

Research advisor: G.E. Yakhyaeva, Cand. Sc. (Phys.-Math.)

Novosibirsk, *Novosibirsk State Technical University*,
sasha.2014.21@yandex.ru

Abstract. The paper addresses the problem of automating the forecasting of indicators of the bank's economic position. The importance of forecasting for the purposes of banking supervision and intrabank management is substantiated. The shortcomings of traditional methods of data processing are revealed. A two-stage

solution architecture is proposed: automation of data collection and validation using VBA macros, and the implementation of a forecasting model in Python using the λ-method, as regulated by the Bank of Russia Ordinance.

Keywords: forecasting, bank economic position assessment, automation, VBA macros, regulatory reporting, Python.

КОМПЛЕКСНЫЙ ПОДХОД К ПРОГНОЗИРОВАНИЮ ПОКАЗАТЕЛЕЙ БАНКОВСКОГО НАДЗОРА

А. Р. Цуканова

Аннотация. В статье рассматривается проблема автоматизации прогнозирования показателей экономического положения банка. Обоснована значимость прогнозирования для целей банковского надзора и внутрибанковского управления. Выявлены недостатки традиционных методов обработки данных. Предложена двухэтапная архитектура решения: автоматизация сбора и валидации данных с помощью макросов VBA и реализация прогнозной модели на Python с использованием метода λ, регламентированного Указанием ЦБ РФ.

Ключевые слова: прогнозирование, оценка экономического положения банка, автоматизация, макросы VBA, регулятивная отчетность, Python.

The assessment of a bank's economic position is one of the key tools of banking supervision used by the Bank of Russia to classify credit institutions according to their risk level for depositors and creditors. The results of this assessment directly determine the intensity of supervisory actions and the number of contributions made by banks to the compulsory deposit insurance fund: the worse the assessment, the closer the supervision and the higher the contribution [5]. The current methodology for economic position assessment, established by Bank of Russia Ordinance No. 4336-U, involves a comprehensive analysis of capital, assets, profitability, liquidity, as well as interest rate risk and concentration risk, based on which a bank is assigned to one of five classification groups [4]. However, an analysis of current trends shows that this methodology has lost the necessary risk sensitivity. Most banks fall into the same group despite differences in their actual risk profiles, and the indicators used reflect problems that have already materialized rather than potential threats. Under such conditions, the ability to conduct a forward-looking assessment of a bank's future state becomes a critically important task for both the regulator and the credit institutions themselves [5].

The availability of a sound forecast allows a bank to assess the dynamics of key indicators, forecast profitability, coordinate the activities of its divisions in a timely

manner, and, if necessary, adjust its development strategy to avoid falling into higher-risk groups. Effective forecasting becomes a core management function, enabling a bank to maintain financial stability in an unstable economic environment and avoid situations that threaten the interests of creditors and depositors [3].

The methodological basis for such forecasting is laid down by the Bank of Russia Ordinance itself, which mandates the calculation of forecast values for capital and profitability indicators 12 months ahead. The calculation is performed using the formula:

$$Ct + 12 = Ct + \Delta \times N,$$

where Ct is the unrounded value of the capital or profitability indicator component at the reporting date; Δ is the average growth, calculated using correction coefficients λ based on data from previous periods; N is the forecasting period.

If the forecast deviates from the actual values by 2 points or more, the supervisory authority has the right to adjust the bank's final assessment, which underscores the importance of forecast quality [4].

However, the implementation of even this formalized model in practice encounters the problem of source data quality. Research shows that the bulk of information for regulatory reporting circulates in spreadsheet formats and processing it manually or using disparate tools leads to data fragmentation, high labor costs, and significant operational risks [1].

In this study, a software solution implementing a two-stage forecasting architecture was developed. The first stage addresses the problem of "raw" tabular data, while the second stage implements the forecasting model itself in accordance with the regulator's requirements.

For the first stage, the following VBA macros were developed:

1. Data Collection Macro. This macro automatically processes regulatory reporting files for the retrospective period (25 monthly reports for capital indicators and 9 quarterly reports for profitability indicators). It copies the necessary sheets from the reporting files for each period and consolidates them into a single Excel workbook. In this workbook, each source file corresponds to a separate sheet named with the reporting date. This preserves the structure of the source data and eliminates the need for manual searching and copying.

2. Validation and Primary Calculation Macro. This macro checks the collected data for completeness and correctness. Subsequently, it calculates all intermediate indicators required for forecasting. The calculations are performed strictly according to the algorithms defined in Ordinance No. 4336-U.

Automating these processes significantly reduces data preparation time and minimizes manual entry errors [2]. The macro's output is a prepared dataset, ready for transfer to the forecasting module.

In the second stage, a program was developed in Python to carry out forecasting using the λ-method. The program automatically downloads the current values of the correction coefficients λ from the official website of the Bank of Russia, ensuring compliance with current regulatory requirements. For each forecasted indicator (e.g., capital adequacy, return on assets), an algorithm calculates the weighted average increase Δ using a system of declining weights, where more recent observations are assigned greater weight in accordance with the modified least squares method. The resulting forecast values are automatically rounded according to the rules established by the methodological guidelines. To assess forecast quality, a back testing module is built into the program. This module compares forecast values calculated 12 months ago with the actual values achieved on the current reporting date. If the discrepancy between the forecast and actual score is 2 points or more, the module generates a signal. According to the Bank of Russia Ordinance, such a discrepancy requires an analysis of the reasons for the deviation and may serve as a basis for adjusting the bank's final economic position assessment [3, 4].

Thus, the developed two-stage architecture provides a comprehensive approach to forecasting bank economic position indicators. VBA macros effectively solve the problems of collecting and initial processing of tabular data, characteristic of most credit institutions, while Python ensures the implementation of the forecasting requirements established by the Bank of Russia. The proposed solution can be integrated into a credit institution's existing document flow without significant changes to its IT infrastructure, creating a foundation for improving management quality and bank stability.

REFERENCES

1. Bank of Russia (2025) Doklad dlya obshchestvennykh konsul'tatsiy «Sovershenstvovanie sbora otchetnosti kreditnykh organizatsiy» [Consultation Paper "Improving the Collection of Reporting by Credit Institutions"]. Available at: https://cbr.ru/Content/Document/File/183159/Consultation_Paper_03102025.pdf (accessed 26.02.2026). (in Russian)

2. Kurnykina, O. V. (2022) Metodicheskie aspekty primeneniya elektronnykh technologiy v informatsionno-analiticheskom obespechenii otchetnosti banka [Methodological aspects of applying electronic technologies in the information and analytical support of bank reporting]. Uchet.Analiz.Audit [Accounting.Analysis.Auditing], 5, 34-41 (in Russian).

3. Pupkova, I. A. (2019) Planirovanie i prognozirovanie finansovykh rezul'tatov deyatel'nosti kreditnykh organizatsiy [Planning and forecasting of financial results of credit institutions]. Master's thesis. Ekaterinburg: UrFU (in Russian).

4. The Central Bank of the Russian Federation (2018) Ukazanie ot 03.04.2017 № 4336-U «Ob otsenke ekonomicheskogo polozheniya bankov» [Ordinance No. 4336-U dated April 3, 2017 "On the Assessment of the Economic Position of Banks"] (as amended on November 27, 2018) (in Russian).

5. The Central Bank of the Russian Federation (2025) Doklad dlya obshchestvennykh konsul'tatsiy «Izmenenie podkhoda k otsenke ekonomicheskogo polozheniya bankov» [Consultation Paper "Changing the Approach to Assessing the Economic Position of Banks"]. Available at:https://cbr.ru/Content/Document/File/177312/Consultation_Paper_25062025. pdf (accessed 25.02.2026). (in Russian)

CITIZENS' PERCEPTIONS OF USABILITY AND TRUST IN AUTOMATED E-GOVERNMENT SERVICES

I. S. Vidergold., Y. V. Orlova, E. E. Plyusnina

Novosibirsk, *Novosibirsk State Technical University*,
iravidergold@yandex.ru

Abstract. This paper examines user perceptions of automated e-government services in Russia. A questionnaire of 78 respondents found that participants value autofill and notifications but face technical failures and unclear navigation. Most used services are medical appointments and document submission. Respondents report login issues and data-protection concerns. Results suggest improving system stability and transparency is essential.

Keywords: e-government; digital public services; user experience; usability; trust; algorithmic decision-making; Russia.

ВОСПРИЯТИЕ ГРАЖДАНАМИ УДОБСТВА И ДОВЕРИЯ К АВТОМАТИЗИРОВАННЫМ ЭЛЕКТРОННЫМ ГОСУДАРСТВЕННЫМ УСЛУГАМ

И. С. Видергольд, Я. В. Орлова, Е. Е. Плюснина

Аннотация. Исследуется восприятие пользователями автоматизированных электронных госуслуг в России. Опрос 78 респондентов показал, что участники ценят автозаполнение и уведомления, но сталкиваются с техническими сбоями и неясной навигацией. Наиболее востребованы услуги записи к врачу и подачи документов. Респонденты отмечают трудности с авторизацией и опасения по защите данных. Необходимо повышение стабильности системы и прозрачности интерфейсов.

Ключевые слова: электронное правительство; цифровые государственные услуги; пользовательский опыт; удобство использования; доверие; алгоритмическое принятие решений; Россия.

The digital transformation of public administration in Russia has led to the active deployment of automated online services for citizens. Instead of visiting government offices in person, users can now submit applications, track requests, and obtain documents via integrated electronic platforms. One of the core tools in this ecosystem is the Gosuslugi portal, which aggregates a wide range of services and relies on automated data processing and decision-making. At the same time, citizens' readiness to use such tools depends not only on technical availability, but also on their everyday experience, perceived reliability, and overall institutional trust. Previous studies show that a lack of transparency and unstable system performance can undermine positive attitudes toward digital government, even when the functional capabilities of the services are high [1]. Against this background, it becomes important to assess how citizens actually evaluate usability and trust in concrete automated services they face in routine life.

To explore these issues, an online survey was carried out using a web-based questionnaire form. The sample included 78 respondents aged 18 and above who had experience using state digital services during the previous year. Participants were asked to self-assess their level of digital skills, describe how often they use the portal, and indicate for which types of services they most frequently apply. The majority positioned their digital competence at medium or higher levels, which suggests that they can be considered an active target audience of e-government platforms. Most respondents reported using the portal at least several times a year, and roughly one third access it on a monthly basis. The most common use cases mentioned were booking appointments with doctors, submitting applications for documents, and obtaining various certificates [3]. The questionnaire also included Likert-scale questions evaluating the convenience of specific automated functions and separate items measuring the degree of trust in algorithmic processing of personal data and requests.

Survey responses indicate that users generally rate the usability of core automated features highly. Tools that help to minimize manual input, such as automatic completion of personal data and system-generated notifications, received the most favorable scores. Many respondents noted that these elements significantly reduce the time spent on routine actions and lower the risk of making mistakes when filling in forms. The clarity of step-by-step procedures and the overall speed of the services were also evaluated positively, although some users still reported occasional delays at peak times [2]. Figure 1 presents average ratings for key automated features, while Figure 2 provides a radar overview of satisfaction across different dimensions.

At the same time, attitudes toward algorithmic processing remain more cautious. A considerable proportion of respondents indicated that they trust automated

decisions only partially and would prefer clearer explanations of how their data are analyzed and how final outcomes are produced. Concerns mostly relate to the stability of personal profiles, possible technical failures, and the protection of sensitive information from unauthorized access [4]. Figure 3 illustrates the distribution of trust levels. Common difficulties mentioned include slow response times, authentication problems, instability during peak usage, and non-intuitive interface elements, all of which underline the importance of infrastructure upgrades [2].

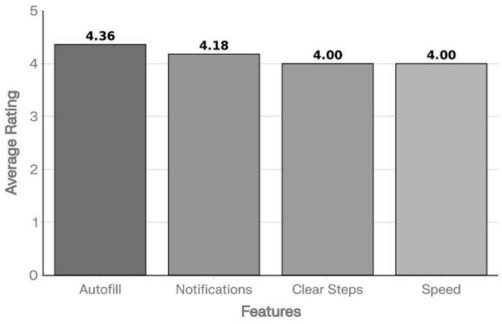


Figure 1. Average ratings for automated features

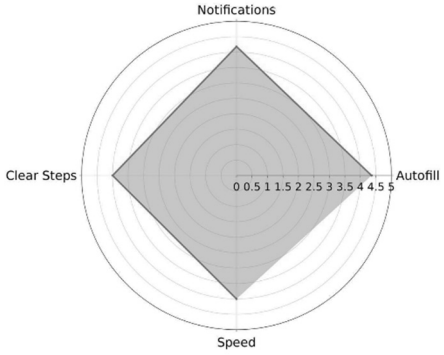


Figure 2. Radar chart of feature satisfaction

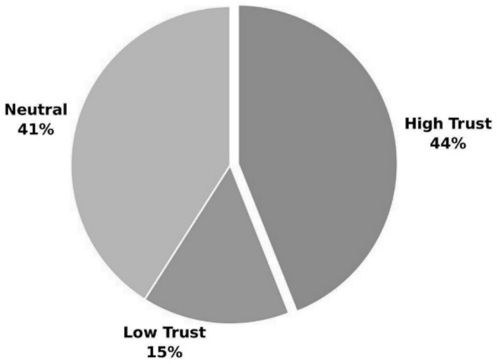


Figure 3. Trust levels in algorithmic processing

Users expressed a desire for interface improvements, faster system performance, and better support when dealing with more complex tasks. Research confirms that stable infrastructure and adaptive design play a crucial role in building trust, as evidenced by international experiences in digital government development [5]. While automation is generally appreciated, persistent barriers require further attention and refinement.

The findings demonstrate that automation of digital public services is perceived positively by citizens and contributes to more convenient interaction with government structures. However, the presence of technical and interface barriers, combined with only moderate levels of trust in algorithmic decision-making, indicates that further modernization is necessary. The results obtained can inform the optimization of existing solutions and guide the development of new user-oriented digital government services.

Key recommendations include: analyzing high-demand service flows such as appointments and document submissions; expanding the use of autofill and notification features; providing clear explanations of algorithmic outcomes; upgrading infrastructure and user experience design; and conducting regular testing alongside enhanced support mechanisms.

REFERENCES

1. Belyi, V. A. (2021). K voprosu o doverii k elektronnym gosudarstvennym servisam: po rezultatam issledovanij v Sankt-Peterburge [On trust in electronic government services: findings from St. Petersburg studies]. International Journal of Open Information Technologies, 9(12), 126-132 (in Russian).

2. Lishchuk, E. N., Kapelyuk, S. D. (2024). Tsifrovizatsiya gosudarstvennykh uslug v Rossii: statisticheskij analiz [Digitalization of public services in Russia: statistical review]. Ekonomika, predprinimatelstvo i pravo, 14(12), 7059-7078. DOI: 10.18334/epp.14.12.122314 (in Russian).

3. Perova, M. V., Matevosyan, S. A., Orel, D. M. (2022). Tsifrovizatsiya gosudarstvennykh uslug v Rossijskoj Federatsii: itogi i perspektivy [Digitalization of public services in Russia: outcomes and outlook]. In Vyzovy sovremennosti i strategii razvitiya obshchestva v usloviyakh novoj realnosti (pp. 133-138). Moscow: IP Ovchinnikov M.A. (in Russian).

4. Dolganova, O. I., Vasileva, E. V., Ryabov, D. A. (2022). Tsifrovoj profil grazhdanina: neobkhodimyj i dostatochnyj nabor personalnykh dannykh [Citizen digital profile: essential data scope]. Voprosy innovatsionnoj ekonomiki, 12(3), 1523-1540. DOI: 10.18334/vinec.12.3.116277 (in Russian).

5. Tsifrovoe obshchestvo v Rossii i Kitae (2025). [Digital Society in Russia and China]. Proceedings of XXI Russian-Chinese Sociological Conference, St. Petersburg. St. Petersburg: Asterion. 538 p. ISBN 978-5-00188-653-2 (in Russian).

THE DIGITAL TWIN MODEL OF THE TASKS MANAGEMENT SYSTEM

A. V. Vilyan

Novorossiysk, Novorossiysk Branch of the Financial University under the Government of the Russian Federation,
anastasia.villyan@mail.ru

Abstract. A customer-oriented model of a digital twin for task management system is developed. A comparative analysis of digital twin and chatbot is performed. Functional architecture is designed using IDEF0. Interaction scenarios are detailed with UML use case diagrams. The human role in management loop, personalization and proactivity principles are defined. The model can be used for digital assistants in task trackers.

Keywords: digital twin (DT), task management system, IDEF0, UML, customer orientation, chatbot, forecasting, simulation

МОДЕЛЬ ЦИФРОВОГО ДВОЙНИКА СИСТЕМЫ УПРАВЛЕНИЯ ЗАДАЧАМИ

А. В. Вильян

Аннотация. Разработана клиентоориентированная модель цифрового двойника системы управления задачами. Выполнен сравнительный анализ цифрового двойника и чат-бота. Функциональная архитектура спроектирована в IDEF0. Сценарии взаимодействия детализированы диаграммами прецедентов UML. Определена роль человека в контуре управления, принципы персонализации и проактивности. Модель может быть использована при создании цифровых помощников в таск-трекерах.

Ключевые слова. цифровой двойник (ЦД), система управления задачами, IDEF0, UML, клиентоориентированность, чат-бот, прогнозирование, симуляция.

The term "digital twin" came into use in the early 2000s, but it is only in recent years that the technology has acquired the status of one of the drivers of digital transformation. If we refer to the wording of ISO/DIS 23247, a DT is understood as a digital representation of a specific observable element, which is created for a specific purpose and equipped with mechanisms that ensure the consistent state of the element and its model with a given synchronization rate [4].

To grasp the essence of a DT, it makes sense to compare it with chatbots. Both tools are similar, but their architecture and functional content differ.

Table 1 – Model for comparative analysis of chatbot and DT characteristics

Criteria	Chatbot	DT
Operating Logic	Reactive – triggers a response to a query	Proactive – operates based on continuous monitoring
Purpose	Informing, assistance with routine operations	Forecasting, substantiation of management decisions
Type of data processed	Message text, knowledge base content	Forecasting, substantiation of management decisions
Role in the Management System	Command executor	Advisor

Chatbots, by their nature, are conversational agents that simulate dialogue. Their operation boils down to analyzing an incoming message, identifying key intentions, and selecting a response [6]. Such systems are triggered only after receiving a request. Forecasting and, moreover, proactive behavior lie beyond their capabilities [2].

A digital twin is a proactive system focused on analysis and forecasting. Instead of waiting for commands, it continuously processes data streams: from sensors, archives, etc. Based on the analysis, the twin builds forecasts and offers optimal options for further actions [4, 5]. One of its key differences is the ability to conduct "what-if" simulations, allowing one to assess the consequences of certain decisions before they are implemented in practice [5].

To describe and analyze the functions that a DT must perform, it is advisable to use the IDEF0 methodology. The graphical language of the notation allows for a visual representation of processes [3].

Building the model begins with creating a parent diagram A-0 "Task management using a digital twin," which represents the system as a whole and its interaction with the external environment [7]. At this level, the DT of the task management system is considered as a single whole, and all its functions are combined into one block.

At the next level of detail, the main block of the child diagram is decomposed into four functional blocks, interconnected by data and control flows [7].

This division reflects the DT's operational logic and information processing stages. Block 1 receives data from various sources. Block 2 performs analytics and forecasting. Block 3 runs "what-if" simulations, enabling users to evaluate decision consequences beforehand. Block 4 presents results to the user, enhancing system customer-centricity. This clear delineation of responsibilities ensures independent module development and modernization.

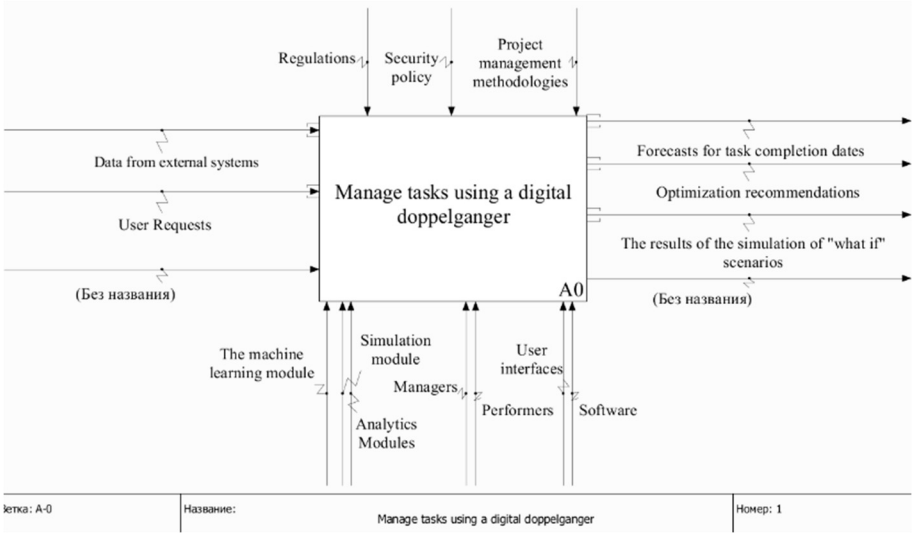


Figure 1. Model "Task management using DT"

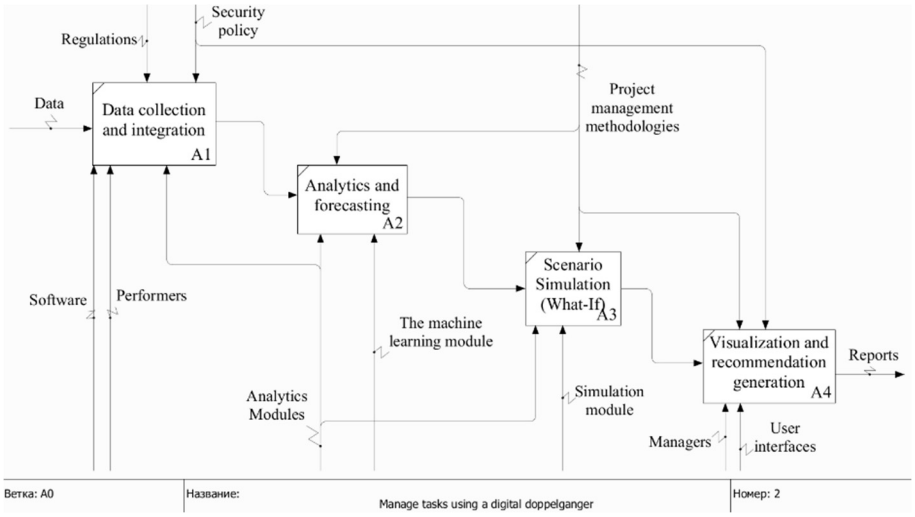


Figure 2. First-level decomposition model (diagram A0): "Main functional blocks of DT"

Figure 3 shows a UML use case diagram reflecting the functional requirements for the digital twin system. The actors of the system are the Project Manager, the Executor, the System Administrator, and an External System. The Manager initiates five use cases aimed at strategic management and analysis. The Executor works with four use cases focused on personal planning and feedback. The Administrator configures the twin's operating parameters.

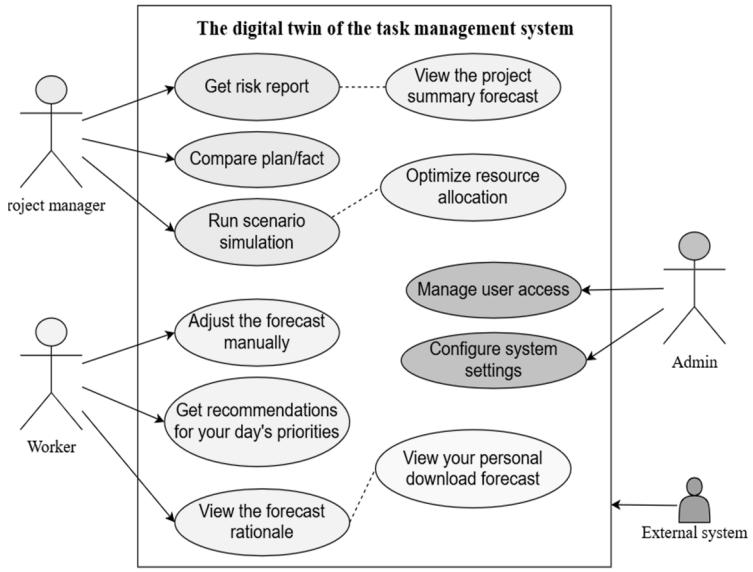


Figure 3. Interaction Use Case Model

The effectiveness of a DT directly depends on how successfully its interaction with humans is structured. The interaction model is built on the principles of symbiosis, where the twin acts not as a substitute, but as an amplifier of human competencies [5].

The human role is multifaceted. First, they act as a source of unique data and expert knowledge that is inaccessible to automation (for example, contextual reasons for delays, personal plans). Second, the human is the ultimate decision-maker: the twin offers options, but the responsibility for the choice always remains with the person [1]. Third, the user acts as a "teacher," whose feedback on the system's recommendations serves as a crucial signal for retraining the models [4].

Customer-centricity in the interface and interaction mechanisms is implemented through several key principles:

1. The interface and the set of available functions adapt to the user's role (the manager sees project summaries; the executor sees their own workload).

2. The system itself initiates dialogue, warning about potential problems, rather than waiting for queries.

3. Any forecast or recommendation is accompanied by a brief and clear rationale; which builds trust in the system.

4. The user is provided with simple tools to accept, reject, or adjust the recommendation, and this feedback must be immediately taken into account.

REFERENCES

1. Egorova V.P. (2022) Analysis of integration processes of automated control system levels using use case diagrams. Scientific Notes of Komsomolsk-na-Amure State Technical University, 1, 45-51. URL: https://elibrary.ru/item.asp?id=49314116 (accessed 18.02.2026) (in Russian).
2. Ivanova T.B. (2025) Digital twins as a technology for forecasting changes in the labor market. In: Security in the Modern World: Proceedings of the VII International Scientific and Practical Conference. Volgograd: Volgograd Institute of Management – RANEPA Publishing House, 126-128. URL: https://elibrary.ru/item.asp?id=82800853 (accessed 18.02.2026) (in Russian).
3. Kovalenko N.V., Finogeeva, V.E. (2019) Modern aspects of business process modeling in metallurgical industry enterprises using the IDEF0. Economic Bulletin of DonSTU, 1, 18-25. URL: https://elibrary.ru/item.asp?id=39820703 (accessed 18.02.2026) (in Russian).
4. Lofichenko A.A. (2025) Cyber-sociophysical systems and digital twin networks: a look at future digital twin ecosystems. Bulletin of Lugansk Vladimir Dahl State University, 2(92), 250-253. URL: https://elibrary.ru/item.asp?id=83201508 (accessed 18.02.2026) (in Russian).
5. Vityaev E.E., Sviridenko D.I., Rofe A.R. (2025) Task-based approach to digital transformations. The Bulletin of Irkutsk State University. Series "Mathematics", 54, 78-95. URL: https://elibrary.ru/item.asp?id=86437807 (accessed 18.02.2026) (in Russian).
6. Omarov B., Narynov S., Zhumanov Zh. (2022) Development of chatbot-psychologist: dataset, architecture, design and chatbot in use. The Bulletin of KazATC, 4(123), 463-471. URL: https://elibrary.ru/item.asp?id=50769894 (accessed 18.02.2026).
7. Rzun I.G., Rzun V.V. (2016) Modeling of outsourcing business processes. In: Priority Scientific Directions: From Theory to Practice. Novorossiysk: Kuban State University, 203-209. URL: https://elibrary.ru/item.asp?id=27278694 (accessed 18.02.2026) (in Russian).

AUTOMATION OF TECHNICAL SUPPORT SERVICES USING TELEGRAM-BOT AND 1C

I. M. Zakharov

Research advisor: M. S. Antonenko

Novosibirsk, *Novosibirsk State Technical University*,
zaxaroov2004@yandex.ru

Abstract The article discusses the issues of automating the organization's technical support service through the integration of the Telegram messenger and the 1C:Enterprise information system. It provides an analysis of the disadvantages of the traditional process of registering requests, describes the architecture of the developed solution, and explains how the Telegram Bot API interacts with the 1C web service mechanisms. Special attention is given to improving the efficiency of technical

support, reducing the time required to process requests, and reducing the workload on operators.

Key words: technical support automation, Telegram bot, 1C:Enterprise, request processing, system integration, Telegram API, help desk.

АВТОМАТИЗАЦИЯ СЛУЖБ ТЕХНИЧЕСКОЙ ПОДДЕРЖКИ С ИСПОЛЬЗОВАНИЕМ TELEGRAM-БОТА И 1С

И. М. Захаров

Аннотация. В статье рассматриваются вопросы автоматизации службы технической поддержки организации посредством интеграции мессенджера Telegram и информационной системы 1С:Предприятие. Приводится анализ недостатков традиционного процесса регистрации обращений, описывается архитектура разработанного решения, а также методы взаимодействия Telegram Bot API с механизмами веб-сервисов 1С. Особое внимание уделено вопросам повышения эффективности работы технической поддержки, сокращению времени обработки заявок и снижению нагрузки на операторов.

Ключевые слова: автоматизация техподдержки, Telegram-бот, 1С:Предприятие, обработка заявок, интеграция систем, Telegram API, служба поддержки.

An effective organization of technical support is a prerequisite for the stable and uninterrupted operation of an enterprise's information infrastructure. In the context of ongoing digital transformation, the continuous growth in the number of users, as well as the increasing complexity of information systems, inevitably leads to a significant rise in the number of incoming requests. Under such conditions, traditional methods of interaction between users and support services become less effective and fail to meet modern requirements for speed, scalability, and service quality.

An analysis of the existing technical support service process shows that the traditional model of receiving and processing requests has several significant drawbacks. Users are typically required to contact the support service via phone or email, which leads to manual registration of requests by an operator. This approach is highly dependent on human factors, requires considerable time, and is often accompanied by data entry errors and inconsistencies. In addition, the absence of structured input forms and the inability to easily attach visual materials, such as screenshots or log files, significantly complicates the process of diagnosing problems at an early stage.

As a result, technical support operators are overloaded with repetitive and routine tasks, which reduces overall operational efficiency. Furthermore, the registration of requests outside business hours is often unavailable, which leads to the accumulation of unresolved requests and an increase in response time. This negatively affects user satisfaction and the overall quality of IT services provided by the organization.

The choice of Telegram as a platform for automation is due to its cross-platform availability, high-speed messaging capabilities, extensive support for media file transfer, and a well-developed API [1] that enables the implementation of multi-step and scenario-based dialogues. The use of chatbots allows for the automation of user interaction by guiding users through a structured sequence of questions, ensuring the completeness and correctness of the submitted information. In addition, Telegram is widely used in corporate environments, making it a natural and convenient platform that does not require additional training for end users.

The developed solution is based on a three-component architecture that includes a Telegram bot, a server-side integration layer, and a request processing module within the 1C system [1, 2]. The Telegram bot serves as the primary user interface, providing data collection and organizing a consistent and logically structured dialogue with the user [3]. The integration layer acts as an intermediary component responsible for processing incoming data, converting it into JSON format, and transmitting it to the 1C system via web services.

Within the 1C environment, an automated request registration module is implemented. This module processes incoming data, creates a "Technical Support Request" document, assigns a responsible specialist, sets the appropriate status, and initiates further processing workflows if necessary. After processing, the system sends feedback to the user via the Telegram bot, ensuring continuous and transparent communication.

The integration of the Telegram bot with the 1C system significantly accelerates the request registration process [4]. The time required to create a request is reduced to a few seconds, completely eliminating the need for manual data entry. The use of structured data collection reduces the number of clarifying questions and minimizes the risk of incomplete or incorrect information. As a result, technical support specialists can begin resolving issues more quickly and efficiently. Pilot implementation results demonstrate a noticeable reduction in the workload of first-line operators, as well as an improvement in the quality and consistency of the data provided by users.

Another alternative to Telegram is Yandex Messenger, which can be considered as a platform for implementing a similar automation solution. Unlike general-purpose messaging applications, Yandex Messenger is designed specifically for corporate use and takes into account the requirements of enterprise environments, including enhanced security and centralized user management [5].

Yandex Messenger provides an API that enables interaction with external systems, including 1C:Enterprise [5]. This makes it possible to build a similar technical support automation architecture, consisting of a conversational interface, an integration layer, and a request processing module. The platform supports the exchange of text messages, files, and images, which ensures that users can provide complete and detailed descriptions of their issues.

In addition, Yandex Messenger complies with corporate security standards and enhances data protection through controlled access mechanisms and secure data storage [5, 6]. This makes it particularly suitable for organizations that have strict information security requirements and prefer to use domestic or corporate communication tools.

The proposed architecture is scalable and can serve as a foundation for further system development. In the future, it is possible to implement intelligent request processing mechanisms, including automatic classification of requests, prioritization based on content analysis, and integration with knowledge bases to provide users with predefined solutions. Furthermore, the development of analytical tools can help evaluate the performance of the technical support service, identify bottlenecks, and optimize operational processes.

In conclusion, I would like to note that the developed technical support automation system will reduce the time required to register requests, reduce the workload, and improve the quality of customer service. In the future, it may also be possible to consider the implementation of artificial intelligence, specifically language models, for data analysis and processing. This approach will take the technical support process to a new level.

REFERENCES

1. Telegram Bot API. Official documentation [Electronic resource]. Available at: https://core.telegram.org/bots/api (accessed 01.03.2026).

2. 1C:Predpriyatie 8. Tekhnologicheskoe opisanie platformy [1C:Enterprise 8. Technological description of the platform] [Electronic resource]. Available at: https://its.1c.ru/db/v8std (accessed 01.03.2026) (in Russian).

3. Kulikov A. A. (2021) Razrabotka i integratsiya Telegram-botov [Development and integration of Telegram bots]. St. Petersburg: Piter, 256 p. (in Russian).

4. Gusev E. V. (2020) Integratsiya informatsionnykh sistem: metody i instrumenty [Integration of information systems: methods and tools]. Moscow: Infra-M, 312 p. (in Russian).

5. Bot API dlya Messendzhera v Yandeks 360 dlya biznesa. Ofitsial'naya dokumentatsiya [Bot API for Messenger in Yandex 360 for Business. Official documentation] [Electronic resource]. Available at: https://yandex.ru/dev/messenger/doc/ru/ (accessed 01.03.2026) (in Russian).

6. Kak sdelat' bota v Yandeks Messendzhere [How to make a bot in Yandex Messenger] [Electronic resource] // Habr. — 2025. — 14 noyabrya. Available at: https://habr.com/ru/articles/965558/ (accessed 01.03.2026) (in Russian).

TRANSFORMATION AND APPLICATION OF ARTIFICIAL INTELLIGENCE TECHNOLOGY IN DATA ANALYSIS OF INDUSTRIAL AUTOMATION SYSTEMS

Zhang XinLei

South Ural State University, *Chelyabinsk*, *Russia*,
2938263525@qq.com

Abstract. In recent years, the wave of technological innovations such as intellectualization, automation and digitalization has been reshaping the traditional industrial automation and its value system. As a core driving force, artificial intelligence technology has become an important engine for promoting the transformation and upgrading of traditional industrial automation. At the same time, the guidance of national policies and the improvement of social attention have further highlighted the important role of artificial intelligence technology in the transformation of traditional industrial automation. From the perspective of technological development trends, artificial intelligence technology has achieved a breakthrough in traditional industrial automation. However, these applications still face problems such as technical maturity, cost-effectiveness and limitations of application scenarios. Combined with the current industrial situation, traditional industries are faced with the demand for technological upgrading, and artificial intelligence technology just provides a solution, which has significant theoretical and application value.

Key words: Artificial Intelligence; Industrial Automation; Data Analysis; Machine Learning Technology; Intelligent Control

ТРАНСФОРМАЦИЯ И ПРИМЕНЕНИЕ ТЕХНОЛОГИИ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В АНАЛИЗЕ ДАННЫХ СИСТЕМ ПРОМЫШЛЕННОЙ АВТОМАТИЗАЦИИ

Чжан Синлэй

Аннотация. В последние годы волна технологических инноваций, таких как интеллектуализация, автоматизация и цифровизация, меняет традиционную промышленную автоматизацию и её систему ценностей. Искусственный интеллект как ключевая движущая сила становится важным двигателем содействия трансформации и модернизации традиционной промышленной автоматизации. В то же время направление государственной политики и повышение внимания общества ещё больше подчёркивают важную роль технологии искусственного интеллекта в трансформации традиционной промышленной автоматизации. С точки зрения тенденций технологического развития, технология искусственного интеллекта достигла прорыва в традиционной промышленной автоматизации. Однако эти приложения по-прежнему сталкиваются с такими проблемами, как техническая зрелость, экономическая эффективность и ограниченность сценариев применения. В сочетании с текущей промышленной ситуацией традиционные отрасли сталкиваются с потребностью в технологическом обновлении, и технология искусственного интеллекта как раз предлагает решение, что имеет значительную теоретическую и прикладную ценность.

Ключевые слова: искусственный интеллект; промышленная автоматизация; анализ данных; технология машинного обучения; интеллектуальное управление.

Introduction

In the current era, the success of enterprises often requires handling a large number of affairs and processes, such as sales processes, production processes, financial processes and so on. However, these processes are extremely tedious and time-consuming for enterprises. This calls for a type of technology to execute these processes automatically, and AI industrial automation is exactly such a technology. AI industrial automation combines artificial intelligence (AI) with automation to execute enterprise tasks in a fully or partially automatic manner, thereby improving the efficiency of business processes. This technology can be used to handle repetitive and tedious tasks, greatly improving production efficiency and reducing error rates. AI business process automation involves many different technologies, including natural language processing, machine learning, intelligent document recognition and visualization. Understanding the working principles of these technologies and how to apply them is crucial for the successful implementation of automated processes.

Definition of Relevant Concepts

To deeply understand the application of artificial intelligence technology in the transformation of traditional industries, it is first necessary to clearly define the relevant core concepts. These concepts are not only the cornerstone of subsequent analysis, but also the premise to ensure the accuracy and focus of the research content [1].

Artificial Intelligence (AI)

Artificial Intelligence (AI) refers to the intelligence exhibited by systems created by humans. It is an important branch of computer science, aiming to study and develop theories, methods, technologies and application systems for simulating, extending and expanding human intelligence. A formal definition can be referred to as follows:

Let A be an Intelligent Agent, E be the environment, and P be the performance index. For any environment E, if the agent A perceives the state S of the environment E, performs action A in the environment E, and meets the performance index P, then the agent A is said to exhibit intelligent behavior in the environment E. That is:

$$extAI = \{extperceive, extact, extreach\, P | \forall E, S \in E\}$$

Figure 1. Definition of Artificial Intelligence

More specifically, artificial intelligence covers multiple subfields such as Machine Learning (ML), Deep Learning (DL), Natural Language Processing (NLP), and Computer Vision (CV). Against the backdrop of industrial transformation, the most widely applied AI technologies are mainly concentrated in machine learning, especially deep learning algorithms capable of processing non-linear and high-dimensional complex data patterns.

Traditional Industrial Automation

Industrial automation is an integrated system that applies control theory, instruments and meters, computers and other information technologies to realize detection, control, optimization, scheduling, management and decision-making in the industrial production process, with the goals of increasing output, improving quality, reducing consumption and ensuring safety [2].

Logical Mechanism of Artificial Intelligence Empowering the Transformation of Traditional Industries

The application of artificial intelligence technology in the transformation of traditional industries has brought unprecedented opportunities and challenges to various industries. Its logical mechanism of empowering the transformation of traditional industries is mainly reflected in the following aspects:

(1) Data-driven Decision Making

– *Data Collection*: Through technologies such as the Internet of Things and sensors, traditional industries can collect a large amount of data in real time.

$$V(S_t) \leftarrow V(S_t) + \alpha\,(G_t - V(S_t))$$

Figure 2. Data Collection formula

– *Data Cleaning*: The data cleaning process is of great significance for subsequent data analysis [3]. Rule-based data cleaning work such as data normalization and field correction can be processed at the data collection stage.

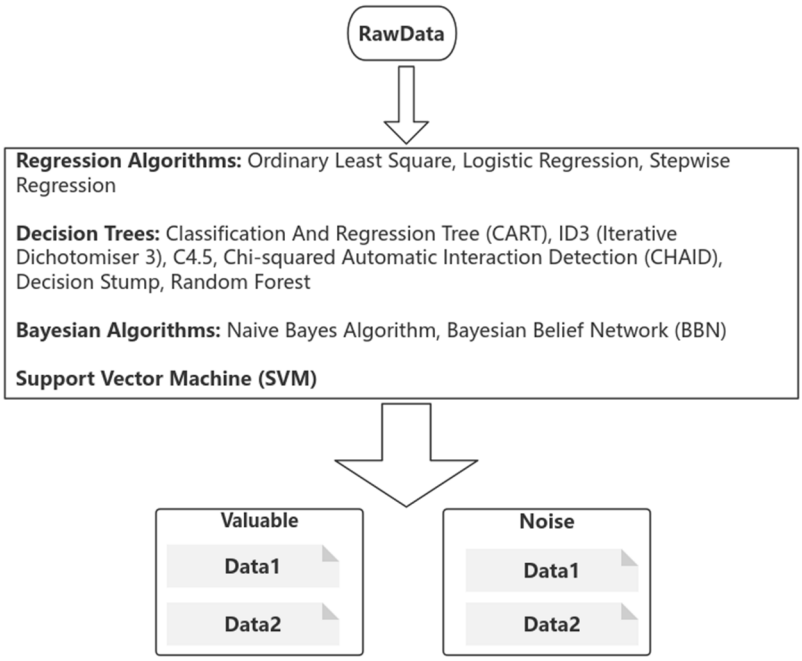


Figure 3. Data Cleaning formula

– *Data Analysis*: Machine learning algorithms are used to conduct in-depth mining and analysis of data to discover potential laws and trends. Data analysis is divided into two parts: *sentiment discrimination* and *data classification*.

Sentiment Discrimination: Classify data into preset categories through classifiers to conduct a comprehensive observation of data from different dimensions.

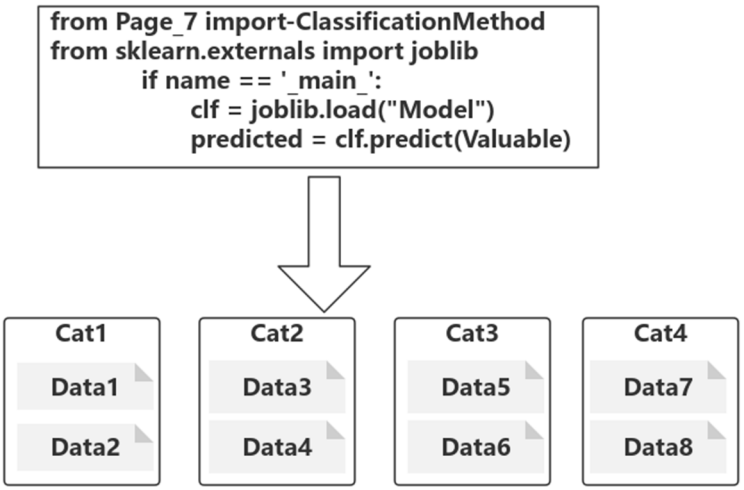


Figure 4. Sentiment Discrimination formula

Data Classification: Sentiment analysis is essential for compiling public opinio=-'n monitoring reports.

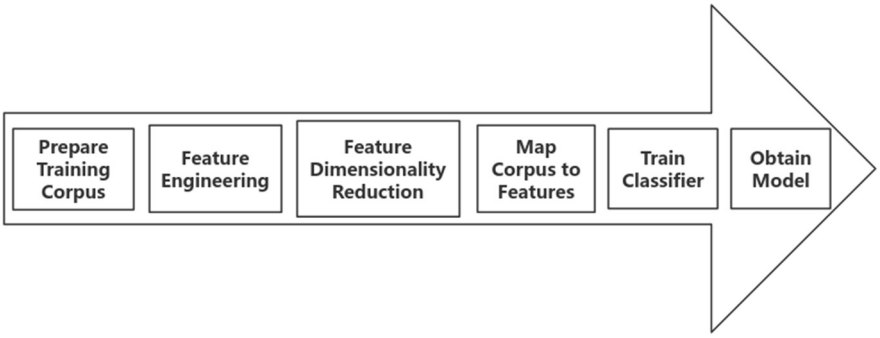


Figure 5. Data Classification formula

– *Intelligent Decision Making*: Based on the analysis results, artificial intelligence systems can assist or replace humans in making decisions, improving the efficiency and accuracy of decision-making.

(2) Automated Production Processes

- *Process Identification*: Artificial intelligence technology can identify and parse the existing production processes of traditional industries [4].
- *Optimization Suggestions*: Through machine learning models, AI can identify bottlenecks and wastes in the process and put forward optimization suggestions.
- *Automated Execution*: Combined with robots and automated equipment, AI can realize the automated execution of production processes and improve production efficiency [2].

(3) Innovation of Intelligent Products and Services

- *Demand Analysis*: By analyzing user data and behavior patterns, artificial intelligence can help traditional industries better understand market demand.
- *Product Innovation*: Based on in-depth insights into market demand, AI can assist in the development of new products and services to meet the diversified needs of consumers.
- *Service Upgrading*: Using technologies such as natural language processing, AI can enhance the customer service experience and realize the intelligent upgrading of services [1].

(4) Optimal Allocation of Resources

- *Resource Identification*: Artificial intelligence technology can identify various resources in traditional industries, such as human, material and financial resources.
- *Demand Forecasting*: Through data analysis and forecasting models, AI can accurately predict future resource demand.
- *Optimal Allocation*: Based on the forecasting results, AI can intelligently adjust resource allocation to realize the efficient utilization and conservation of resources.

The logical mechanism of artificial intelligence empowering the transformation of traditional industries is mainly reflected in data-driven decision-making, automated production processes, innovation of intelligent products and services, and optimal allocation of resources. These mechanisms jointly drive the digital transformation and upgrading development of traditional industries.

Results

In summary, enterprises need to combine artificial intelligence with automation to realize business process automation, and continuously optimize any automated tools to ensure that they not only maintain the accuracy and legitimacy of processes, but also can continuously develop and improve over time. This is one of the keys for enterprises to succeed in the increasingly competitive market at present. Industrial automation technology has obvious advantages in improving enterprise efficiency, reducing costs and enhancing service quality. The integration of machine learning

technology can further improve the effectiveness and comprehensiveness of this technology. Machine learning technology can not only analyze and familiarize with data, but also independently explore trends from data, helping enterprises establish a more intelligent process optimization system. In the future development, business process automation technology and machine learning will bring greater improvement and challenges to enterprises, and it is believed that they will become the new core competitiveness of enterprises. Through the efforts in the above research directions, artificial intelligence technology will play a greater role in the transformation of industrial automation, promoting the intelligent upgrading and sustainable development of traditional industries.

REFERENCES

1. Kumar A. Enabling Intelligent Industrial Automation: A Review of Machine Learning Applications / A. Kumar, R. Singh // International Journal of Advanced Manufacturing Technology. – 2024. – Vol. 120, No. 5. – P. 2101-2118.

2. Smirnov A.B. AI in Business Process Automation: A Case Study of Russian Manufacturing [Iskusstvennyy intellekt v avtomatizatsii biznes-protsessov] / A.B. Smirnov, I.I. Petrov // Bulletin of the South Ural State University. Series: Computer Technologies. – 2025. – Vol. 15, No. 2. – P. 45-55. (in Russian)

3. Goodfellow, I. Deep Learning / I. Goodfellow, Y. Bengio, A. Courville. – Cambridge: MIT Press, 2016. – 800 p.

4. Zhang L. A Review of Machine Learning for Predictive Maintenance / L. Zhang, Y. Wang // IEEE Transactions on Industrial Informatics. – 2023. – Vol. 19, No. 8. – P. 8901–8915.

BUSINESS AND GOVERNMENT IN THE CONTEXT OF DIGITAL TRANSFORMATION

STRATEGIES FOR SCIENTIFIC ORGANIZATIONS TO ENTER GLOBAL MARKETS

A. A. Alekseeva

Research advisor: E. A. Stukalenko, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
anya_alexeeva_03@mail.ru

Abstract. The article discusses modern strategies for the internationalization of research institutes and organizations. Based on the analysis of the practical experience of Russian and foreign scientific centers, the main models of entering international markets are identified and the results of an analysis of the dynamics of export indicators of scientific organizations are presented.

Keywords: scientific organizations, international markets, internationalization strategies, technology transfer, export of high-tech products, international scientific cooperation.

СТРАТЕГИИ ВЫХОДА НАУЧНЫХ ОРГАНИЗАЦИЙ НА МИРОВЫЕ РЫНКИ

А. А. Алексеева

Аннотация. В статье рассматриваются современные стратегии интернационализации научно-исследовательских институтов и организаций. На основе анализа практического опыта российских и зарубежных научных центров выделены основные модели выхода на международные рынки и представлены результаты анализа динамики экспортных показателей научных организаций.

Ключевые слова: научные организации, международные рынки, стратегии интернационализации, трансфер технологий, экспорт наукоемкой продукции, международное научное сотрудничество.

Introduction

In the context of the globalization of scientific and technological development, research institutes face the task of not only producing new knowledge, but also effectively bringing the results of intellectual activity to international markets, which is becoming an important factor for sustainable development, a source of off-budget financing and a mechanism for demonstrating the competitiveness of developments.

The process of forming a strategy for entering international markets requires a systematic approach and includes several successive stages: from the initial analysis of market opportunities to the direct implementation of the expansion strategy [6]. Research institutes have specific features that distinguish them from industrial enterprises: the main product is not so much finished products as the results of intellectual activity, technologies, patents and scientific and technical services. An analysis of modern practice allows us to identify several main strategic models used by research institutes to internationalize their activities:

– *an export strategy* involves the direct sale of high-tech products and services to foreign customers [2];

– *a licensing strategy* - transfer of intellectual property rights to foreign companies [9];

– *the strategy of foreign presence* is implemented through the creation of research units in other countries [5];

– *the strategy of scientific and technical cooperation* involves participation in international research projects and programs [12];

– *a comprehensive strategy* that includes the introduction of advanced technologies, joint research, industrial innovation, market expansion, brand strengthening and talent attraction [11].

Empirical Analysis and Implementation Stages

To assess the effectiveness of various strategies for entering international markets, we will analyze the dynamics of export indicators of scientific organizations using the example of the Belarusian State University (BSU), which includes 4 research institutes, 2 national research centers and 41 research laboratories [7]. As the publicly available statistics show, the export of high-tech products and services by BSU demonstrates a steady positive trend, as shown in Table 1.

Research institutes are able to achieve significant growth rates in export revenue, comparable to those of high-tech industrial companies, thanks to systematic efforts to increase international cooperation. Several factors were key drivers of growth: the successful implementation of contracts under the NICA project, which provided a twofold increase in supplies to Russia [12]; expansion of cooperation with Chinese partners, including the creation of joint laboratories [1]; the presence of specialized

enterprises as part of BSU's organizational structure that provide a full cycle of commercialization of developments – from idea to production [7].

Table 1 – Dynamics of exports of high-tech products and services of BSU in 2022-2024

Indicator	2022	2023	2024	Growth rate, 2023/2022	Growth rate, 2024/2023
Total exports, USD million	2.29	2.76	4.18	+20.0%	+51.5%
Exports to Russia, USD million	0.85	1.25	2.30	+47.0%	+83.7%
Exports to China, USD million	0.32	0.50	0.65	+56.0%	+30.0%
Number of international contracts, units	84	94	124	+12.0%	+32.0%

Source: calculated by the author based on data from [3, 4, 10]

An additional analysis of the effectiveness of various internationalization strategies is presented in table 2.

An analysis of table 2 shows that the most ambitious results are achieved when using the strategy of scientific and technical cooperation within the framework of large international projects (the NICA project, cooperation with RSC Energia), as well as with an integrated approach to internationalization combining various mechanisms and areas of activity.

The process of developing and implementing the strategy of internationalization of the research institute can be represented as a sequence of interrelated stages [6]:

The initial analysis stage includes studying the potential of foreign markets, assessing the demand for specific scientific developments and services, and analyzing the competitive environment. At this stage, it is important to understand the political, economic and cultural characteristics of the recipient countries and identify possible niches.

The strategic planning stage involves selecting target markets and defining specific modes of presence. It is necessary to determine which products or services will be in demand on the international market and which business models will be most effective [8].

The capacity-building stage is associated with strengthening the competitive advantages of the organization: increasing investments in technological developments, attracting specialists with international experience, and developing the intercultural competencies of employees.

Table 2 – Comparative analysis of the effectiveness of internationalization strategies of scientific organizations

Strategy	Organization	Key indicators	Examples of products/services
Export	Institute of Physics of the National Academy of Sciences of Belarus	Export volume of 0.5 million dollars (2024)	Optoelectronics, laser technology
Export	Research Institute of Radio Materials of the National Academy of Sciences of Belarus	Export volume of 1.3 million dollars (2024)	Materials for microelectronics
Licensed	Bialystok University	Bialystok University First international license agreement (2026)	Bacterial strains for crop production
Licensed	UP Unitechprom BSU	Patents in 56 countries, the only manufacturer of Temodex	Anticancer drugs
Foreign presence	KIST (Korea)	4 international hubs in Germany, USA, Vietnam, India	Joint research, support of partner companies
Scientific and Technical cooperation	BSU Research Institute of Nuclear Problems	Twofold increase in supplies to Russia (2023), contracts for the NICA project	Thermal stabilization and cooling system for detectors
Scientific and Technical cooperation	BSU PFP Research Institute	9 contracts worth more than $2 million.	Equipment for remote sensing of the Earth from the ISS
Integrated	ITRI (Taiwan)	6 strategic areas of international cooperation	Advanced technologies, industrial innovations

Source: compiled by the author based on the data [2, 5, 7, 9, 11, 12].

The stage of implementation and expansion involves direct access to foreign markets, followed by increased presence. At this stage, risk management, adaptation of products to the requirements of local markets, and the formation of sustainable partnerships are of particular importance.

Effective implementation of strategies for entering international markets requires the creation of appropriate organizational infrastructures [7]; integration structures uniting scientific organizations and industrial enterprises [2]; implementation of support programs for partner companies through their foreign centers [5].

Using specialized online platforms and blockchain infrastructure makes it possible to accelerate technology transfer and ensure reliable legal protection of intellectual property objects when entering foreign markets.

Conclusion

The strategies of scientific organizations entering global markets differ in a variety of forms and implementation mechanisms. The choice of a specific strategy depends on the research profile, the level of readiness of developments for commercialization, the resource capabilities of the organization and the characteristics of the target markets. Specialized online platforms and blockchain infrastructure are important tools for the digital transformation of internationalization processes.

Effective internationalization requires a systematic approach that includes not only the technological readiness of developments, but also a well-developed organizational infrastructure, competent personnel capable of working in an intercultural environment, and stable partnerships with foreign research and industrial structures.

REFERENCES

1. BGU: za 2023 god eksport naukoemkoy produktsii i uslug vuza vyros na 20% // Soyuz.by. – 27 fevralya 2024 g. – URL: https://soyuz.by/realizaciya-soyuznyh-programm-i-proektov/za-2023-god-eksport-naukoemkoy-produkcii-i-uslug-v-bgu-vyros-na-20 (data obrashcheniya: 25.02.2026). [BSU: in 2023, the export of high-tech products and services of the university increased by 20% // Soyuz.by . – February 27, 2024 – URL: https://soyuz.by/realizaciya-soyuznyh-programm-i-proektov/za-2023-god-eksport-naukoemkoy-produkcii-i-uslug-v-bgu-vyros-na-20 (date of request: 02/25/2026).] (e.g., (in Russian))

2. Eksport naukoemkikh tovarov belorusskogo proizvodstva vyros pochti vdvoe // STV. – 13 fevralya 2025 g. – URL: https://ctv.by/news/obshestvo/eksport-naukoyomkih-tovarov-belorusskogo-proizvodstva-vyros-pochti-vdvoe (data obrashcheniya: 25.02.2026). [Exports of high–tech goods of Belarusian production have almost doubled // STV. – February 13, 2025 - URL: https://ctv.by/news/obshestvo/eksport-naukoyomkih-tovarov-belorusskogo-proizvodstva-vyros-pochti-vdvoe (date of request: 02/25/2026).] (e.g., (in Russian))

3. Eksport naukoemkikh tovarov i uslug BGU v 2023 godu vyros na 20% // Belarus.by. – 26 fevralya 2024 g. – URL: https://www.belarus.by/ru/business/business-news/eksport-naukoemkix-tovarov-i-uslug-bgu-v-2023-godu-vyros-na-20_i_0000168124.html (data

obrashcheniya: 25.02.2026). [Exports of knowledge-intensive goods and services of BSU increased by 20% in 2023 // Belarus.by. – February 26, 2024 – URL: https://www.belarus.by/ru/business/business-news/eksport-naukoemkix-tovarov-i-uslug-bgu-v-2023-godu-vyros-na-20_i_0000168124.html (date of request: 02/25/2026).] (e.g., (in Russian))

4. Eksport nauchno-tekhnicheskoy produktsii BGU v Kitay uvelichilsya na 56% // Nastaŭnitskaya gazeta. – 22 aprelya 2024 g. – URL: https://nastgaz.by/eksport-nauchno-tehnicheskoj-produktsii-bgu-v-kitaj-uvelichilsya-na-56/ (data obrashcheniya: 25.02.2026). [Exports of scientific and technical products of BSU to China increased by 56% // Nastunitskaya gazeta. – April 22, 2024 – URL: https://nastgaz.by/eksport-nauchno-tehnicheskoj-produktsii-bgu-v-kitaj-uvelichilsya-na-56 / (date of request: 02/25/2026).] (e.g., (in Russian))

5. KIST Expands Global R&D Collaboration to Support Corporate Internationalization // Korea Institute of Science and Technology. – 1 April 2025. – URL: https://kist.re.kr/eng/newscenter/press-release.do?mode=view&articleNo=16074 (date of request: 02/25/2026).

6. Lyu Khua. Poetapnyy protsess formirovaniya i realizatsiya strategii vykhoda organizatsii na mezhdunarodnye rynki // Voprosy ekonomiki i upravleniya. – 2023. – № 3. – S. 45-52. [Liu Hua. The step-by-step process of forming and implementing an organization's entry strategy into international markets // Issues of economics and management. – 2023. – No. 3. – pp. 45-52.] (e.g., (in Russian))

7. Nauka v BGU // Belorusskiy gosudarstvennyy universitet. – URL: https://bsu.by/nauka-i-proizvodstvo/nauka-v-bgu.php (data obrashcheniya: 25.02.2026). [Science at BSU // Belarusian State University. – URL: https://bsu.by/nauka-i-proizvodstvo/nauka-v-bgu.php (date of request: 02/25/2026).] (e.g., (in Russian))

8. Otdelenie mezhdunarodnykh svyazey i marketinga // Ufimskiy nauchno-issledovatel'skiy institut glaznykh bolezney. – URL: https://www.ufaeyeinstitute.ru/ru/science/nauchno-innovatsionnoe-otdelenie-/otdelenie-mezhdunarodnykh-svyazey-i-marketinga/ (data obrashcheniya: 25.02.2026). [Department of International Relations and Marketing // Ufa Scientific Research Institute of Eye Diseases. – URL: https://www.ufaeyeinstitute.ru/ru/science/nauchno-innovatsionnoe-otdelenie-/otdelenie-mezhdunarodnykh-svyazey-i-marketinga / (date of request: 02/25/2026).] (e.g., (in Russian))

9. Poland Advances in Global Research: First International University Licensing Agreement in Białystok // Research in Poland. – 6 February 2026. – URL: https://researchinpoland.org/news/poland-advances-in-global-research-first-international-university-licensing-agreement-in-bialystok/ (date of request: 02/25/2026).

10. Prorektor BGU: eksport naukoemkikh tovarov i uslug v vuze dostig 4 mln dollarov // Belarus' segodnya. – 24 fevralya 2025 g. – URL: https://www.sb.by/articles/eksport-naukoemkikh-tovarov-i-uslug-v-bgu-dostig-4-mln-dollarov.html (data obrashcheniya: 25.02.2026). [Vice-rector of BSU: the export of high-tech goods and services at the university has reached $ 4 million // Belarus today. – February 24, 2025 – URL: https://www.sb.by/articles/eksport-naukoemkikh-tovarov-i-uslug-v-bgu-dostig-4-mln-dollarov.html (date of request: 02/25/2026).] (e.g., (in Russian))

11. Six International Collaboration Strategies to Advance Taiwan‘s Global Technology and Innovation Presence // ITRI. – 2 September 2025. – URL: https://itrisdgs.itri.org.tw/

eng/datadetail?SiteID=1&MmmID=13071140367623016 52&MGID=1311066512271361561 (date of request: 02/25/2026).

12. V 2023 godu eksport naukoemkoy produktsii i uslug BGU sostavil 2,76 mln dollarov SShA // Belarus' segodnya. – 26 fevralya 2024 g. – URL: https://www.sb.by/articles/v-2023-godu-eksport-naukoemkoy-produktsii-i-uslug-bgu-sostavil-2-76-mln-dollarov-ssha-.html (data obrashcheniya: 25.02.2026). [In 2023, exports of high-tech products and services of BSU amounted to 2.76 million US dollars // Belarus Today. – February 26, 2024 – URL: https://www.sb.by/articles/v-2023-godu-eksport-naukoemkoy-produktsii-i-uslug-bgu-sostavil-2-76-mln-dollarov-ssha-.html (date of request: 02/25/2026).] (e.g., (in Russian))

METHODS FOR EVALUATING THE IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN GOVERNMENT AGENCIES IN THE CONTEXT OF PROJECT MANAGEMENT: MODELING AND SCENARIO FORECASTING

A. T. Assylbekova

Research advisor: G.K. Mukhanova, PhD (Economics)

Astana, Astana IT University,
255707@astanait.edu.kz

Abstract. The paper examines approaches to evaluating artificial intelligence implementation in government regulatory processes from a project management perspective. The study proposes an integrated framework combining process evaluation, organizational governance and scenario-based analysis. Special attention is paid to document-centric administrative procedures where AI affects workflow continuity, accountability and decision quality.

Keywords: artificial intelligence, public sector, digital transformation, regulatory processes, project management, process evaluation, governance.

МЕТОДЫ ОЦЕНКИ ВНЕДРЕНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ГОСУДАРСТВЕННЫХ ОРГАНАХ В КОНТЕКСТЕ УПРАВЛЕНИЯ ПРОЕКТАМИ: МОДЕЛИРОВАНИЕ И СЦЕНАРНОЕ ПРОГНОЗИРОВАНИЕ

А. Т. Асылбекова

Аннотация. В статье рассматриваются подходы к оценке внедрения искусственного интеллекта в государственные регуляторные процессы с позиции проектного управления. Предлагается интегрированная рамочная модель, объединяющая оценку процессов, организационное управление и сценарный

анализ. Особое внимание уделяется документоориентированным административным процедурам, в которых ИИ влияет на непрерывность рабочих процессов, подотчетность и качество принимаемых решений.

Ключевые слова: искусственный интеллект, государственный сектор, цифровая трансформация, регуляторные процессы, проектное управление, оценка процессов, управление.

1. Introduction

The rapid diffusion of artificial intelligence (AI) in the public sector has become one of the most visible manifestations of digital transformation. Government organizations increasingly apply AI tools to support document processing, automate routine checks, classify applications, identify inconsistencies and improve decision support. At the same time, AI implementation in public administration differs significantly from technological adoption in private companies. In the public sector, the quality of implementation cannot be measured only through productivity growth or cost reduction, since government processes must remain transparent, accountable and procedurally consistent [5].

This issue is particularly relevant in regulatory procedures, which are typically document-centric, multi-stage and highly dependent on formal verification. In such contexts, AI rarely replaces administrative workflows entirely. Instead, it is integrated into selected stages such as preliminary validation of applications, extraction of structured data from documents, identification of inconsistencies and compliance checking [4]. Therefore, the effect of AI implementation should be evaluated at the process level rather than at the level of isolated technological functions.

The scientific novelty of this study lies in conceptualizing AI implementation in government regulatory processes as a project-based intervention requiring systematic evaluation across organizational and procedural dimensions. Unlike prior studies that focus mainly on technological efficiency, this paper emphasizes governance, workflow continuity and institutional adaptability as central evaluation criteria.

2. Literature Review

2.1 AI Adoption in Government Contexts

The literature highlights that public sector AI adoption should be understood as an organizational and governance issue rather than only a technological one. Research demonstrates that successful implementation depends on institutional design, distribution of responsibilities and coordination mechanisms across agencies [10].

AI-driven decision-making also transforms professional roles and organizational power dynamics, making evaluation essential for responsible implementation [6].

2.2 Digital Regulatory Processes and Workflow Transformation

Regulatory procedures typically involve repeated cycles of submission, review, revision and approval. Therefore, the impact of AI often appears through reduced rework, improved workflow stability and greater predictability of outcomes. Studies on digital building permit systems show that compliance-checking tools improve administrative continuity but depend strongly on process design and institutional context [3], [1]. These findings highlight the importance of evaluating AI at the systemic rather than operational level.

2.3 Process-Oriented Analytical Approaches

Recent research emphasizes the relevance of process-based analytical tools in public administration. Process mining studies demonstrate how workflow data can reveal bottlenecks, inefficiencies and coordination challenges across agencies [8], [9]. In regulatory environments, these approaches allow decision-makers to move from generalized assumptions toward evidence-based evaluation of administrative performance.

3. Research Methods

This study adopts a conceptual and analytical methodology based on a structured literature review and comparative synthesis. Following approaches proposed in previous research [4], the study was conducted in three stages: literature identification, analytical framework development and conceptual integration.

Ten sources published between 2022 and 2025 were selected for analysis. These sources include journal articles [1–7, 9, 10] and conference-based studies [8]. The analytical framework was developed to evaluate AI implementation across three dimensions: process performance, organizational governance and scenario-based resilience. The comparative analysis focused on identifying common evaluation indicators, governance mechanisms and methodological approaches applicable to regulatory environments.

4. Discussion

4.1 Project-Based Evaluation of AI Implementation

The findings suggest that AI implementation in regulatory processes should be treated as a project-based intervention rather than a purely technical initiative. A project management perspective enables structured evaluation across the lifecycle of implementation, distinguishing between direct effects such as reduced processing

time and indirect effects such as improved workflow coordination and reduced administrative overload.

The proposed evaluation framework integrates three analytical dimensions. First, process-level evaluation focuses on measurable indicators such as processing time, rework rates and workflow stability. Second, governance-oriented evaluation addresses oversight mechanisms, accountability structures and exception management procedures within administrative systems [7]. Third, scenario-based evaluation examines the sustainability of AI-enabled processes under changing workloads, regulatory reforms and resource constraints [4].

4.2 Practical Implications for Regulatory Systems

Construction-related regulatory procedures provide a relevant context for applying this framework due to their document-intensive nature and complex stakeholder interactions. Digital validation tools improve efficiency but also introduce challenges related to monitoring, coordination and procedural transparency [2]. Therefore, effective evaluation must balance operational improvements with institutional considerations.

In addition, AI systems influence long-term institutional development by reshaping administrative routines and interdepartmental coordination mechanisms. As a result, evaluation frameworks should incorporate dynamic indicators reflecting organizational learning and institutional flexibility in digital governance environments.

5. Conclusion

This study confirms that evaluating AI implementation in government regulatory processes requires an integrated project-based approach. A meaningful evaluation framework should combine process indicators, governance criteria and scenario-based analysis to capture both operational and institutional outcomes.

The scientific contribution of this study lies in developing a conceptual framework that integrates project management logic with public sector AI evaluation. The practical significance of the research is reflected in its applicability to document-centric regulatory procedures, particularly in sectors such as construction where administrative complexity is high.

Future research should focus on empirical validation of the proposed framework using real administrative datasets and process mining tools to further assess AI-driven transformation in public governance systems.

REFERENCES

1. Beach T., Yeung J., Nisbet N., Rezgui, Y. (2024) Digital approaches to construction compliance checking: Validating the suitability of an ecosystem approach to compliance checking. Advanced Engineering Informatics, 59, 102288.

2. David A., et al. (2023) Understanding local government digital technology adoption strategies: A PRISMA review. Sustainability, 15, 9645.

3. Fauth J., Pasetti Monizza G., Malacarne G. (2023) Understanding processes on digital building permits – a case study in South Tyrol. Building Research & Information, 51(5), 518–532.

4. Kruiper R., Kumar B., Watson R., Sadeghineko F., Gray A., Konstas, I. (2024) A platform-based natural language processing-driven strategy for digitalising regulatory compliance processes for the built environment. Advanced Engineering Informatics, 62, 102653.

5. Lee J., Dai Y. (2025) Artificial intelligence and data-driven technology in the public policy cycle: Comparative applications, opportunities, and risks. Journal of Comparative Policy Analysis: Research and Practice, 27(5–6), 477–493.

6. Mahroof K., Weerakkody V., Hussain Z., Uivarajah S. (2025) Navigating power dynamics in the public sector through AI-driven algorithmic decision-making. Government Information Quarterly, 42, 102053.

7. Papagiannidis E., Mikalef P., Conboy K. (2025) Responsible artificial intelligence governance: A review and research framework. Journal of Strategic Information Systems, 34, 101885.

8. Rawiro D., Gaol F. L., Supangkat S., Ranti, B. (2022) Process mining applications in government sector: A systematic literature review. In Proceedings of the 5th European International Conference on Industrial Engineering and Operations Management (IEOM).

9. Rott J., Böhm M., Krcmar H. (2024) Laying the ground for future cross-organizational process mining research and application: A literature review. Business Process Management Journal, 30(8), 144–206.

10. Selten F., Klievink B. (2024) Organizing public sector AI adoption: Navigating between separation and integration. Government Information Quarterly, 41, 101885.

MARKET SIZE ASSESSMENT FOR THE DIGITAL SERVICE DEVELOPMENT STARTUP

V. E. Bednenko, A. V. Novikov

Research advisor: O. V. Gordyachkova, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
vadimbednenko2004@gmail.com

Abstract: This paper addresses the problem of financial losses in food retail due to the write-off of expired goods, which represents a significant portion of store revenue in Novosibirsk chain retailers. The proposed solution is the "Festina" digital service, a platform that informs consumers about discounted products with approaching expiration dates. Based on an analysis of retailer revenue and interview data, the authors assess the Total Addressable Market, Serviceable Addressable Market, and Serviceable Obtainable Market for the Novosibirsk agglomeration. The study concludes that the market has high potential and the startup is viable for implementation.

Keywords: digital service, food retail, product write-offs, market assessment, market size, startup, Novosibirsk.

ОЦЕНКА ЕМКОСТИ РЫНКА В РАМКАХ СТАРТАПА ПО РАЗРАБОТКЕ ЦИФРОВОГО СЕРВИСА

В. Е. Бедненко, А. В. Новиков

Аннотация: Данная статья посвящена проблеме финансовых потерь в сфере продуктовой розничной торговли, являющихся следствием списаний товаров с истекшим сроком годности, что составляет весомую часть выручки в новосибирских сетевых ритейлах. В качестве решения предлагается цифровой сервис «Festina» – платформа, информирующая потребителей о продуктах с приближающимся сроком годности. Основываясь на анализе доходов ритейлеров и данных интервью, авторы оценивают совокупный доступный рынок (TAM), доступный объем обслуживаемого рынка (SAM) и реально достижимый объем рынка (SOM) для Новосибирской агломерации. Исследование позволяет сделать вывод о высоком потенциале рынка и жизнеспособности стартапа.

Ключевые слова: цифровой сервис, розничная торговля, списание продуктов, оценка рынка, объем рынка, стартап, Новосибирск.

The relevance of this research is determined by the presence of the persistent problem in modern food retail, specifically the issue of systematic losses from writing off expired goods. As shown by the results of the authors' research, conducted

through in-person interviews with directors of Russian chain grocery stores operating in the retail sector in Novosibirsk, stores monthly write off goods worth 60,000-100,000 rubles due to expiration, which amounts to approximately 1% of each outlet's revenue; upon expiration, goods are subject to disposal, and only in rare cases are they given to charity.

The solution to this problem is the "Festina" application, which allows supermarkets to reduce expenses from writing off expired products by publicly posting information about the availability, remaining shelf life, and reduced price of goods on a unified digital platform.

The business relationship model corresponding to the product is B2B, as the application will be purchased exclusively by other companies. Consequently, the primary market for the product will be large companies and retail chains engaged in food trade in Novosibirsk.

When determining market size, one can only rely on approximate values. According to estimates by analyst Stas Sokolov of the Novosibirsk State Website [1], the potential revenue figures for the largest national retailers and a few local companies are presented in Table 1.

Table 1 – Revenue of the largest food retailers in Novosibirsk in 2024

Company	Revenue, billion rubles	Number of Outlets
Pyaterochka	40	375
Lenta & Monetka	35	38 +179
Magnit	26	301
Maria-Ra	25	288
Yarche	23	242
K&B & Bristol	23	335 + 143
Svetofor & Mayak	12	28 + 8
Auchan	8	3
Metro & Fasol	7	3+51
Spar	5,2	21
Bystronom	3,8	13
Chizhik	2,2	83
Total	210,2	1 126

The data in the table indicate that retail chains sold more than 210 billion rubles worth of food products to Novosibirsk residents in 2024. We extrapolate this figure

to 2025, adjusting for the inflation rate (6.15% in Novosibirsk in 2025 [4]), and obtain 223 billion rubles.

According to Rosstat data for 2024, the retail trade turnover in the Novosibirsk region amounted to 1,084 billion rubles. Food products accounted for 45.5% of this amount, while the portion of turnover generated by large and medium-sized organizations was 61.1% [2]. This yields a food retail turnover value for large and medium-sized companies of 301 billion rubles. However, this sum also includes non-chain and medium-sized companies that do not match the startup's customer profile. After making appropriate adjustments, the turnover value approaches that described in Table 1.

Based on a series of interview surveys conducted by the authors with 11 directors of stores from the largest food chains (Pyaterochka, Magnit, Maria-Ra) in Novosibirsk, it was found that expenses from writing off expired products average about 1% of a retail outlet's revenue. Therefore, the estimated annual losses amount to more than 2.23 billion rubles. This sum effectively represents the Total Addressable Market (TAM) [3] in the Novosibirsk agglomeration.

$$TAM = 223 * 0{,}01 = 2{,}23 \text{ billion rubles} \quad (1)$$

Since, according to their marketing strategy, the specialized products in "Krasnoe & Beloe" and "Bristol" stores are alcohol and accompanying snacks, and the share of perishable goods in their revenue is extremely small, including these chains in the Serviceable Addressable Market is not practical. Regarding "Svetofor" and "Mayak" stores, they are discounters with a limited assortment. Both brands use a low-price model by minimizing expenses on finishing, staff, and advertising. Effectively, all goods in these stores already have reduced prices – margins are minimal, which is why these brands are also not included in the serviceable market segment. The estimated revenue for these chains, adjusted to 2025, is approximately 371 million rubles. Thus, the Serviceable Addressable Market (SAM) [3] is approximately 1.76 billion rubles.

$$SAM = 2{,}23 - 0{,}37 = 1{,}76 \text{ billion rubles} \quad (2)$$

The competitor analysis conducted did not reveal any application possessing the specified functionality. Some chain stores have their own applications where data about promotional events and sales may be posted, but in most cases, this is not related to expiration dates and is part of a marketing strategy, rather than targeted actions to reduce costs.

The innovative nature of the development ensures a practical absence of competitors in the market; moreover, it leads to the creation of a new market. Therefore, it is theoretically possible that a monopoly could emerge. However, due to institutional

uncertainties and the understanding that the subscription cost for stores must be lower than the amount of expenses eliminated, we hypothesize that in the first years of the application's operation, it will be possible to capture 30% of the described market.

Also, upon completion of the expert study, it was hypothesized that the application would allow a retail outlet to reduce expenses on writing off expired products by approximately 75%. Consequently, this would represent the upper limit for the application's subscription price for a supermarket. Considering these conditions, we accept the Serviceable Obtainable Market (SOM) [3] as equal to 395 million rubles.

$$SOM = 1{,}76 * 0{,}3 * 0{,}75 = 0{,}395 \text{ billion rubles} \quad (3)$$

Thus, the Serviceable Obtainable Market amounting to 395 million rubles represents the maximum potential revenue that all players within the chosen segment can capture. This obtained value of the Serviceable Obtainable Market becomes the financial basis for sales planning, marketing budget allocation, and investment seeking, proving that the market is promising and capable of reaching profitability, which indicates the feasibility of implementing the startup in the Novosibirsk region.

REFERENCES

1. Novosibirsk State Website. Revenue of the largest retailers [Electronic resource] – Available at: https://ngs.ru/text/economics/2025/04/20/75350213/ (accessed 22.02.2026).

2. Rosstat. Retail Trade Turnover in the Novosibirsk Region – Available at: https://54. rosstat.gov.ru/storage/mediabank/54_PRESS015%20_ 2025.pdf (accessed 22.02.2026).

3. Sovik I.A. Methodological recommendations for assessing the conditions of the regional goods market / I. A. Sovik // Geopolitics and Ecogeodynamics of Regions. – 2024. – No. 1. – pp. 109-120. – ISSN 2309-7663. – Text : electronic // Lan : electronic library system. – URL: https://e.lanbook.com/journal/issue/356933 (accessed: 22.02.2026).

4. Website of the Bank of Russia. Inflation in NSO – Access mode: https://www.cbr.ru/press/reginfl/?id=64814#:~:text=Цены%20в%20Новосибирской%20области%20в,стране%20(5%2C59%25). (accessed 22.02.2026).

MULTIFUNCTIONAL CENTERS AS A FORM OF PROVIDING PUBLIC AND MUNICIPAL SERVICES IN THE CONTEXT OF DIGITAL TRANSFORMATION

N. V. Degoyan, N. A. Semakina

Research advisor: E. A. Dolbnya, Cand. Sc. (Econ.)

Kemerovo, Kemerovo State University,
deghoyan.narine05@mail.ru

Abstract. Multifunctional centers currently represent an innovative mechanism for the provision of public services, characterized by the integration of functions of several government agencies and departments within a single space. This organizational model provides individuals and legal entities with the opportunity to receive a wide range of services with enhanced convenience, quality, and efficiency.

Keywords: multifunctional centers, public services, municipal services, departments, agencies, "one-stop shop" service.

МНОГОФУНКЦИОНАЛЬНЫЕ ЦЕНТРЫ КАК ФОРМА ПРЕДОСТАВЛЕНИЯ ГОСУДАРСТВЕННЫХ И МУНИЦИПАЛЬНЫХ УСЛУГ В КОНТЕКСТЕ ЦИФРОВОЙ ТРАНСФОРМАЦИИ

Н. В. Дегоян, Н. А. Семакина

Аннотация. Многофункциональные центры в настоящее время представляют собой инновационный механизм предоставления государственных услуг, характеризующийся интеграцией функций нескольких государственных учреждений и ведомств в едином пространстве. Эта организационная модель предоставляет физическим и юридическим лицам возможность получать широкий спектр услуг с повышенным удобством, качеством и эффективностью.

Ключевые слова: многофункциональные центры, государственные услуги, муниципальные услуги, ведомства, учреждения, обслуживание «единого окна».

In the era of digitalization, multifunctional centers are expanding the range of their responsibilities, one of the key ones being assisting applicants in obtaining electronic services. To this end, MFCs have created a special area where specialists help citizens master digital services and provide support in obtaining them online.

«The key features of multifunctional centers (MFCs) include the "single window" principle, which allows citizens to receive the required service without having to visit

multiple agencies and institutions additionally. The centers also provide comprehensive services, independently coordinating interactions with various organizations to meet clients' needs.

An important aspect of multifunctional centers work is customer orientation, which is achieved through continuous improvement based on feedback from visitors. The centers employ qualified and trained personnel who regularly undergo professional development.

Furthermore, MFCs are actively evolving by continuously analyzing their operations, collecting client feedback, and implementing new initiatives to enhance service quality. This allows them to remain relevant and in-demand institutions, providing a wide range of services in a convenient and accessible format» [5].

The main objective of creating a broad network of multifunctional centers throughout Russia is to guarantee high standards of service for citizens when applying for state and municipal services. [3]

Multifunctional centers provide services of government agencies, for example, it can be various ministries and departments, regional and municipal authorities, as well as extra-budgetary funds. Most often, it is the Ministry of Internal Affairs, the Social Fund, etc.

The government has defined a list of mandatory services for all multifunctional centers; many of these are provided as part of packages—several services upon a single request. Furthermore, a "one-stop shop" principle is in effect: applicants visit the multifunctional centers only once, and all subsequent interactions between the center and relevant agencies occur without their direct involvement. [4]

At the federal level, a mandatory minimum of services has been established that must be provided by all multifunctional centers, federal agencies, and state extra-budgetary funds. This list includes 59 items, 55 of which are available through the multifunctional centers. In addition, multifunctional centers are authorized to provide comprehensive services—when a citizen receives several services for a single application.

In fact, the service providers are the relevant agencies and departments; the role of the multifunctional centers is to receive and forward documents to them and to transmit responses to applicants.

Multifunctional centers act as a kind of intermediary between the state and citizens. In the context of digital transformation, Russian citizens began actively using the «Gosuslugi» app in 2020 due to the spread of COVID-19.

In the era of digital transformation, multifunctional Centers and the «Gosuslugi» mobile application are creating an integrated platform that simplifies citizen interaction with government authorities. Through the application, users can remotely fill out

and submit necessary documents, which reduces the need for in-person visits and speeds up the service delivery process.

The government has defined a list of services recommended for provision at multifunctional centers. In addition to the basic set established by Government Decree No. 43-r, this list also includes services from regional authorities and branches of federal institutions, in particular:

1. Registration of an Individual Entrepreneur (IE);
2. Obtaining social support measures – benefits, allowances, subsidies, etc., as well as information on these matters;
3. Assistance in finding a job or employees, information on the labor market, assistance for the unemployed in filing applications and relocating, etc.;
4. Provision of Civil Registry Office services – marriage registration (divorce), birth (death) registration, and issuance of certificates;
5. Registration at the place of residence (stay);
6. Interaction on construction matters (obtaining land plots and urban development plans, filing construction and completion notifications, assigning addresses);
7. Housing services – redevelopment approval, conversion of residential premises to non-residential and vice versa, apartment privatization, etc.;
8. Issuance of permits for transportation by passenger taxi;
9. Obtaining a hunting license and hunting permit. [2]

As mentioned, the multifunctional centers are in constant interaction with various agencies, such as the Social Fund of the Russian Federation, the Tax Service, the Customs Service, the Federal Bailiff Service, the Ministry of Internal Affairs, the Ministry of Justice, the Ministry of Finance, the Ministry of Defense. It is also very important to analyze the effectiveness of the multifunctional centers in the Russian Federation.

In the second quarter of 2024, the Russian network of government service centers demonstrated consistently high results. According to the Ministry of Economic Development's rating, 14 regions maintained high multifunctional centers performance over the past year and a half, and another 15 regions improved their performance, moving from the low or medium to the high group (compared to 2023 and the first quarter of 2024).

“The regions that rose in the rankings based on the results of the second quarter are the Vologda, Kaliningrad, Kirov, Kursk, Kurgan, Orenburg, and Rostov regions; the Krasnoyarsk, Khabarovsk, and Stavropol territories; the Chukotka Autonomous Okrug; the Republics of Ingushetia, Mari El, and Tatarstan; and the city of Sevastopol. A total of 54 constituent entities of the Russian Federation are in the high-performance MFC group” [1].

The multifunctional centers rating is updated quarterly. The multifunctional centers performance is assessed and evaluated based on 23 key criteria. These include, among others: the availability and quality of services provided, the availability of necessary digital technologies in offices, the performance of the user support department, and more.

For each criterion, multifunctional centers receive points, which are ultimately totaled. These points are then assigned a performance level—high, medium, or low. The data is collected based on information and reports from regional authorities, as well as from monitoring hotlines and official websites of multifunctional centers.

Thus, multifunctional centers are an important part of state and municipal administration. They ensure continuous interaction between government agencies and departments, facilitating the process of obtaining the necessary service. Multifunctional centers serve as a broad network providing comprehensive services, minimizing the costs and time required to establish communication between various government departments and institutions to obtain the required service. Today, the continuous improvement and modernization of multifunctional centers is an important task for the state and the regions.

REFERENCES

1. Ministerstvo ekonomicheskogo razvitiya Rossiyskoy Federatsii : ofitsial'nyy sayt. – URL: https://economy.gov.ru/material/news/v_novom_reytinge_mineknomrazvitiya_54_regiona_ voshli_v_gruppu_s_vysokoeffektivnymi_mfc.html [Ministry of Economic Development of the Russian Federation: official website. – URL: https://economy.gov.ru/material/news/v_novom_reytinge_mineknomrazvitiya_54_regiona_voshli_v_gruppu_s_vysokoeffektivnymi_mfc.html] (in Russian).

2. Mnogofunktsional'nye tsentry kak odna iz innovatsionnykh tekhnologiy v predostavlenii gosudarstvennykh i munitsipal'nykh uslug / Sedaev P. V. [i dr.] // Vlast'. 2022. [Multifunctional centers as one of the innovative technologies in providing state and municipal services / Sedayev, P. V. [et al.] //Power. 2022] (in Russian).

3. Ob organizatsii predostavleniya gosudarstvennykh i munitsipal'nykh uslug: feder. zakon ot 27 iyulya 2010 g. № 210-FZ (red. ot 25.12.2023). – Elektron. Tekstovye dan. // Konsul'tantPlyus: sprav. pravovaya sistema. [On the Organization of the Provision of State and Municipal Services: Federal Law of July 27, 2010 No. 210-FZ (as amended on December 25, 2023). – Electronic text data // ConsultantPlus: reference legal system] (in Russian).

4. Sergeeva N. V. Aktual'nye voprosy organizatsiya seti MFTs v Rossiyskoy Federatsii / N.V. Sergeeva // Vestnik Altayskoy akademii ekonomiki i prava. – 2021. – № 3-2. – S. 219-224. – URL: https://vaael.ru/ru/article/view?id=1633. [Sergeeva, N. V. Current issues of organizing the MFC network in the Russian Federation / N. V. Sergeeva // Bulletin of the Altai Academy of Economics and Law. – 2021. – No. 3-2. – Pp. 219-224. – URL: https://vaael.ru/ru/article/view?id=1633] (in Russian).

5. Shelukhin N. L. Rol' i mesto MFTs v sisteme okazaniya uslug sub"ektam khozyaystvennoy deyatel'nosti / N. L. Shelukhin, I. F. Kharaberyush // Vestnik Instituta ekonomicheskikh issledovaniy. – 2023. – № 3(31). – S. 264-275. – EDN LFMSLW. [Sheloukhin, N. L. The role and place of MFCs in the system of providing services to business entities / N. L. Sheloukhin, I. F. Kharaberyush // Bulletin of the Institute of Economic Research. – 2023. – No. 3(31). – Pp. 264-275. – EDN LFMSLW] (in Russian).

OPTIMIZING ADMINISTRATIVE DECISION-MAKING IN AI-ENABLED E-GOVERNMENT: A READINESS FRAMEWORK AND INTERNATIONAL LESSONS

Yelzhan Duisebay

Astana, *Astana IT University*,
e-mail: elzhanduysebai@gmail.com

Abstract. AI implementation into e-governance is aiming to increase the speed and efficiency with which government services are rendered and to streamline delivery systems. Based upon governance and research tools from UK, Canada and Singapore, I provide a framework to assess and enhance AI-assisted decisions while maintaining transparency, accountability and trust of the public.

Keywords: accountability, decision-making, e-government, transparency, auditing, oversight, trust.

ОПТИМИЗАЦИЯ АДМИНИСТРАТИВНОГО ПРИНЯТИЯ РЕШЕНИЙ В УСЛОВИЯХ ВНЕДРЕНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ЭЛЕКТРОННОЕ ГОСУДАРСТВЕННОЕ УПРАВЛЕНИЕ: МОДЕЛЬ ГОТОВНОСТИ И МЕЖДУНАРОДНЫЙ ОПЫТ

Е. Дуйсебай

Аннотация. Внедрение искусственного интеллекта в систему электронного государственного управления направлено на повышение скорости и эффективности предоставления государственных услуг, а также на оптимизацию процессов их оказания. На основе инструментов государственного управления и исследовательских практик Великобритании, Канады и Сингапура предлагается модель оценки и совершенствования решений, принимаемых с использованием ИИ, при сохранении прозрачности, подотчётности и общественного доверия.

Ключевые слова: подотчётность, принятие решений, электронное государство, прозрачность, аудит, надзор, доверие.

Introduction

The evolution of digital government has restructured value delivery with AI-assisted public services. However, optimization in government differs from optimization in private platforms. AI adds a decision support layer with a legal risk that the system will also remain biased, and explainability and contestability will be limited or eliminated altogether. Therefore, the central challenge contemporary e-governance systems must resolve is determining the legitimacy and safety of governance structures that allow for AI-assisted decision making. This article addresses that challenge and proposes a framework for readiness of AI-enabled decision-making in e-governments. Additionally, this article identifies a number of actionable role model policy practices from Canada, Singapore, and the United Kingdom to illustrate the framework. [4, 8, 11].

AI-Enabled Decision-Making as Public Sector Optimization

While AI can operate autonomously, that is reserved for few instances as most often, AI systems assist human operators by evaluating and ranking priorities, flagging and evaluating risks, providing recommended actions or next steps, as well as providing textual explanations for human operators to review. AI systems can increment operational efficiency by limiting the amount of time needed for human review to conduct screening and routine steps. This allows operators to focus their expertise on cases that are more intricate [7]. AI systems can also improve operational policy efficiency by assisting an agency to learn and adapt to the citizen needs by analyzing service data. The Organization for Economic Co-operation and Development (OECD) has reported an increased interest by governments on the utilization of AI on crime predictions, detection of fraud, processing of documents, and interaction with citizens as part of the transformation of the public service delivery process. AI systems can improve the overall efficiency of an agency by learning from citizen service data [1].

While utilizing the fastest and most cost-effective means is important to public administration, the legal aspects of providing equitable and transparent public service delivery with the right to know, and the right to appeal, cannot, and must not, be ignored. The creation of algorithmic public systems does not change the way that processes are structured, but adds another layer of decision-making to an already existing decision-making structure. The advisory role of decision-making structures does not remove the legal and ethical obligations of the agent for making the decision, and although the role of algorithmic systems is to assist and advise, their impact on the existing decision-making processes is significant [2]. If frontline staff treat model scores as definitive, discretion may narrow and errors may scale.

Consequently, the design objective should be framed as improving decision quality, not simply automating decisions. Decision quality includes accuracy, consistency, proportionality of risk responses, and procedural safeguards that allow citizens to understand and challenge outcomes [5].

Governance Risks: Legitimacy, Bias, and Contestability

Three governance risks particularly concern the use of AI for administrative decision-making. First, opacity can undermine legitimacy. Citizens may distrust digital services if they cannot find out what data informed a decision, how the model was validated, and how the model's recommendations were used by humans. Second, bias may become entrenched when a model learns from prior decisions that reflect inequitable distribution, discriminatory enforcement, or erroneous measurement. Third, when accountability for a decision is fragmented among data owners, vendors, model creators, and caseworkers, contestability is obstructed. The literature on accountable algorithms emphasizes that when decisions affect rights and benefits, governance must ensure traceability, explanation, and mechanisms to correct errors at scale [5].

Empirical studies of AI adoption in the public sector demonstrate that many challenges to implementation are organizational, rather than technical, such as unclear accountability, poor data governance, a lack of procurement skills, and insufficient professional competencies [10]. Most ethical frameworks for AI identify similar central principles of beneficence, non-malfeasance, respect for autonomy, justice, and explicability, which are particularly relevant in the context of public decision making [3]. Practical guidance for public leaders further points out that risks should be addressed through process-based governance: impact assessment, oversight, documentation, communication with affected groups, and continuous monitoring after deployment [6].

Role-Model Practices from International Digital Governments

International practice offers concrete mechanisms that can be adopted without relying on any single country context. Canada’s Directive on Automated Decision-Making is notable for treating automated decision systems as risk-bearing administrative tools. It necessitates human intervention safeguards tailored to the degree of potential harm, proportional transparency measures, and an algorithmic effect assessment [4]. This strategy operationalizes a straightforward concept: greater governance rules and more transparent citizen communication are necessary for higher-stakes decisions.

The United Kingdom has advanced transparency instruments that complement risk-based oversight. The Algorithmic Transparency Recording Standard encourages public bodies to publish structured information about algorithmic tools, including purpose, data sources, evaluation, and accountability arrangements [11]. When combined with internal documentation and public communication, such records can reduce the gap between technical design and public understanding. With recommendations that can be modified for both public and private deployments, Singapore's Model AI Governance Framework offers a practical governance toolset with an emphasis on internal governance structures, risk management, and stakeholder communication [8]. Together, these strategies show that practical documentation, evaluation, and disclosure procedures can be used to seek reliable AI in government.

These role models align with broader digital government benchmarks. The United Nations (UN) highlights that advanced digital governments increasingly combine service delivery with institutional capacity, data integration, and accountability to achieve inclusive outcomes [12]. The World Bank's GovTech work similarly frames digital transformation as a citizen-centric reform agenda, where technology should strengthen institutions and feedback loops rather than simply digitize legacy procedures [13].

A Readiness Framework for AI-Enabled Administrative Decisions

Building on the literature and role-model practices, this article proposes a readiness framework with six mutually reinforcing elements. Agencies that aim to apply AI to support choices about services, benefits, compliance, or resource allocation are the target audience for this approach. Readiness is an institutional capacity to use AI responsibly, explainably, and adaptably; it is not a single maturity level.

1) Decision and legal mapping. Agencies should define where AI will influence decisions (screening, recommendation, or final determination) and map each decision point to legal authority, procedural rights, and appeal pathways. This makes constraints explicit and prevents informal automation of discretionary judgment [2, 5].

2) Data governance and quality. Because decision-support models inherit the structure of administrative data, agencies need clear data stewardship, documentation of data provenance, and routine checks for representativeness and drift. Data governance also protects privacy and ensures that cross-system data sharing is justified and auditable [6, 13].

3) Impact assessment and proportional controls. Risk-based assessment should determine documentation depth, evaluation requirements, human oversight,

and transparency measures. Canada's directive provides a practical template for scaling controls to potential harm and specifying responsibilities across units [4].

4) Model lifecycle documentation and auditing. Documentation should cover objectives, training and testing procedures, performance metrics, limitations, and monitoring plans. Internal audits can be structured as stage-gated reviews that produce evidence artefacts throughout development and deployment, reducing the accountability gap identified in auditing research [9].

5) Human oversight and decision quality assurance. Agencies should specify how human decision-makers interpret AI outputs, when they may override them, and how overrides are logged and reviewed. Training is essential to avoid automation bias, where staff defer to model recommendations even when context suggests otherwise [2, 6].

6) Transparency, contestability, and feedback. Citizens should be informed when algorithmic tools contribute to decisions and should receive understandable explanations and routes for redress. Public registers and structured disclosure, as promoted in the UK transparency standard, support legitimacy and enable scrutiny over time [11].

The framework supports optimization by shifting attention from isolated model accuracy to end-to-end decision performance. Agencies can track not only predictive metrics but also downstream outcomes: error rates in appeals, disparities across groups, time-to-resolution, and citizen satisfaction with explanations. Such measures tie technical performance to administrative justice and service quality [3, 12].

Conclusion

AI can optimize administrative decision-making by improving consistency and enabling proactive services, but without governance readiness it may undermine legitimacy and contestability. Role-model instruments – impact assessment, documentation, auditing, and transparency registers – translate ethical principles into operational controls.

REFERENCES

1. Berryhill, J., Kok Heang, K., Clogher, R., McBride, K. (2019) Hello, World: Artificial intelligence and its use in the public sector (OECD Working Papers on Public Governance, No. 36). Paris: OECD Publishing. URL: https://www. oecd.org/ content/dam/ oecd/en/ publications/reports/2019/11/hello-world_7734f030/ 726fd39d-en.pdf (accessed 03.03.2026).

2. Engstrom D. F., Ho D. E., Sharkey C. M., Cuellar, M.-F. (2020) Government by Algorithm: Artificial intelligence in federal administrative agencies. Washington, DC: Administrative Conference of the United States. URL: https://law.stanford.edu/wp-content/uploads/2020/02/ACUS-AI-Report.pdf (accessed 03.03.2026).

3. Floridi L. et al. (2018) AI4People - An ethical framework for a good AI society: Opportunities, risks, principles, and recommendations. Minds and Machines, 28, 689-707.

4. Government of Canada, Treasury Board Secretariat. (2021) Directive on Automated Decision-Making. URL: https://publications.gc.ca/collections/collection_2021/sct-tbs/BT48-31-2021-eng.pdf (accessed 03.03.2026).

5. Kroll, J. A. et al. (2017) Accountable Algorithms. University of Pennsylvania Law Review, 165 (3), 633-705.

6. Leslie, D. (2019) Understanding artificial intelligence ethics and safety. London: The Alan Turing Institute. URL: https://www.turing.ac.uk/sites/default/files/ 2019-08/understanding_artificial_intelligence_ethics_and_safety.pdf (accessed 03.03.2026).

7. Mehr H. (2017) Artificial intelligence for citizen services and government. Cambridge, MA: Harvard Kennedy School, Ash Center for Democratic Governance and Innovation. URL: https://ash.harvard.edu/wp-content/uploads/2024/02/artificial_intelligence_for_citizen_services.pdf (accessed 03.03.2026).

8. Personal Data Protection Commission (PDPC). (2020) Model Artificial Intelligence Governance Framework. 2nd ed. Singapore: PDPC. URL: https://www. pdpc.gov.sg/help-and-resources/2020/01/second-edition-of-model-artificial-intelligence-governance-framework (accessed 03.03.2026).

9. Raji I. D. et al. (2020) Closing the AI accountability gap: Defining an end-to-end framework for internal algorithmic auditing. Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency, 33-44.

10. Sun T. Q., Medaglia, R. (2019) Mapping the challenges of Artificial Intelligence in the public sector: Evidence from public healthcare. Government Information Quarterly, 36 (2), 368-383.

11. UK Government, Central Digital and Data Office. (2022) Algorithmic Transparency Recording Standard. URL: https://oecd-opsi.org/wp-content/uploads/2022/ 10/20220622-Algorithmic-transparency-standard-in-a-standard-format_iteration_2.pdf (accessed 03.03.2026).

12. United Nations, Department of Economic and Social Affairs. (2024) United Nations E-Government Survey 2024. New York: United Nations. URL: https://desapublications.un.org/sites/default/files/publications/2024-09/%28Web%20version%29%20E-Government%20Survey%202024%201392024.pdf (accessed 03.03.2026).

13. World Bank. (2020) GovTech: The new frontier in digital government transformation. Washington, DC: World Bank. URL: https://documents1.worldbank. org/curated/en/898571612344883836/pdf/GovTech-The-New-Frontier-in-Digital-Government-Transformation.pdf (accessed 03.03.2026).

REAL OPTIONS AND BUSINESS DIGITALIZATION: THE RELATIONSHIP OF CONCEPTS

A. S. Goleshev

Research adisor: E. I. Muzyko, Dr. of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
art-energy01@mail.ru

Abstract: The article explores the conceptual relationship between the theory of real options and the stage-by-stage model of digital business transformation. Based on the analysis of five levels of digitalization, the article shows that each stage corresponds to specific types of options. A correspondence matrix of real options and stages of digital business transformation is proposed, which offers tools for financial management in making managerial decisions.

Keywords: business digitalization, real options theory, managerial flexibility, digital strategy, information ecosystems, stages of business digitalization.

РЕАЛЬНЫЕ ОПЦИОНЫ И ЦИФРОВИЗАЦИЯ БИЗНЕСА: СВЯЗЬ КОНЦЕПЦИЙ

А. С. Голешев

Аннотация: В статье исследуется концептуальная связь между теорией реальных опционов и поэтапной моделью цифровой трансформации бизнеса. На основе анализа пяти уровней цифровизации показано, что каждому этапу соответствуют специфические типы опционов. Предложена матрица соответствия реальных опционов и этапов цифровой трансформации бизнеса, которая предлагает инструментарий для финансового менеджмента при принятии управленческих решений.

Ключевые слова: цифровизация бизнеса, теория реальных опционов, управленческая гибкость, цифровая стратегия, информационные экосистемы, этапы цифровизации бизнеса.

Currently, businesses face numerous economic challenges that require rapid and economically costly changes in company operations. One such challenge is the need for digital business transformation, which requires significant investment. This challenge is not merely a factor of competitive struggle; it is a condition for business survival in the current market environment. In this regard, an increasing number of organizations are turning to business digitalization.

The process of digital business transformation is multilevel and represents a series of sequential stages, starting from understanding the need for digitalization for the business and ending with the formation of its own digital system. However, in analyzing this process, it is important not only to understand the content of each stage, but also to be aware of the mechanisms of transitions between them. A key aspect of the analysis of digitalization is occupied by the process of evaluating investments during the transition between stages.

The most common methods for evaluating the effectiveness of investments in business digitalization are traditional methods, among which NPV, IRR, PP and others stand out. However, traditional methods do not allow for assessing the potential positive effects that arise at each stage of business digitalization, and consequently, company management may refuse to invest in the development of digital transformation due to the use of traditional investment evaluation methods.

Given the above, companies have a need to improve the tools for evaluating investments in digital transformation, as well as for determining the logic of decision-making when transitioning between different stages of the process under study. To solve this problem, the author proposes using the theory of real options, which is applied in evaluating investments under conditions of significant uncertainty and takes into account managerial flexibility. The application of real options theory in business digitalization allows us to identify the value of managerial flexibility at each stage of this process, which will make it possible to more accurately assess the effectiveness of each stage of business digitalization and make the most effective management decisions.

There are various approaches to defining business digitalization. According to the author, the most comprehensive is the definition by T.F. Kuznetsova, who defines this process as: "the transformation of organizations or economic sectors into new process models implemented on the basis of digital technologies" [1].

Within the framework of the process under study, E.A. Nigai proposes a model consisting of five stages of digital business transformation that organizations encounter [2]. The entire process begins with the zeroth stage, at which companies realize their need for digitalization of business processes. At the first stage, management understands the benefits and value of digitalization, and the company's digital intelligence develops through the creation of digital competencies among employees. At the next stage, point digitalization is carried out, that is, various digital tools are applied, some business processes are automated, and data begins to accumulate. The third stage is the acceptance of digital reality and is characterized by the creation of a coherent IT strategy covering the main areas of the company's activities. At the fourth stage, self-regulation and foresight occur through predictive

analytics, using forecast models and business modeling methods, which makes it possible to predict changes in the organization's activities. At the final fifth stage, its own open digital ecosystem is created, which, through the use of open interfaces (API), unites all processes and all counterparties in a single interface. Through the use of these technologies, companies achieve a high level of efficiency and significantly improve their financial results. However, this model only demonstrates the stages of digitalization, without explaining how companies make investment decisions about the transition between these stages.

To identify the process of making managerial decisions about investments in the transition between stages of business digitalization, the author proposes using the concept of real options. Its application provides a more accurate assessment of investments at each stage of digitalization, by creating options that provide managerial flexibility at each stage. The author proposes real options that arise at each stage of business digitalization. The results are shown in Table 1.

Table 1 – Matrix of correspondence between business digitalization stages and real options

№	Digital Transformation Stage	Type of Real Option	What does it give the right to do?
1	Actualization	Entry Option	Decide whether to implement technologies
2	Point Digitalization	Scale Option	Scale successful solutions
3	Acceptance of Digital Reality	Abandonment Option / Switching Option	Abandon failures / switch technologies
4	Foresight	Scenario Choice Option	Choose the optimal future scenario
5	Ecosystem	Compound Option (portfolio of options)	Connect partners, integrate into ecosystems

At the first stage, an entry option appears, when investments in training digital competencies provide an opportunity to begin building the digital transformation process. At the stage of point digitalization, investments in individual processes create a scale option, which subsequently allows management to decide on expanding and further developing digital technologies. At the third stage, the acceptance of digital reality occurs, and management has two options: in the first case, they have the right to abandon ineffective areas, and in the second, to switch technologies. At the next stage, a scenario choice option arises, which allows, through data forecasting, the selection of a development trajectory. At the final stage, companies acquire a compound option or a portfolio of options, since the presence of an ecosystem

creates many interconnected opportunities for business development, the value of which exceeds the sum of the values of individual options. Notably, the transition between stages of business digitalization is carried out through the exercise of real options.

The proposed real options for the stages of digital business transformation lead to the conclusion that considering the business digitalization process through the application of real options theory enables an organization's management to make effective decisions. However, it is worth noting that when considering digital business transformation projects without taking into account real options, management does not consider managerial flexibility, and consequently, the project may be rejected despite its potential benefit.

In summary, the connection between real options and business digitalization is that at each of the stages a real option appears, and through the exercise of this option, the transition to the next stage is carried out. The proposed matrix provides management with tools for planning digital development, allowing for a more accurate assessment of the effectiveness of investments in digital business transformation, taking into account the benefits of managerial flexibility.

REFERENCES

1. Kuznetsova, T. F. (2019) Cifrovizacija kak kul'turnaja cennost' i cifrovye tehnologii [Digitalization as a cultural value and digital technologies]. *Gorizonty gumanitarnogo znanija* [Horizons of Humanitarian Knowledge], 5, 3 (in Russian).

2. Nigai, E. A. (2022) Process cifrovizacii biznesa: ot tochechnoj ocifrovki biznes-processov k cifrovoj transformacii [The process of business digitalization: from point digitization of business processes to digital transformation]. *JETAP* [STAGE], 2 (in Russian).

3. Vatutina, L. A. (2021) Cifrovizacija i cifrovaja transformacija biznesa: sovremennye vyzovy i tendencii [Digitalization and digital transformation of business: modern challenges and trends]. *Vestnik Udmurtskogo universiteta. Serija «Jekonomika i pravo»* [Bulletin of Udmurt University. Series "Economics and Law"], 4 (in Russian).

ADDITIONAL SHARE ISSUANCE AS A TOOL FOR FINANCIAL RECOVERY: A CASE STUDY OF SEGEZHA GROUP

Y. E. Goncharov

Research adisor: E. I. Muzyko, Dr. of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
antares.w76@gmail.ru

Abstract. This article examines the financial recovery process of a major Russian timber industry company – Segezha Group – through a secondary public offering (SPO) in the first half of 2025. Based on a comparative analysis of consolidated financial statement data as of December 31, 2024, and June 30, 2025, the study assesses the impact of the equity issuance on capital structure, debt burden, liquidity, and bankruptcy probability. The study demonstrates that the mechanism of converting liabilities into equity enabled the company to restore financial stability in a short period, reduce its debt burden, and exit the critical bankruptcy risk zone. The findings may be useful for developing crisis management strategies for real-sector companies operating under conditions of high interest rates and limited access to credit resources.

Keywords: Secondary public offering, SPO, capital structure, financial stability, debt restructuring, bankruptcy prediction models, timber industry.

ДОПОЛНИТЕЛЬНАЯ ЭМИССИЯ АКЦИЙ КАК ИНСТРУМЕНТ ФИНАНСОВОГО ОЗДОРОВЛЕНИЯ: КЕЙС ПАО «СЕГЕЖА ГРУПП»

Я. Е. Гончаров

Аннотация. В статье рассматривается процесс финансового оздоровления крупной российской лесопромышленной компании – ПАО «Сегежа Групп» – посредством дополнительного выпуска акций (SPO) в первом полугодии 2025 года. На основе сопоставительного анализа данных консолидированной финансовой отчётности на 31 декабря 2024 года и 30 июня 2025 года оценивается влияние эмиссии на структуру капитала, долговую нагрузку, ликвидность и вероятность банкротства. Показано, что механизм конвертации обязательств в капитал позволил в сжатые сроки восстановить финансовую устойчивость компании, снизить долговое бремя и выйти из зоны критического риска банкротства. Полученные результаты могут быть полезны при выработке антикризисных стратегий для компаний реального сектора в условиях высоких процентных ставок и ограниченного доступа к кредитным ресурсам.

Ключевые слова: дополнительная эмиссия акций, SPO, структура капитала, финансовая устойчивость, реструктуризация долга, модели банкротства, лесопромышленный комплекс.

Introduction

Between 2022 and 2024, the Russian timber industry faced unprecedented pressure from external factors: sanction-related restrictions, the reorientation of export flows from European to Asian markets, rising logistics costs, and monetary policy tightening. Under these conditions, a number of systemically important enterprises found themselves on the brink of insolvency. Segezha Group, vertically integrated holding and one of the world's largest producers of kraft paper and lumber, was no exception. By the end of 2024, the company's financial position was characterized by a high probability of default. The purpose of this article is to quantitatively assess the extent to which the additional share issuance reduced the company's debt burden, improved its liquidity indicators, and decreased its bankruptcy probability [1].

The empirical basis comprises consolidated financial statement data for 2024 and condensed interim financial statements as of June 30, 2025. The methodology includes calculating and comparing standard financial ratios, as well as interpreting changes within the framework of bankruptcy prediction models (Altman, Beaver, Saifullin–Kadykov).

Theoretical Aspects of Using SPO in Crisis Management

In classical capital structure theory, equity issuance is considered one method of attracting financing; however, its role transforms during a crisis. According to pecking order theory, companies prefer internal sources of financing over external ones, and among external sources, they prefer debt instruments. Yet, when debt burden reaches critical levels and access to new credit is either blocked or comes with prohibitively high rates, equity issuance becomes not merely an alternative but the only viable option.

A feature of recent Russian practice has been the use of "substitution bonds" and payments in the currencies of friendly countries. However, for a radical improvement in the balance sheet structure, recapitalization through equity has proven to be a more effective tool. As Lubova T.N. and Zapolskikh Y.A. note, while bankruptcy prediction models require adaptation to Russian conditions, the underlying logic remains: an increase in the share of equity capital reduces the probability of insolvency [2].

Methodology and Study Period

Two time points were used for the analysis: December 31, 2024 – data from the annual report. As of this date, the company's equity capital amounted to RUB 1,084 million, total liabilities – RUB 205,554 million, and net loss for the year –

RUB 22,280 million. The second analysis point is June 30, 2025 – data from the condensed interim consolidated financial statements.

Indicators were calculated using standard formulas:

- Equity ratio: Equity / Assets.
- Current ratio: Current assets / Current liabilities.
- Net debt: Long-term and short-term loans and borrowings – Cash and cash equivalents.
- Altman Z-score (for public companies): $1.2 \cdot X1 + 1.4 \cdot X2 + 3.3 \cdot X3 + 0.6 \cdot X4 + + 1.0 \cdot X5$.

Commonly accepted threshold values were used to interpret bankruptcy probability:

- $Z < 1.81$ – high probability, $1.81 < Z < 2.77$ – medium probability, $Z > 2.99$ – low probability.

Characteristics of the Additional Share Issuance and Analysis of Its Impact

On December 26, 2024, the General Meeting of Shareholders approved an increase in the authorized capital through the issuance of 62,760 million ordinary shares with a par value of RUB 0.1 per share at an offering price of RUB 1.8 per share. The placement was conducted via a private subscription among the main shareholder (AFK Sistema) and a pool of external investors, and was completed on June 2, 2025. The total capital increase amounted to RUB 87,333 million, of which RUB 51,012 million was paid in cash, and RUB 36,321 million was settled by netting mutual claims (effectively, debt-to-equity conversion) [3].

Table 1 – Liability Structure of Segezha Group, RUB million [3, 4]

Indicator	31.12.2024	30.06.2025	Change
Equity Capital	1 084	66 641	+65 557
Long-term Liabilities	109 423	58 318	-51 105
Short-term Liabilities	96 047	73 555	-22 492
Balance Sheet Total	206 554	198 840	-7 714

The equity ratio increased from 0.005 to 0.335. Thus, the share of equity in financing sources rose from virtually zero to 33.5%, which corresponds to a moderately conservative capital structure for an industrial enterprise.

The reduction in net debt by 60.7% was accompanied by the disappearance of collateral: as of June 30, 2025, the Group had no assets pledged as security, whereas at the end of 2024, pledged assets were valued at RUB 2,173 million. This indirectly

indicates a revision of credit agreement terms and increased confidence on the part of creditors.

Table 2 – Debt Dynamics of Segezha Group, RUB million

Indicator	31.12.2024	30.06.2025	Change
Long-term Loans and Borrowings	89 498	42 183	-47 315
Short-term Loans and Borrowings	62 923	19 793	-43 130
Total Loans and Borrowings	**152 421**	**61 976**	**–90 445**
Cash and Cash Equivalents	4 641	3 923	–718
Net Debt	147 780	58 053	–89 727

Despite an overall reduction in current assets, a faster decline in short-term liabilities led to an improvement in the current ratio from 0.49 to 0.64.

Applying the five-factor Altman model to the data as of December 31, 2024, yielded a Z-score of 0.57, corresponding to the "high-risk" zone (80–100% probability of bankruptcy within the next year). For the assessment as of June 30, 2025, the market capitalization indicator (X4) is required. Given that the market price of the shares stabilized after the placement at levels close to the offering price (RUB 1.8), market capitalization can be conservatively estimated at approximately RUB 141 billion (78.45 billion shares × RUB 1.8). Under this assumption, X4 would be about 1.07 (capitalization / liabilities). Substituting into the formula yields a Z-score in the range of 1.8–2.2, which corresponds to a medium risk level. The Beaver model also shifts from the 'one year before bankruptcy' category to a borderline zone between the second and third groups. The Saifullin–Kadykov model, tailored to Russian specifics, shows improvement due to the positive dynamics of equity capital, although the final R remains below unity, indicating continued vulnerability.

The improvement in the balance sheet structure achieved over six months should be considered significant. However, it must be emphasized that operating activities remain unprofitable. For the first half of 2025, the net loss amounted to RUB 21,765 million – higher than for the same period in 2024. The loss is largely attributable to expenses related to the reorganization of the Woodworking segment (RUB 5,574 million) and persistently high interest payments (RUB 15,834 million). Revenue decreased by 8% year-on-year, reflecting sales difficulties in new markets.

Thus, the achieved financial stability is of a "balance-sheet" nature, not an "operational" one. The Company has gained a breathing space and resources to

undertake production and logistics optimization without the threat of imminent default. Future research could focus on evaluating the effectiveness of real investments that have become possible following the restructuring [5].

Conclusion

The Segezha Group case demonstrates that a SPO combined with the conversion of part of the debt can radically improve the capital structure in a short period and lift a company out of a pre-bankruptcy state. The main conclusions of the study are as follows:

The described experience may be useful for companies facing excessive debt burdens in an environment of tight monetary policy and limited access to capital markets. The key success factor was the willingness of shareholders and creditors to convert debt into equity, which made it possible to avoid a lengthy and costly bankruptcy procedure.

REFERENCES

1. B1 (2024) Lesopromyshlennyy kompleks Rossii: rezul'taty ezhegodnogo issledovaniya [Russian timber industry: results of an annual study]. URL: https://b1.ru/analytics/b1-russian-forest-industry-2024-overview/ (accessed 24.02.2026)

2. Lubova, T.N., & Zapolskikh, Y.A. (2024). Methods for assessing the probability of potential corporate bankruptcy. UGNF, 1. URL: https://cyberleninka.ru/article/n/metody-otsenki-veroyatnosti-potentsialnogo-bankrotstva-predpriyatiya (accessed: 26.03.2026)

3. Segezha Group. (2025). Unaudited interim condensed consolidated financial statements for the six months ended June 30, 2025. (accessed 21.02.2026)

4. Segezha Group. (2024). Consolidated financial statements for the year ended December 31, 2024. (accessed 21.02.2026)

5. Zhurnal «Kompaniya». (2025, August 25) «Segezha Grupp» povyshaet finansovuyu stabil'nost' i effektivnost' biznesa [Segezha Group improves financial stability and business efficiency]. ko.ru. URL: https://ko.ru/news/segezha-grupp-povyshaet-finansovuyu-stabilnost-i-effektivnost-biznesa/ (accessed 25.02.2025)

GOVERNMENT INCENTIVES AND BUSINESS STRATEGIES FOR DIGITALIZING OIL SUPPLY CHAINS FOR EXPORT

A. A. Grigorev

Research advisor: N. V. Bozo, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
Supermars29@mail.ru

Abstract. The article examines the mechanism of interaction between state development institutions and the strategies of vertically integrated oil companies in the context of global fragmentation of energy markets. Special attention is paid to the transition from fragmented automation to the creation of end-to-end digital ecosystems for export logistics.

Key words: digital transformation, supply chain, Asia-pacific markets, sovereignty, predictive analytics, digital oil passport, cybersecurity, BRICS+.

ГОСУДАРСТВЕННЫЕ СТИМУЛЫ И БИЗНЕС-СТРАТЕГИИ ЦИФРОВИЗАЦИИ ЭКСПОРТНЫХ ЦЕПОЧЕК ПОСТАВОК НЕФТИ

А. А. Григорьев

Аннотация. В статье рассматривается механизм взаимодействия институтов развития и стратегий вертикально интегрированных нефтяных компаний в условиях глобальной фрагментации энергетических рынков. Особое внимание уделяется переходу от фрагментированной автоматизации к созданию сквозных цифровых экосистем для экспортной логистики.

Ключевые слова: цифровая трансформация, цепочка поставок, рынки Азиатско-Тихоокеанского региона, суверенитет, прогнозная аналитика, цифровой нефтяной паспорт, кибербезопасность, БРИКС+.

Introduction

Between 2024 and 2026, the export strategy of the domestic energy sector underwent a fundamental transformation. The reorientation of supplies to the markets of the Asia-Pacific region required not only a change in geography, but also a radical revision of all logistics algorithms. Previously, hydrocarbon exports relied on stable routes that had been established over decades, but modern deliveries are characterized by a high degree of multimodality and unprecedented volatility in freight schemes. In these conditions, digitalization is the main tool for hedging operational risks. Within Rosneft PJSC, the digital supply chain is viewed as a single

continuous flow that combines the physical level of sensors at metering nodes, the information level of cloud platforms, and the cognitive level of predictive analytics for route optimization decisions.

Government Architecture to Support the Digital Transition

The government has shifted from a policy of targeted subsidies to creating comprehensive macroeconomic conditions to ensure IT sovereignty in the fuel and energy sector. The most important mechanism here is the updated special investment contracts, which allow companies to receive significant tax benefits in exchange for implementing end-to-end control technologies for the movement of hydrocarbons. This condition is critical for verifying and confirming the origin of oil shipments at international hubs. In parallel, industrial competence centers are accelerating the development of domestic software for mathematical modeling of complex transport systems, which allows for the systematic replacement of Western solutions. An additional incentive was the creation of so-called "digital sandboxes," which significantly simplified the legal regime for using unmanned aerial systems to monitor remote sections of export pipelines, directly reducing companies' operational costs for infrastructure maintenance.

Strategic business priorities and uncertainty management

For a large international player, the digital transformation of supply chains has become an essential tool to adapt to the uncertainty of the market. Under the external pressure of sanctions, the development of sovereign ship traffic monitoring systems and the promotion of smart freight is crucial. The company's corporate strategy relied on the proactive use of neural network algorithms to analyze the behavior patterns of the fleet of tankers – this provided predictive management of logistics and avoidance of congestion in the narrow straits and the optimization of on-board transshipment processes. Meanwhile Asian (Northeastern and Southeastern) importers are presenting more and more environmentally demanding requirements for the delivered cargo. The response to this challenge was the ESG-digitization of every export barrel. The automation of the continuous emission monitoring systems from the well to the port terminal generated a transparent digital oil passport and brought a considerable enhancement of the reputation of the export blend competitiveness in the markets of the Global South.

Mathematical Justification of Integration Efficiency

The economic efficiency of the modernized export system is calculated by minimizing the cost of inventory in transit and optimizing logistics costs. Mathematically, the objective function can be expressed through the minimization of the delay in the information signal when making management decisions:

$$E_{eff} = \int_0^T \left(P_{market}(y) - C_{log}(t, \Delta t)\right) dt \rightarrow max$$

In this model, the variable P_{market} represents the current price of hydrocarbons on a FOB or CIF basis, while the parameter C_{log} reflects the total logistics costs, which are directly dependent on the data processing speed Δt. The use of edge computing technologies directly on maritime terminals reduces the Δt value to a minimum, ensuring that trading departments can respond almost instantly to changes in exchange rates or adverse weather conditions.

Barriers to transformation and development prospects

The industry encounters several systemic obstacles in building intelligent logistics. First, the widespread use of digital invoices and smart contracts has created an expanded attack surface for cyber espionage and hacking of electronic data, thus creating the need for a secure transnational data transfer channel. The problem is compounded by the shortage of specialists at the intersection of disciplines: there is an urgent need for the market to hire professionals with profound knowledge of oil chemistry, logistics, and distributed database architectures. Second, the lack of uniform digital standards for trade between BRICS+ countries prevents the application of full-fledged blockchain-based solutions. Nevertheless, a new export image has all but taken shape through the interaction of state incentives and corporate initiatives. through the interaction of state incentives and corporate initiatives. In the near future, market supremacy will come through the creation of a common secure digital energy space for partner states.

REFERENCES

1. Zarajskij A.A., & Korotaev, S.A. Cifrovaya transformaciya e`nergeticheskogo kompleksa Rossii: problemy` i perspektivy`. E`nergeticheskaya politika, №2, 2023, s. 45–58.

2. Petrov V.V., Ivanova, E.V., & Smirnov, D.A. Informacionny`e texnologii v e`lektroe`nergetike: vnedrenie cifrovy`x platform. Zhurnal «E`lektrichestvo», 2024, T. 78, №4, s. 12–27.

3. Minin I.Yu. Cifrovizaciya ob``ektov neftegazovogo kompleksa: opy`t rossijskix kompanij. Neftegazovaya otrasl`, 2022, №6, s. 33–41.

4. Nazari Z., & Musilek, P. Impact of Digital Transformation on the Energy Sector: A Review. Algorithms, 16(4), 211. MDPI AG, 2023. DOI: https://doi.org/10.3390/a16040211

5. Bourgeois, R. et al. Digital transformation in the resource and energy sectors: A systematic review. Resources Policy, Vol. 76, 102622, 2022. DOI: https://doi.org/10.1016/j.resourpol.2022.102622

6. Rajavuori M., & Huhta K. Digitalization of security in the energy sector: evolution of EU law and policy. The Journal of World Energy Law & Business, 13(4), 353–367, 2020. DOI: https://doi.org/10.1093/jwelb/jwaa030

7. Levina A., & Isakova A. Energy transition: developing a concept of a digital transformation model for a renewable energy enterprise. Technoeconomic: an international journal, 4(1), 22–32, 2025.

DIGITAL LOGISTICS AND EXPORT OF MINERAL FERTILIZERS TO AFRICA: THE ROLE OF THE STATE AND THE EXPERIENCE OF PHOSAGRO

K. B. Kopylov

Research advisor: N.V. Bozo, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
kirill.kopylov.1@mail.ru

Abstract. The article examines the transformation of logistics processes in the context of exporting Russian mineral fertilizers to the African continent. It also reveals the theoretical essence of digital logistics, analyses the dynamics of export supplies, identifies key areas of state support, and summarises the practical experience of digital transformation at PJSC PhosAgro – the leader in Russian fertilizer exports to Africa.

Keywords: digital logistics, mineral fertilizers, export, PhosAgro, digital transformation, supply chains.

ЦИФРОВАЯ ЛОГИСТИКА И ЭКСПОРТ МИНЕРАЛЬНЫХ УДОБРЕНИЙ В АФРИКУ: РОЛЬ ГОСУДАРСТВА И ОПЫТ ФОСАГРО

К. Б. Копылов

Аннотация. В статье исследуется трансформация логистических процессов в контексте экспорта российских минеральных удобрений на африканский континент. Также в статье раскрывается теоретическая сущность цифровой логистики, анализируется динамика экспортных поставок, определяются ключевые

направления государственной поддержки и обобщается практический опыт цифровой трансформации ПАО «ФосАгро» – лидера российского экспорта удобрений в Африку.

Ключевые слова: цифровая логистика, минеральные удобрения, экспорт, ФосАгро, цифровая трансформация, цепочки поставок.

The relevance of the topic stems from Africa's rapid emergence as a key market for Russian non-commodity, particularly agrochemical, exports. Amid geopolitical shifts and redirected trade flows, logistics efficiency and reliability are crucial competitive advantages. Digitalizing logistics processes helps overcome traditional barriers like market remoteness, administrative complexity, and high transaction costs.

Digital logistics marks an evolutionary stage in transport and logistics, moving beyond simple automation to create new business processes and integrated information ecosystems [7]. Key enabling technologies include the Internet of Things (IoT, 17% prevalence), artificial intelligence (AI), blockchain, big data analytics, robotics, cloud computing, autonomous vehicles, and warehouse automation. However, barriers such as data fragmentation, legacy IT systems, and a skills shortage necessitate systematic state and scientific support to realize this new paradigm's full potential [10].

In Russia, this concept will soon be implemented through the National Digital Transport and Logistics Platform «GosLog», which will combine digital logistics services and become a single window service for issuing permits and shipping documents to carriers, which will allow businesses to increase the speed and volume of deliveries of necessary goods. In addition, for bulk goods such as mineral fertilizers, the platform will improve the safety of cargo transportation – control along the entire cargo route from the sender to the recipient will be digital. [3].

Africa is one of the fastest growing markets for Russian agricultural exports. According to the Russian Association of Fertilizer Producers (RAFU), in 2024, Russia supplied 1.9 million tons of fertilizers to Africa worth about $1.5 billion, which is 50% more than three years ago [5]. Combined with agricultural products, the total trade turnover between the Russian agro-industrial complex and African countries reached $7 billion in 2024 [8].

The market is highly concentrated. The key players are:

– PhosAgro Group. The undisputed leader, accounting for an estimated 33% of all Russian mineral fertilizer exports to Africa [1]. The company supplies 21 countries on the continent;

– EuroChem and Uralchem. These companies are also expanding aggressively. EuroChem increased its 2024 shipments to Africa by 45%, reaching 0.7 million tons.

Uralchem has announced a strategic goal to boost exports to 5 million tons by 2030, including via joint ventures with local partners.

The supply geography is vast. The top five importers of PhosAgro products in 2024 were: South Africa (+10%), Mozambique (+80%), Morocco (5.5x growth), Ethiopia (first major shipment in 8 years), and Cameroon (+60%). Other significant destinations include Senegal, Cote d'Ivoire, and Tanzania. PhosAgro's export growth has been phenomenal: over five years (2018-2023), its African deliveries increased nearly fivefold, from 118,000 to 557,000 tons [9]. In 2024, growth was 33%, with total exports exceeding 730,000 tons. The company plans to double its African supplies within the next 3-5 years.

Persistent logistics challenges include market remoteness, a lack of modern port and warehouse infrastructure in importing countries, and a high reliance on manual operations and paper documentation in international corridors.

The state plays a foundational role in facilitating Russian business expansion in Africa through financial and infrastructural measures under the «International Cooperation and Export» national project. From 2025, the Ministry of Industry and Trade, via the Russian Export Center (REC), subsidizes transportation to priority countries (including in Africa and Latin America), compensating up to 60% of actual shipping costs. Support extends to specific international corridors; for instance, in 2025, Senegal, South Africa, and Tanzania were designated priority destinations for shipments from Baltic and Black Sea ports [6].

The Government of the Russian Federation emphasizes the need to invest in Africa's logistics infrastructure – ports, grain elevators, and fertilizer terminals – to create controlled supply chains and ensure a long-term presence on the continent [4].

The practice of PJSC PhosAgro vividly illustrates how corporate digital transformation synergizes with state support to boost export potential. The company runs a comprehensive program involving import substitution of IT infrastructure and adoption of domestic solutions. At its Cherepovets production site, Russia's first domestically developed Automated Production Management System (APMS) was launched, processing hundreds of mimic diagrams and over 50,000 process parameters. In 2025, its functionality was expanded by integrating Sber's «GigaChat MAX» language model for product quality forecasting and compliance control [2].

Optimization of physical logistics was achieved by launching a plant with a capacity of 1 million tons per year in Volkhov (Leningrad region). The strategic location of the plant near the Baltic ports (Ust-Luga, Primorsk) has reduced logistics time and supply costs to Africa. The strategy is complemented by digital services for African partners, such as the Pro Agro Lectorium educational platform on sustainable agriculture and participation in the creation of the AFRILAB regional network of soil laboratories, which by 2025 covers 220 laboratories in 54 countries [1].

State-business collaboration in export development combines public support and private initiative. The state lowers market entry barriers through logistics subsidies (covering up to 60% of transport costs) and creates the cross-industry «GosLog» platform, which sets unified standards and cuts transaction costs. Companies like PhosAgro, in turn, implement advanced digital solutions (AI, IoT, Big Data) into their operations and invest in scaling supplies. Consequently, state measures make deliveries to remote African regions economically viable, while consistent export activity by leading firms helps establish new, profitable logistics routes for other exporters.

Despite progress, the Russian logistics sector still lags in digitalization and automation, with many enterprises relying on manual processes. Further challenges include the parallel need to develop physical logistics infrastructure in Africa and the digital divide and regulatory differences between countries, which hinder the end-to-end digitalization of international supply chains.

In conclusion, digital logistics signifies a new qualitative stage in industry development through integrated digital ecosystems. Their application to mineral fertilizer exports substantially reduces costs and enhances the reliability and transparency of supply chains to the strategically vital African market. Over the past five years, Russia's fertilizer exports to Africa have grown by 50% industry-wide, with market leader PhosAgro achieving a fivefold increase, cementing the continent's status as a priority for Russian agrochemical exports. The state plays a decisive role by reducing expansion barriers through targeted financial support. PhosAgro's experience confirms that profound internal digital transformation – encompassing import substitution of IT solutions, deployment of automated management systems, and AI technologies – is not merely a tool for operational efficiency but a key competitive advantage for increasing volumes and expanding export geography.

REFERENCES

1. FosAgro namerena za 3 goda udvoit' postavki mineral'nykh udobreniy v strany Afriki (PhosAgro intends to double mineral fertilizer supplies to African countries within 3 years). Available at: https://www.phosagro.ru/press/company/fosagro-namerena-za-3-goda-udvoit-postavki-mineralnykh-udobreniy-v-strany-afriki-/ (accessed 18.02.2026).

2. «Fosagro» zapustila otechestvennuyu sistemu upravleniya proizvodstvom v Cherepovtse (PhosAgro launched a domestic production management system in Cherepovets). Available at: https://myseldon.com/ru/news/index/326203899 (accessed 19.02.2026).

3. Pravitel'stvo utverdilo polozheniye o natsional'noy tsifrovoy transportno-logisticheskoy platforme «GosLog» (The government-approved regulations on the national digital transport and logistics platform «GosLog»). Available at: http://government.ru/news/57902/ (accessed 21.02.2026).

4. Rossiya sozdast transportno-logisticheskiye tsentry v Afrike dlya pereoriyentatsii nesyr'yevogo eksporta (Russia will create transport and logistics hubs in Africa to redirect non-resource exports). Available at: https://afrinz.ru/2024/05/rossiya-sozdast-transportno-logisticheskie-czentry-v-afrike-dlya-pereorientaczii-nesyrevogo-eksporta (accessed 19.02.2026).

5. Russia increases fertilizer exports to Africa by 50% in past three years. Available at: https://russiaspivottoasia.com/russia-increases-fertilizer-exports-to-africa-by-50-in-past-three-years/ (accessed 19.02.2026).

6. Russian belt & road support for maritime shipping to Africa & Latin America. Available at: https://russiaspivottoasia.com/russian-belt-road-support-for-maritime-shipping-to-africa-latin-america/ (accessed 18.02.2026).

7. Tsifrovaya logistika: chto eto, ee aspekty i preimushchestva (Digital logistics: what it is, its aspects and advantages). Available at: https://dalli-service.com/blog/tsifrovaya-logistika-chto-eto-aspekty-i-preimuschestva/ (accessed 19.02.2026).

8. Willargi (2025) Russian agri-food exports to Africa up 19%. Available at: https://willagri.com/2025/03/25/russian-agri-food-exports-to-africa-up-19/?lang=en (accessed 19.02.2026).

9. Za posledniye 5 let FosAgro narastila postavki v Afriku pochti v 5 raz (Over the past five years, PhosAgro has increased its supplies to Africa almost fivefold). Available at: https://nord-news.ru/news/2024/08/13/?newsid=167543 (accessed 18.02.2026).

10. Zhukovskaya, I. F. (2024) Logistika v usloviyakh tsifrovoy transformatsii ekonomiki [Logistics in the conditions of digital transformation of the economy]. Voprosy upravleniya [Management Issues], 18(5), 5-18 (in Russian).

DIGITAL DIRECTIONS FOR ENHANCING THE EFFICIENCY OF A PROFESSIONAL SPORTS CLUB

D. A. Kostenko

Research advisor: G. P. Litvintseva, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
dakkuz@yandex.ru

Abstract. The article examines the directions of digital transformation of professional hockey clubs as a factor in increasing their efficiency. Based on an analysis of the practices of clubs in the Kontinental Hockey League (KHL) and the National Hockey League (NHL), three key directions are identified: the implementation of sports analytics systems to optimize game and transfer decisions, the digitalization of administrative and management processes, and technologies for enhancing the spectator experience and fan engagement. It is concluded that digital transformation

allows clubs not only to improve sports results but also to optimize resource allocation, which together creates the foundation for long-term competitiveness.

Keywords: digitalization, sports management, hockey club, management efficiency, sports analytics.

ЦИФРОВЫЕ НАПРАВЛЕНИЯ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ПРОФЕССИОНАЛЬНОГО СПОРТИВНОГО КЛУБА

Д. А. Костенко

Аннотация. В статье рассматриваются направления цифровой трансформации профессиональных хоккейных клубов как фактора повышения их эффективности. На основе анализа практик клубов Континентальной хоккейной лиги (КХЛ) и Национальной хоккейной лиги (НХЛ) выделены три ключевых направления: внедрение систем спортивной аналитики для оптимизации игровых и трансферных решений, цифровизация административно-управленческих процессов, а также технологии повышения зрелищности и вовлеченности болельщиков. Сделан вывод о том, что цифровая трансформация позволяет клубам не только улучшать спортивные результаты, но и оптимизировать расходование ресурсов, что в совокупности создает основу для долгосрочной конкурентоспособности.

Ключевые слова: цифровизация, спортивный менеджмент, хоккейный клуб, эффективность управления, спортивная аналитика.

Modern professional sports operate under conditions of high competition not only on the playing field but also in the economic sphere. Sports clubs, being complex economic entities, are forced to seek new ways to increase the efficiency of their activities. One of the directions is digital transformation, covering the sports component (player training, tactical decisions) and management processes, as well as interaction with fans [2].

The most intensively developing area of digitalization in sports is the implementation of advanced sports analytics systems. The Russian startup «Iceberg Sports Analytics» (Moscow) created the solution *iceberg.hockey* on the Microsoft Azure platform, which allows clubs to receive about 500 parameters for each player in real-time. The system, utilizing computer vision and machine learning technologies, records actions on the ice every tenth of a second with an error margin of no more than 4%. Clients include NHL clubs (New York Islanders) and KHL clubs (HC Sochi) [3].

Another domestic development is the YouChip system (startup *YouChip*, Veliky Novgorod), based on the use of micro-sensors placed on players and inside sports

equipment. The technology enables tracking more than 300 statistical indicators and offers analytical tools using artificial intelligence. Significantly, this system was tested during the «Match of the Year» 2024 on the ice of CSKA Arena with the participation of KHL and NHL stars, confirming its competitiveness [9].

The implementation of such systems directly impacts the economic efficiency of clubs. As Iceberg developers note, using analytics allows optimizing the team budget through more informed transfer decisions and reducing risks in player selection. According to the company's estimates, the penetration level of analytical solutions in hockey is 20 – 25% of the total sports analytics market, indicating significant growth potential [8].

The second important direction is the automation of internal business processes of clubs. A pioneer in this direction among Russian clubs was HC Ak Bars (Kazan, Republic of Tatarstan, Russia), which implemented an automated management system based on Microsoft Dynamics. The solution, developed by *Norbit* (Moscow), covered the club's financial and economic processes, which not only increased operational efficiency but also adapted foreign experience in automating sports organizations (specifically, NHL clubs) to Russian practice [4].

The experience of the "*Night Hockey League*" Amateur Hockey Development Foundation (Moscow) demonstrates that the digitalization of document flow on the Directum Lite platform (DIRECTUM LLC, Izhevsk) increased the efficiency of administrative departments by 30%, while the speed of processing incoming documentation increased twentyfold, and the number of errors decreased by 90%. Furthermore, the optimization of contract work and reporting simplified interaction with regulatory authorities and reduced costs for postal mailings and courier services [7].

In the NHL, similar tasks are addressed through a partnership with the company ServiceNow (USA), whose platform unites the operations of all 32 league arenas, centralizing personnel planning, infrastructure management, and asset management. According to NHL Commissioner Gary Bettman, such cooperation is aimed at optimizing operational activities and increasing the efficiency of work processes [6].

The third direction of digitalization is associated with creating additional value for fans, which directly affects the revenue side of clubs. The example of Minsk *Dynamo* is indicative; at the opening match of the KHL 2024/2025 season, they implemented a large-scale immersive show using generative graphics technologies, laser projections, and interactive elements. Using a special platform and tracking system, a complex visual production was created, involving spectators in the action on the ice [1].

Maple Leaf Sports & Entertainment (MLSE, Canada), the owner of the Toronto Maple Leafs club, established a research laboratory, SportsX, in partnership with Amazon Web Services (AWS) (Amazon, USA), where products such as NHL Extended Reality Stats Overlay, an augmented reality technology for spectators in the stadium, are developed. According to an MLSE vice president, over five years the organization launched more than 50 digital products, moving from quarterly releases to daily updates [5].

The following areas of digital transformation can be identified that affect the efficiency of a professional sports club (Table 1).

Table 1 – Key directions of digital transformations of sports clubs

Directions	Examples	Effect
Sports analytics	Iceberg Sports Analytics; YouChip	Tracking a vast number of parameters and characteristics in real time, optimization of transfer decisions, risk reduction
Management and administration	Directum Lite; ServiceNow; Microsoft Dynamics soft	Increased management efficiency, accelerated document flow, enabling big data management
Fan engagement	Immersive shows; Augmented reality	Launch of digital products that increase fan interest in the club

The conducted analysis allows us to identify three key directions of digital transformation of professional sports clubs (using the example of hockey organizations), ensuring an increase in the efficiency of their functioning.

Firstly, the implementation of sports analytics systems contributes to the optimization of sports and transfer decisions, allowing for more rational budget allocation.

Secondly, the digitalization of administrative processes through platform solutions increases operational efficiency and reduces costs.

Thirdly, the use of immersive and interactive technologies enhances fan engagement, creating additional opportunities for monetization.

Thus, digital transformation acts not merely as a technological trend but as a necessary condition for the long-term competitiveness of professional sports clubs in the digital economy.

REFERENCES

1. *«Dinamo» ustroilo shou na «Minsk-Arene»* («Dynamo» staged a show at «Minsk-Arena») (2023) // Sport5.By. URL: https://sport5.by/news/hockey/Mesto-sily--Dinamo-ustroilo-shou-na-MinskArene/

2. Fakhrutdinov R.A., Kosobutskaya E.A. *Cifrovaja transformacija sportivnoj industrii v regionah Rossii*: *vozmozhnosti i vyzovy* [Digital transformation of the sports industry in Russian regions: opportunities and challenges] // Economics: yesterday, today and tomorrow. 2025. No. 5. pp. 103-125 (in Russian).

3. *Hokkejnaja analitika v Azure* (Hockey analytics in Azure) (2025) // Microsoft Source. URL: https://news.microsoft.com/ru-ru/hokkejnaja-analitika-v-azure/

4. *Hokkejnyj klub «Ak Bars» vnedril Axapta* (Hockey club «Ak Bars» implemented Axapta) (2009) // CNews.ru. URL: https://www.cnews.ru/news/top/hokkeisty_ak_bars_ vnedrili_ axapta

5. MLSE looks to revolutionize sports experience with digital R&D lab (2023) // CIO.com. URL: https://www.cio.com/article/471995/mlse-looks-to-revolutionize-sports-experience-with-digital-rd-lab.html

6. NHL announces partnership with ServiceNow for better fan experience, day-to-day ops // Sportskeeda. URL: http://opera.sportskeeda.com/ice-hockey/news-nhl-announces-partnership-servicenow-better-fan-experience-day-to-day-ops

7. *«Nochnaja Hokkejnaja Liga» perevela organizaciju i upravlenie meroprijatijami v Directum Lite* («Night Hockey League» transferred event organization and management to Directum Lite) (2025) // CNews.ru. URL: https://www.cnews.ru/news/line/2025-09-03_nochnaya_ hokkejnaya_liga

8. *Rossijskij startap Iceberg Sports Analytics sozdal iceberg.hockey na platforme Microsoft Azure* (Russian startup Iceberg Sports Analytics created iceberg.hockey on the Microsoft Azure platform) (2016). URL: http://telecoms.kondrashov.ru/index.php?option=com_kunena&view=topic&catid=15&id=48811&Itemid=216

9. *YouChip – sistema aktivnogo trekinga sportsmenov i sbora sportivnoj statistiki i analitiki novogo pokolenija v real'nom vremeni* (YouChip – a system for active tracking of athletes and collecting sports statistics and next-generation analytics in real time) (2024) // BRICS Solutions Awards. URL: https://bricsawards.tech/practices/17902

COMPARATIVE ANALYSIS OF THE MATURITY OF AI TRANSFORMATION IN THE BRANCHES OF THE ECONOMY

D. I. Kratkaya, I. G. Rzun

Novorossiysk, Financial University under the Government of the Russian Federation, seivill@mail.ru

Abstract. The article presents a comparative analysis of the maturity of AI transformation in key sectors of the Russian economy. The levels of artificial intelligence implementation in the financial sector, retail, industry, healthcare, transport and energy are considered. The evaluation criteria used are the intensity of AI application, investment activity, economic impact (ROI, impact on EBITDA), maturity of the data infrastructure and human resources competencies. Based on domestic analytical sources (HSE, ICT.Moscow, TAdviser, industry reports from ministries), it has been revealed that the financial sector and e-commerce demonstrate the highest level of maturity, where AI is integrated into strategic and operational processes. Industry and energy are characterized by an average level of maturity with an upward trend, while healthcare and transport are developing unevenly due to infrastructural and regulatory constraints. Special attention is paid to the factors influencing the effectiveness of AI implementation: data quality, investments, regulatory environment and corporate culture. The conclusion is made about the formation of a sustainable model of AI transformation in the Russian economy and the need to develop a systemic strategy for the digital development of companies.

Keywords: artificial intelligence, AI transformation, AI maturity, digital transformation, AI implementation, economic sectors, comparative analysis, ROI, economic impact, machine learning, financial sector, retail, e-commerce, industry, healthcare, logistics, energy, investments in AI, business processes, automation, predictive analytics, Russian economy, AI strategy, EBITDA, NLP, anti-fraud, credit scoring, personalization, demand forecasting.

СРАВНИТЕЛЬНЫЙ АНАЛИЗ ЗРЕЛОСТИ ИИ-ТРАНСФОРМАЦИИ В ОТРАСЛЯХ ЭКОНОМИКИ

Д. И. Краткая, И. Г. Рзун

Аннотация. В статье представлен сравнительный анализ зрелости ИИ-трансформации в ключевых отраслях российской экономики. Рассмотрены уровни внедрения искусственного интеллекта в финансовом секторе, розничной торговле, промышленности, здравоохранении, транспорте и энергетике. В качестве критериев оценки использованы интенсивность применения ИИ,

инвестиционная активность, экономический эффект (ROI, влияние на EBITDA), зрелость инфраструктуры данных и кадровые компетенции. На основе отечественных аналитических источников (НИУ ВШЭ, ICT.Moscow, TAdviser, отраслевые доклады министерств) выявлено, что наиболее высокий уровень зрелости демонстрируют финансовый сектор и электронная коммерция, где ИИ интегрирован в стратегические и операционные процессы. Промышленность и энергетика характеризуются средним уровнем зрелости с восходящим трендом, тогда как здравоохранение и транспорт развиваются неравномерно из-за инфраструктурных и регуляторных ограничений. Особое внимание уделено факторам, влияющим на эффективность внедрения ИИ: качество данных, инвестиции, нормативно-правовая среда и корпоративная культура. Сделан вывод о формировании устойчивой модели ИИ-трансформации в российской экономике и необходимости выработки системной стратегии цифрового развития компаний.

Ключевые слова: искусственный интеллект, ИИ-трансформация, зрелость ИИ, цифровая трансформация, внедрение ИИ, отрасли экономики, сравнительный анализ, ROI, экономический эффект, машинное обучение, финансовый сектор, розничная торговля, электронная коммерция, промышленность, здравоохранение, логистика, энергетика, инвестиции в ИИ, бизнес-процессы, автоматизация, прогнозная аналитика, российская экономика, ИИ-стратегия, EBITDA, NLP, антифрод, кредитный скоринг, персонализация, прогнозирование спроса.

The modern economy is undergoing a profound digital transformation, one of the key components of which is AI transformation, the process of widespread adoption of artificial intelligence technologies in business models, operational processes and strategic development of companies. Understanding the nature of this transformation, its maturity and impact on the economy is extremely important: AI is no longer an experimental technology and is becoming a source of strategic advantage – it accelerates decision-making, optimizes costs and opens up new areas of growth. In the context of Russia, the concept of "AI maturity" includes an assessment of the levels of implementation, maturity of infrastructure and human capital – from initial piloting to the systematic use of AI solutions at the business process level. Maturity assessment methods often involve analysis of implementation indicators, quality of solutions, cost effectiveness, and impact on key business indicators. The purpose of this article is to compare where and how AI is being implemented in the Russian economy, as well as to identify the current level of maturity of these processes based on domestic data and analytical sources. The analysis is based on data from reports of domestic research companies, including analytical reviews of the IT market, the results of surveys of Russian companies and

investment estimates. The following metrics of AI maturity are used: the level of technology implementation in operational processes, the volume of investments, the share of companies with an AI strategy, the economic effect (ROI and impact on EBITDA), as well as the number of projects and the degree of staff training. The main criteria for comparing industries include the intensity of AI use, the direction of application, and the proportion of companies that have switched from pilot solutions to continuous use.



Figure 1. The effect of the introduction of AI in industries (clck.ru/3Rs5E6)

At the current stage, AI technologies are becoming widespread in the Russian corporate environment (Figure 1). According to a study by the consulting company Yakov and Partners together with Yandex, more than 70% of large Russian companies use generative AI in at least one business function, and a significant part of these companies systematize AI costs in the range of 11-17% of the IT budget, while expecting an economic effect of up to 8% of EBITDA per year. next year. According to respondents, about 78% of companies have already received the economic effect of AI, and by 2030 it is expected that the impact of technology on the Russian

economy may reach 7.9–12.8 trillion rubles per year, which will be equivalent to 5.5% of GDP. (Figure 2)

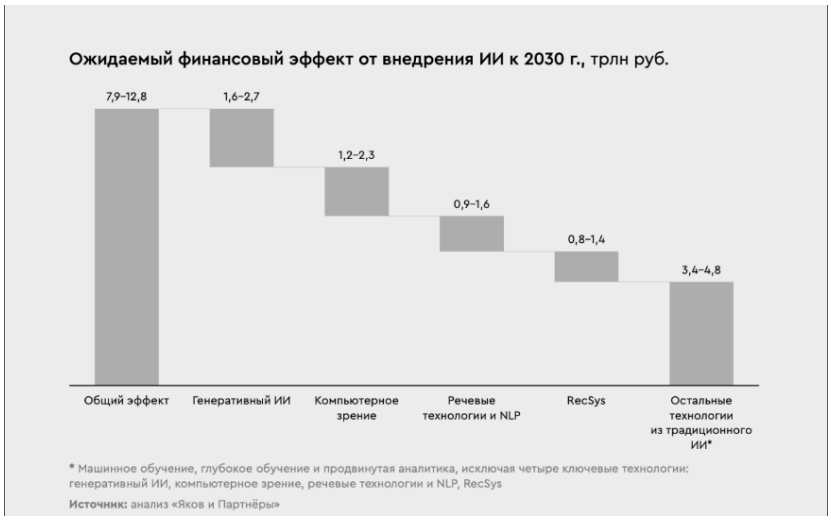


Figure 2. Expected financial impact of AI implementation by 2030 (clck.ru/3Rs5E6)

Other sources record a dynamic expansion in the use of AI: more than 26% of companies have already developed internal strategies for implementing AI, and according to ICT.Moscow surveys, up to 60% of Russian companies use AI in their operational activities, indicating a transition from experimentation to sustainable use. The industry leaders in implementation are IT, telecom and media companies, e-commerce, the banking sector and insurance, while the less technologically advanced media and traditional production industries lag behind in terms of integration. (Figure 3)

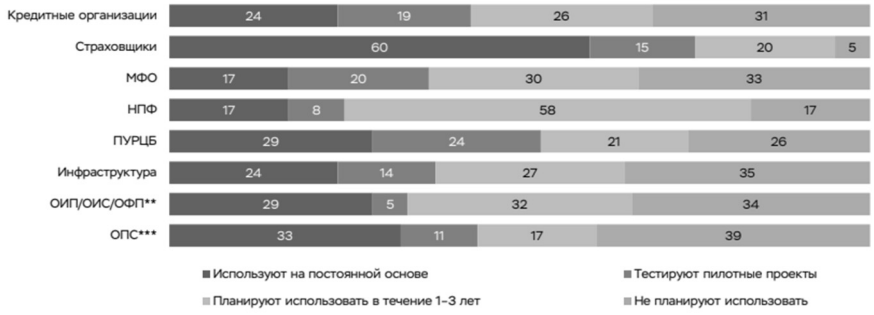


Figure 3. The level of implementation of artificial intelligence technologies in Russian financial institutions

According to the Institute for Statistical Research and Economics of Knowledge at the Higher School of Economics, in 2024 the expenses of Russian companies on AI equipment and software reached a total of 90.3 billion rubles, and the volume of the Russian AI and big data market exceeded 320 billion rubles, which resulted from the active introduction of neural network solutions – NLP, visual systems, intelligent analytics and others. In 2024, more than 15,000 large and medium-sized organizations used AI technologies, which demonstrates the variety of applications.

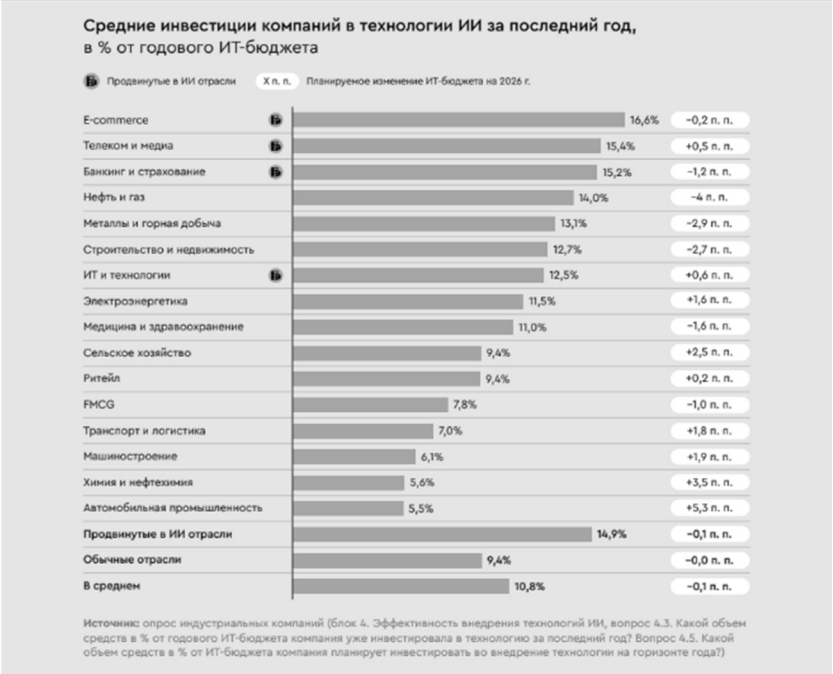


Figure 4. Average investments of companies in AI technologies over the past year (clck.ru/3Rs5ur)

Socio-economic studies show that approximately 29% of Russian enterprises have implemented AI, which is higher than the average level in the European Union, and at the same time, the use of AI in companies leads to a change in the employment structure - enterprises with AI record a reduction in labor costs, but at the same time increase the efficiency of processes.

An active AI transformation model is being formed in Russia: artificial intelligence technologies are becoming part of management and operational processes, and investments in them are steadily growing. Despite external constraints, companies and the government continue to expand the implementation

of AI, and its economic impact is becoming more noticeable. At the same time, the level of maturity varies significantly by industry.

The most mature sector is the financial sector. According to the Bank of Russia and the National Research University HSE, over 85% of the largest banks use machine learning technologies in their operations. AI is used systematically in anti—fraud, credit scoring, and algorithmic trading. BEAC has implemented real-time fraud detection models to prevent billions of rubles in losses, and VTB uses ML algorithms to assess credit risks and speed up decision-making. More than 70% of large banks use AI to analyze transactions and customer data.

In retail and e-commerce, maturity is also high, although somewhat lower than in banking. More than 60% of large retailers use personalization and demand forecasting. Ozon uses recommendation systems and logistics forecasting models, while Wildberries uses AI for dynamic pricing and assortment management. About half of the retail chains have implemented chatbots and voice assistants. The main limitations are related to data quality and high competition, which requires constant improvement of models. In industrial sector, the level of AI maturity is assessed as average but rapidly growing: 35–40% of large enterprises are implementing solutions within the framework of Industry 4.0. The main areas are automation, predictive maintenance, robotics, and logistics optimization.

In healthcare, maturity is also average and depends on the region: about 30% of medical organizations use AI for image analysis. The DM Diagnostic and Telemedicine Center uses algorithms for CT and X-ray processing, which speeds up diagnosis.

In transport and logistics, about 40% of large operators are implementing AI for routing and fleet management. Russian Railways uses predictive models for infrastructure diagnostics, and Yandex Go uses dynamic pricing algorithms. The main barriers are security requirements and the high cost of implementation.

In the energy sector, more than 45% of large companies use AI to predict demand and optimize energy consumption. Gazprom Neft is implementing digital twins, and ROSSETI is implementing loss reduction and accident forecasting systems. The challenges remain the integration of new solutions and the scale of investments.

In general, the financial sector and retail remain the most mature industries: here AI is strategically integrated, demonstrates high ROI and provides significant cost reduction and revenue growth.

If we consider the tasks in which AI is most often used, then in the financial sector these are anti-fraud algorithms, where technologies already allow detecting fraudulent transactions in real time and reducing credit risks; in retail, personalization, demand forecasting and logistics optimization; in industry,

predictive maintenance of equipment; in healthcare, medical image analysis; in the energy sector, load forecasting and optimization of energy flows. According to industry analysis reports by TAdviser and the Ministry of Industry and Trade, the impact of AI is most noticeable where there are large amounts of structured data and clear business goals: in banks, this translates into lower transaction processing costs and faster decision-making, in retail, to increase the average receipt and reduce logistical losses. The effectiveness of AI agents varies significantly depending on the industry. The largest ROI (250-400%) is demonstrated by e-commerce, SaaS, financial services and telecommunications. The average figures (180-250%) are typical for retail, healthcare, and education. Moderate ROI (120-180%) is observed in manufacturing, construction, and logistics. (Figure 4).



Figure 5. AL efficiency in various fields (clck.ru/3Rs7FP)

Factors influencing the maturity of AI in Russia include the availability of high-quality data, the regulatory environment, investments, and a culture of decision-making. Companies with large amounts of structured data (including banks) reach model maturity faster, whereas in industries with fragmented or closed data (for example, in healthcare), implementations are slower. The regulatory environment is also important: personal data protection requirements (Law 152-FZ) and restrictions on data transfer create obstacles for training models on large sets of information. Investments in AI increased in 2024-2025: According to industry experts, corporate spending on AI in Russia has increased by 20-30% annually, while large companies

invest significantly more than SMB, which creates a gap in the maturity of solutions. HR competencies and a culture of digitalization also play a role: companies with dedicated AI competence centers achieve better results. Nevertheless, the challenges and risks remain significant. Technical difficulties include poor data quality and limited learnability of models with a lack of representative samples.; According to the Ministry of Health of the Russian Federation, the problems of standardization of medical data hinder the widespread use of AI in diagnostics. Ethical issues such as bias and opacity of decisions require the development of internal standards and explicable models, especially in areas with a high impact on people's lives. Regulatory risks are associated with the protection of personal data and the need to comply with Russian quality standards for AI systems. Social risks include the impact on employment: automation can reduce jobs in routine tasks, while increasing demand for highly qualified professionals. In recent years, artificial intelligence has ceased to be a highly specialized technology for a select few: it is becoming an essential element of business, without which it is impossible to compete effectively. This is especially noticeable in Russian companies: organizations that have implemented AI solutions record increased efficiency, improved service quality, and accelerated management decision-making. According to research from the Higher School of Economics and industry reports from TAdviser, more than 70% of Russian companies investing in AI report a positive effect from implementations, and leading companies are already forming their own ecosystems of artificial intelligence, including internal competence centers and platforms for automating business tasks. The lack of AI in the strategy is becoming a factor of competitive lag: banks, retail chains and large industrialists who have been slow to digitalize are noticeably losing ground in key performance indicators compared to those who are actively implementing AI technologies. Already today, examples of leading industries that have shaped the AI ecosystem can be found in the financial sector, retail, and telecom companies. For example, Sber has developed its own AI services platform, which is used not only within the bank, but also offered to external customers; similarly, Yandex has implemented AI in logistics, advertising, search and voice assistants, forming an ecosystem of digital services. These examples illustrate how pioneering companies are using AI as a foundation for scaling businesses and creating new revenue streams. Forecasts for the future in Russian realities also point to a further expansion of the role of AI. According to analytical estimates by ICT.Moscow and the Ministry of Finance of the Russian Federation, the next leaders in implementation will be logistics and agriculture, where AI will automate supply chain management and predict harvest seasons, as well as education, where adaptive learning systems will be able to personalize training. New AI task formats will be associated with

generative models for automating routine tasks, intelligent virtual assistants, and the introduction of AI into product quality management systems.

In conclusion, an analysis of the maturity of AI in Russian industries shows a steady trend towards digital transformation: the financial sector and retail are the most mature, industry and energy are developing, and healthcare and transport are gradually increasing their potential. The main conclusions indicate that it is the availability of high-quality data, the support of the regulator, investments and an internal culture of innovation that determine the speed and quality of AI implementation. Business recommendations include developing a clear AI strategy, creating competence centers, investing in employee training and building a data infrastructure - these steps will help companies not only catch up with the leaders, but also create their own innovative solutions. The call for further study of the topic is due to the fact that AI technologies are developing rapidly: understanding new models, participating in professional communities and constantly updating knowledge will be the key to success in the near future.

REFERENCES

1. Nikolaeva A.P. Transformation of the principles of economic management through AI: sustainability and efficiency. eLibrary.ru // (date of issue: 02/09/2026).

2. Bank of Russia. Application of artificial intelligence in the financial market: current status and conditions for further development : report for public consultations // Central Bank of the Russian Federation. – Moscow, 2025. – URL:https://www.cbr.ru/Content/ьDocument/File/185193/Consultation_Paper_20112025.pdf (date of request: 02/09/2026).

3. TAdviser editorial office. Artificial intelligence in banks // TAdviser. - 2026. - URL: https://www.tadviser.ru/index.php/Статья:Artificial intelligence in banks (date of issue: 02/09/2026).

4. Bolotskikh M. et al. Artificial intelligence in Russia - 2025: trends and prospects // Yakov and Partners, Yandex. – Moscow, 2025. – URL: https://adindex.ru/publication/ analitics/ search/ 340222/img/Iskusstvennyy_intellekt_v_Rossii_2025.pdf (date of request: 02/09/2026).

5. The Bank of Russia. Application of artificial intelligence in the financial market : a report for public consultations // Official website of the Bank of Russia. - Moscow, 2023. – URL: https://www.cbr.ru/Content/Document/File/156061/Consultation_Paper_ 03112023. pdf (date of access: 02/10/2026).

6. Yandex. The share of large Russian companies using generative AI has exceeded 70% // AKM Consulting. - 02/17/2026. - URL: https://www.akm.ru/eng/press/the-share-of-large-russian-companies-using-generative-ai-has-exceeded-70 / (date of access: 02/10/2026).

7. Abdikeev N.M., Kiselev A.V. Artificial intelligence in the digital economy: directions and effects of implementation // eLibrary.ru // (accessed: 02/10/2026).

8. ROI from the introduction of AI agents: real figures and calculations for small businesses // SPARK.ru : Nurax startup blog. – 08/28/2025. – URL: https://spark.ru/startup/nurax/blog/270527/roi-ot-vnedreniya-ii-agentov-realnie-tsifri-i-rascheti-dlya-malogo-biznesa (accessed: 02/10/2026).

9. Alekseev A.N. Digital transformation of business and the introduction of artificial intelligence technologies in Russia // eLibrary.ru // (date of access: 02/10/2026).

10. Borovikov V.P. Economic efficiency of the introduction of artificial intelligence technologies in economic sectors. eLibrary.ru // (date of access: 02/10/2026).

11. Kuznetsova E.G. Development of the artificial intelligence market in the Russian Federation // eLibrary.ru // (date of access: 02/10/2026).

12. Solovyov D.B. Assessment of the maturity of digital transformation of organizations in the context of the introduction of AI // eLibrary.ru // (accessed: 02/10/2026).

13. Frolov I.E. Investments in artificial intelligence and their impact on the competitiveness of enterprises // eLibrary.ru // (date of access: 02/10/2026).

14. Shvab K., Russian researchers (translated and analytical publications in eLibrary). The Fourth Industrial Revolution and the AI transformation of the economy // eLibrary.ru // (date of access: 02/10/2026).

VALUATION METHODS FOR INTERNATIONAL TELECOMMUNICATIONS COMPANIES IN THE CONTEXT OF DIGITAL TRANSFORMATION

A. V. Laktionov

Research advisor: O. V. Gordyachkova, Cand. Sc. (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
artemkalaktionov@yandex.ru

Abstract. The digitalization of the economy intensifies business internationalization and significantly increases the complexity of valuing multinational companies, particularly in the telecommunications sector. Digital business models, a high share of intangible assets, and institutional heterogeneity across countries limit the applicability of universal valuation approaches. This article provides a comparative analysis of the sum-of-the-parts method, the Errunza–Senbet model, and the Edwards–Bell–Ohlson model as independent approaches to valuing international businesses. Their theoretical foundations, limitations, and ability to capture digitalization effects are examined. The study substantiates the necessity of reconciling valuation results obtained from different methods when determining the final business value.

Keywords: Business valuation, international business, valuation methods, SOTP, EBO, Errunta-Senbet model.

МЕТОДЫ ОЦЕНКИ СТОИМОСТИ МЕЖДУНАРОДНОГО БИЗНЕСА В СФЕРЕ ТЕЛЕКОММУНИКАЦИЙ С УЧЕТОМ ПРОЦЕССОВ ЦИФРОВИЗАЦИИ

А. В. Лактионов

Аннотация. В условиях цифровизации экономики интернационализация становится одним из ключевых факторов формирования стоимости бизнеса, прежде всего в телекоммуникационном секторе. Особенности цифровых бизнес-моделей, высокая доля нематериальных активов и неоднородность условий функционирования в различных юрисдикциях существенно усложняют задачи оценки стоимости международных компаний. В статье проводится сравнительный анализ метода суммы частей (sum-of-the-parts, SOTP), модели Еррунца–Сенбета и модели Эдвардса-Белла-Ольсона (Edwards–Bell–Ohlson EBO) как самостоятельных методов оценки стоимости международного бизнеса. Рассматриваются их теоретические основы, особенности применения в условиях цифровизации, ограничения и различия в интерпретации результатов. Обоснована целесообразность согласования результатов, полученных различными методами, при формировании итоговой оценки стоимости бизнеса.

Ключевые слова: оценка стоимости бизнеса, международный бизнес, методы оценки, SOTP, EBO, модель Еррунца-Сенбета.

In the context of the digital transformation of the economy, internationalization processes take on a qualitatively new meaning. For telecommunications companies, entering international markets is no longer viewed solely as a form of geographical expansion. It is increasingly considered a tool for scaling digital platforms, redistributing financial responsibility centers, and optimizing capital structure. At the same time, the formation of business value in the international environment is influenced by multiple factors, including differences in tax regimes, regulatory requirements for digital services, and conditions for raising financial resources.

These circumstances significantly complicate the application of traditional business valuation approaches. Universal models designed for a homogeneous institutional environment do not fully reflect the structural complexity of international groups of companies and the nature of digital assets. In this regard, the purpose of the study is to conduct a comparative analysis of business valuation methods applied to international companies and to identify the specific features of their use under digitalization.

The problem of accurately valuing international businesses is extensively examined by both Russian and foreign scholars. Significant contributions to the

study of group valuation issues have been made by E. A. Spiridonova, V. E. Meladze, and A. Damodaran and McKinsey [2, 5, 8]. The information basis of this research includes the Russian Federal Valuation Standards (FVS) [7] and the International Valuation Standards (IVS) [4].

The sum-of-the-parts method is based on the principle of decomposing a business into economically independent segments. It assumes that the value of a group of companies equals the sum of the values of individual segments, adjusted for holding-level adjustments [2, 5]. This method is particularly relevant for international telecommunications companies whose structure combines infrastructure assets, digital services, and foreign operating subsidiaries. It makes it possible to consider differences in the risk profile of segments and apply differentiated discount rates. At the same time, its key limitation lies in its static nature: digitalization effects related to the growth of intangible assets, network effects, and platform scalability are reflected only indirectly through cash flow forecasts and valuation multiples.

The Errunza–Senbet model develops the Modigliani–Miller theorem in relation to multinational corporations and focuses on analyzing the value effects of internationalization. Within this framework, company value is defined as the sum of the value of the unlevered firm and the present value of debt-related effects [3]. This approach makes it possible to quantify the impact of international operations on business value and to determine under which conditions internationalization generates additional value. For telecommunications companies, the Errunza–Senbet model is of particular interest in the context of cross-border financing and tax optimization. However, its limitation is its narrow financial and tax orientation. It does not adequately reflect the specific features of digital business models or the role of intangible assets in value creation [1].

The Edwards–Bell–Ohlson model is based on the concept of residual income and links the market value of a company with its book value of equity and economic profit. It is the most sensitive to digitalization effects because it allows value creation to be analyzed through economic profit and investments in intangible assets. In the international context, this model makes it possible to assess whether internationalization leads to sustainable growth in residual income. Its limitation is the strong dependence on the quality and comparability of accounting data, which may reduce its applicability to international groups operating under different accounting systems [6].

A comparison of the considered methods allowed us to identify their key differences, which are presented in Table 1.

Table 1 – Comparison of business valuation methods for international companies

Criterion	Sum-of-the-parts method	Errunza–Senbet model	Edwards–Bell–Ohlson model
Theoretical basis	Business decomposition	Modigliani–Miller theorem	Residual income theory
Orientation	Structural	Financial and tax	Economic
Consideration of digitalization	Limited	Low	High
Applicability to international business	High	High	Medium-high
Limitations	Indirect reflection of digital effects	Narrow focus	High data requirements

Source: compiled by the author based on [1 – 3, 6].

The differing orientation of the considered methods determines the necessity of reconciling the obtained results when forming the final valuation of an international business. This approach makes it possible to mitigate the weaknesses inherent in individual methods and to more fully account for the effects associated with digitalization and the international nature of the business. Such a methodological combination increases the analytical depth of valuation and corresponds to modern requirements for assessing the value of international digital and telecommunications companies.

REFERENCES

1. Cherkasova, T. N. (2013) Mezhdunarodnyi finansovyi menedzhment [International Financial Management]. Moscow: Faculty of Economics, Lomonosov Moscow State University (accessed 19.02.2026) (in Russian).

2. Damodaran, A. Sum-of-the-Parts Valuation. NYU Stern School of Business. Available at: https://pages.stern.nyu.edu/~adamodar/ (accessed 19.02.2026).

3. Errunza, V. R., Senbet, L. W. (1981) The Effects of International Operations on the Market Value of the Firm. Journal of Finance, 36 (2), 401–417.

4. International Valuation Standards Council (2022) International Valuation Standards. London: IVSC.

5. McKinsey & Company (2024) Is your "conglomerate discount" a performance discount or a communication problem? Available at: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/is-your-conglomerate-discount-a-performance-discount-or-a-communication-problem (accessed 09.02.2026).

6. Mironova, M. D., Avdonina, S. G. (2023) Praktikum po kursu “Mezhdunarodnyi finansovyi menedzhment” [Workshop on the course “International Financial Management”]. Kazan: Kazan University (in Russian).

7. Ob utverzhdenii federal'nogo standarta otsenki “Otsenka biznesa” (FSO №8) [On approval of the Federal Valuation Standard “Business Valuation” (FVS No. 8)]. Order of the Ministry of Economic Development of Russia No. 200 dated 14.04.2022. Available at: https://www.consultant.ru/document/cons_doc_LAW_180654/45ed846e59587aa360f7edd d475dd01ea88f468d (accessed 26.02.2026) (in Russian).

8. Spiridonova, E. A. (2025) Otsenka i upravlenie stoimost'yu biznesa [Business Valuation and Value Management]. 3rd ed. Moscow: Yurait (in Russian).

FACTORS ENHANCING THE INTERNATIONAL COMPETITIVENESS OF AUTOMOTIVE INDUSTRY ORGANIZATIONS

O. A. Makhammadjonov

Research advisor: M. M. Melnikov, Doctor of. Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
olerbekmuhammadjonov@gmail.com

Abstract. This paper investigates the key drivers of international competitiveness in the automotive industry. The analysis considers a range of factors, including technological innovation, corporate governance, supply chain relationships, human capital, and long-term strategic planning. The findings provide actionable insights for automotive companies aiming to grow and achieve sustainable success in global markets.

Keywords: automotive industry, international competitiveness, technology, supply chain, human capital, market strategy, global competition.

ФАКТОРЫ ПОВЫШЕНИЯ КОНКУРЕНТОСПОСОБНОСТИ АВТОМОБИЛЬНЫХ КОМПАНИЙ НА МЕЖДУНАРОДНОМ РЫНКЕ

О. А. Махаммаджонов

Аннотация. В данной работе исследуются ключевые факторы международной конкурентоспособности организаций автомобильной промышленности. Анализ охватывает широкий круг аспектов, включая технологические инновации, корпоративное управление, взаимодействие в цепочках поставок, человеческий капитал и долгосрочное стратегическое планирование. Полученные результаты содержат практически значимые рекомендации для автомобильных

компаний, стремящихся к росту и достижению устойчивого успеха на глобальных рынках.

Ключевые слова: автомобильная промышленность, международная конкурентоспособность, технологии, цепочка поставок, человеческий капитал, рыночная стратегия, глобальная конкуренция.

1. Introduction

The car industry is very big. Many companies make cars. They sell them all over the world. But it is not easy to be successful. Why? Because there is a lot of competition. Every company wants to sell more cars. Every company wants to make more money.

Some companies have been making cars for a long time. They have experience. Others are new. They have new ideas. Both can win. But it depends on many things. A company must know what people in different countries want. In some places, people like small cars. In other places, they want big cars. Some people care about fuel. Others care about speed. A good company understands this.

This paper talks about the main things that help car companies compete in international markets. We look at new technology. We look at how they work. We look at suppliers. We look at workers. And we look at the market. All of these things are important.

2. New Technology

Technology changes all the time. Every year, there is something new. First, it was electric cars. Now, it is cars that can drive themselves. Soon, there will be other things.

If a company does not follow new technology, it will fall behind. Other companies will make better cars. Customers will buy from them. So, companies must spend money on research. They must try new things.

Look at electric cars. A few years ago, not many people bought them. Now, more and more people want them. Companies that started early are doing well. Tesla is one. BYD is another. They saw what was coming and worked on it.

But technology is not just about the car. It is also about how the car is made. Factories today use robots. They use computers. They use data. This helps make cars faster. It also helps make fewer mistakes. And it helps save money. Saving money is always good.

3. Running the Business Well

Making cars costs a lot of money. You need materials. You need workers. You need machines. If you are not careful, you can lose money fast.

Some companies are very good at saving money. They do not waste anything. They plan everything carefully. Toyota is famous for this. Many other companies try to copy them.

But saving money is not simple. If you save too much, quality goes down. And if quality goes down, people stop buying your cars. So, you must find a balance. This is hard. But good companies do it.

Also, you must work with good suppliers. Suppliers give you parts. If the parts are bad, the car is bad. So, you must choose suppliers carefully. And you must build good relationships with them. This takes time. But it is worth it.

4. Supply Chain and Problems

A car has many parts. Thousands of parts. These parts come from all over the world. One part from Germany. Another from Japan. Another from Mexico. All of them must arrive at the factory at the right time.

Sometimes, things go wrong. A few years ago, there was a big problem. The pandemic happened. Factories closed. Ships stopped moving. There were not enough computer chips. Without chips, you cannot make modern cars.

Companies that had backup plans did better. They had more than one supplier. They kept extra parts in storage. They were ready for problems. Others were not ready. They had to stop making cars. This taught everyone a lesson. You must always be ready for unexpected things.

So, it is good to have many suppliers. It is good to keep some extra parts. It costs more money. But it is safer. And safety is important in business.

5. People Are the Key

Some people think machines make cars. But that is not true. People make cars. Machines help. But people are the most important.

Good workers are hard to find. Especially now. The industry needs new skills. Software. Electronics. Batteries. These are not old skills. They are new. Companies must find people who know these things.

And once you find good people, you must keep them. How? Pay them well. Treat them well. Give them chances to learn new things. If they feel good, they work better. They also come up with new ideas. This helps the company grow.

Some companies have training programs. They teach workers new skills. This is good for everyone. The worker learns. The company gets better work. It is a win-win.

6. Knowing the Market

Every country is different. What works in Russia may not work in India. What works in India may not work in Brazil. Companies must understand this.

In some countries, people want small cars. Gas is expensive there. In other countries, gas is cheap. People want big cars. In some places, roads are bad. People want strong cars. You must know all of this before you sell.

Also, there is the brand. A strong brand helps a lot. When people know your name, they trust you. They buy from you. Building a brand takes time. You must advertise. You must be consistent. But it pays off in the end.

Toyota is a strong brand. BMW is a strong brand. People all over the world know them. This is why they sell so many cars.

7. Conclusion

So, there is no one secret to success. Many things matter. Technology matters. Efficiency matters. Suppliers matter. People matter. The market matters. All of these things work together.

The world is changing fast. Electric cars are growing. Digital technology is everywhere. New companies appear all the time. Old companies must change. Those that change will survive. Those that do not will disappear.

In the future, it would be good to study more. How do governments affect all of this? How do partnerships between companies help? These are questions for later.

REFERENCES

1. Porter M.E. (2008) Competitive Advantage: Creating and Sustaining Superior Performance. New York: Free Press.
2. Kotler P., Keller, K.L. (2016) Marketing Management. 15th ed. Boston: Pearson.
3. Christensen C.M. (2013) The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. Boston: Harvard Business Review Press.
4. International Energy Agency (2024) Global EV Outlook 2024. Paris: IEA Publications.
5. Schwab K. (2017) The Fourth Industrial Revolution. New York: Crown Business.
6. Liker J.K. (2021) The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer. 2nd ed. New York: McGraw-Hill.
7. Porter M.E. (1985) Competitive Advantage: Creating and Sustaining Superior Performance. New York: Free Press.
8. Sheffi Y. (2015) The Power of Resilience: How the Best Companies Manage the Unexpected. Cambridge: MIT Press.
9. Christopher M. (2016) Logistics and Supply Chain Management. 5th ed. London: Pearson UK.
10. Barney J.B., Hesterly W.S. (2015) Strategic Management and Competitive Advantage: Concepts and Cases. 5th ed. Boston: Pearson.

11. Nonaka I., Takeuchi H. (2019) The Wise Company: How Companies Create Continuous Innovation. New York: Oxford University Press.
12. Kohli A.K., Jaworski B.J. (1990) Market Orientation: The Construct, Research Propositions, and Managerial Implications. Journal of Marketing, 54(2), 1-18.
13. Keller K.L. (2013) Strategic Brand Management: Building, Measuring, and Managing Brand Equity. 4th ed. Boston: Pearson.

PECULIARITIES OF RUSSIAN NITROGEN FERTILIZER EXPORTS IN THE CONTEXT OF CHANGING GLOBAL ECONOMIC RELATIONS

A. V. Morgunov

Research advisor: G.P. Litvintseva, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
artem_morgunov2024@mail.ru

Abstract. Russian producers of nitrogenous fertilizers have traditionally been leaders in global exports. Therefore, an analysis of nitrogenous fertilizer exports by destination country, both in value and volume terms, is essential for improving new approaches to entering foreign markets, as well as for selecting strategies to strengthen the positions of Russian exporters in their traditional sales markets. Under the new political and economic conditions, such analysis requires alternative methods of collecting and processing data on nitrogenous fertilizer shipments from the Russian Federation, based on the mirror statistics approach. Within this framework, Russia's export volumes were estimated using data on imports of the relevant goods as declared by partner countries. This approach makes it possible to account for export flows to all importing countries and to minimize the impact of incomplete national export statistics.

Keywords: nitrogenous fertilizers, export, import, price, market share, tariffs, institutional factors.

ОСОБЕННОСТИ РОССИЙСКОГО ЭКСПОРТА АЗОТНЫХ УДОБРЕНИЙ В УСЛОВИЯХ ИЗМЕНЕНИЯ МИРОХОЗЯЙСТВЕННЫХ СВЯЗЕЙ

А. В. Моргунов

Аннотация. Российские производители азотных удобрений традиционно являются лидерами в экспорте. Потому анализ экспорта азотных удобрений по странам в стоимостном и количественном выражении необходим для совершенствования новых методов выхода на внешние рынки, а также выбора стратегий

для укрепления позиций российских экспортеров на традиционных рынках сбыта продукции. В новых политико-экономических условиях для подобного анализа необходимо использовать иные методы сбора и анализа данных о поставках азотных удобрений из Российской Федерации, которые сформированы с использованием зеркального метода статистического наблюдения. В рамках данного подхода объёмы экспорта России определялись на основе данных об импорте соответствующих товаров, декларируемых странами-партнёрами. Это позволило учесть направления поставок во все страны-импортёры и минимизировать влияние неполноты национальной экспортной статистики.

Ключевые слова: азотные удобрения, экспорт, импорт, цена, рыночная доля, тарифы, институциональные факторы.

The structure and dynamics of Russian nitrogenous fertilizer (NF) exports are examined in both value and physical terms, both in value and physical terms (HS 3102). By 2024, NF shipments by country can be characterized as largely maintaining existing export positions, taking into account price factors across different markets. Priority destinations include the United States (2,419,895 tons, 17% of total exports; 0% change in 2024 compared to 2021; exports totalling USD 761,321 thousand), Brazil (2,636,946 tons, 19% of total exports; a 14% decrease compared to 2021; USD 727,794 thousand), India (1,392,645 tons, 10% of total exports; an 86% increase; USD 507,223 thousand), Poland (764,748 tons, 5% of total exports; a 70% increase; USD 241,489 thousand), Peru (574,362 tons, 4% of total exports; a 29% decrease; USD 127,688 thousand), France (431,303 tons, 3% of total exports; a 39% increase; USD 122,002 thousand), and Kazakhstan (400,427 tons, 3% of total exports; a 23% increase; USD 95,540 thousand) [1]. Figure 1 presents the dynamics of NF exports in 2019–2024 by country.

Export diversification has been underway since 2019, accompanied by increased shipments to the United States, India, Colombia, and other countries. Exporters have primarily expanded supplies to Latin America and, to a lesser extent, to Asia and Africa; however, the U.S. market remains important. A significant factor is the price per ton of nitrogenous fertilizers and the extent of market presence in each country. The average and median export prices per ton for Russian NF were as follows: in 2019, the average price was USD 343.85 and the median USD 300.39; in 2020, USD 305.03 and USD 272.37; in 2021, USD 422.63 and USD 409.80; in 2022, USD 712.44 and USD 688.01; in 2023, USD 500.74 and USD 441.70; and in 2024, the average price was USD 343.85 and the median USD 300.39 [2].

A distinctive feature of Russian NF exports is diversification driven not by price considerations but by relatively favourable transaction costs. Russia supplies nitrogenous fertilizers to 90 countries, including markets with high prices but low growth in shipments, as well as countries with lower per-ton prices but higher

volumes. This pattern suggests that diversification into new fertilizer markets is still at an early stage. For example, in the U.S. market in 2024, the average price per ton was USD 314.61, compared to an average of USD 423.20 across other countries. Figure 2 presents the average prices at which Russian-produced NF were sold in 2024.

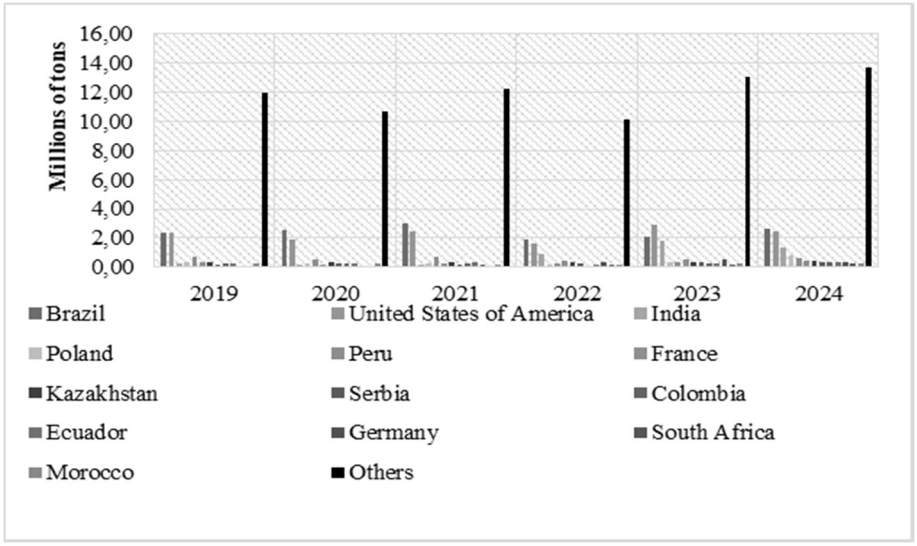


Figure 1. Dynamics of Russian export, HS3102 (in millions of tons)

Source: Compiled by the author based on ITC data (Product: 3102 Mineral or chemical nitrogenous fertilizers) [1]

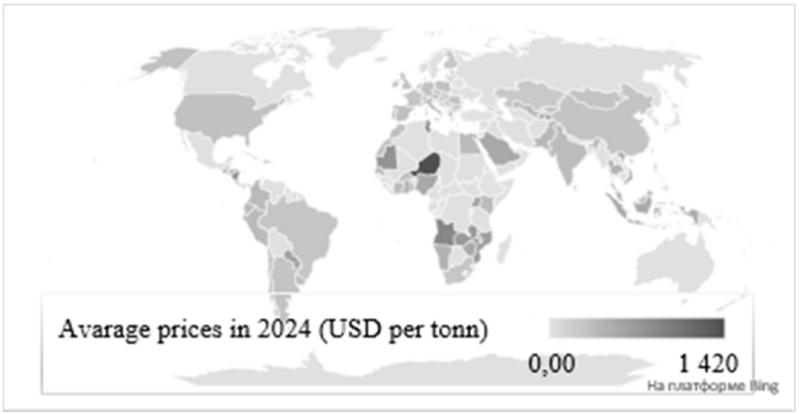


Figure 2. – Average prices HS 3102 in 2024 for Russian nitrogen fertilizer producers (USD per tonne)

Source: Compiled by the author based on ITC data (Product: 3102 Mineral or chemical nitrogenous fertilizers) [3]

The dynamics of average prices per ton in importing countries for Russian products are as follows: a 17% decrease in 2020 compared to 2019; a 30% increase in 2021 compared to 2020; a 35% increase in 2022 compared to 2021; a 56% decrease in 2023 compared to 2022; and a 23% decrease in 2024 compared to 2023. The price surge in 2022 was associated with rising natural gas prices, as natural gas is a key input in nitrogenous fertilizer production [3]. After 2023, amid declining feedstock prices and the fading price shocks of 2022, fertilizer prices decreased. An additional factor is the specific pattern of Russian NF exports, characterized by maintaining positions in American markets while increasing supplies to Asian markets [4].

Russian exporters hold a dominant share in imports of neighbouring countries (Kazakhstan 65.79%, Armenia 84.99%, Azerbaijan 78.89%, Kyrgyzstan 74.20%, Tajikistan 15.20%), a relatively significant share in Latin American countries (Brazil 13.38%, Argentina 7.65%, Peru 36.38%, Ecuador 91.90%, Colombia 23.82%, Nicaragua 55.57%, Honduras 67.20%, Guatemala 43.94%, Costa Rica 53.63%, Panama 48.37%, Chile 3.93%), a substantial share in the U.S. market (31.86%), a negligible share in China (less than 1%), and a small share in India (4.25%). In European countries, the share ranges from 5–10%, except for Serbia (51.04%). In Southern Africa, it is around 10–15%, and in West Africa from 20% to 70% (calculated based on [5]).

New markets for the Russian Federation include countries in West and Southern Africa, where, due to the zero-base effect, there has been significant growth in the presence of Russian enterprises. However, these markets are limited by fertilizer consumption levels. Favourable tariff conditions also play an important role. In many countries, Russian exporters face zero tariff barriers (United States, Peru, South Africa, West Africa, and EAEU countries). Import duties amount to 28.27% in China, 2.06% in Brazil, 4.37% in Argentina, 3% in Southeast Asia, and 15.12% in EU countries (compiled based on [6]).

Having characterized price, volume, and value indicators of Russian exporters and their market shares across different countries, conclusions can be drawn taking into account the constraints on Russia's export potential under the export quotas introduced by the Government of the Russian Federation, amounting to approximately 7.1 million tons in 2024 [7].

China is a major consumer of nitrogenous fertilizers; however, price factors (around USD 287 per ton compared to an average of USD 423.20 and a median of USD 366.16 per ton), a market share of about 1%, and high tariffs limit the expansion of Russian supplies. Latin America remains a priority and strategically important market for NF exporters, where price and tariff conditions, combined with a substantial import share, support high export volumes. EU countries, despite relatively favourable prices (above USD 300 per ton), face unfavourable tariff

conditions and a limited market share, making exports to this region costly and less profitable. Central Asian countries traditionally remain important partners and consumers of Russian NF; however, price factors and overall supply volumes from Russia constrain further export growth. The United States is a major consumer of Russian NF, given favourable price conditions, a high market share, and the absence of tariff barriers. India represents a rapidly growing market with a favourable combination of factors and potential for increasing the share of Russian exporters.

REFERENCES

1. ITC / Product: 3102 Mineral or chemical nitrogenous fertilisers (tons), exported by Russian Federation / URL: https://www.trademap.org/Country_SelProductCountry_TS.aspx? nvpm= 1%7c643%7c%7c%7c%7c3102%7c%7c%7c4%7c1%7c2%7c2%7c2%7c1%7c2%7c2%7c1%7c1

2. ITC / Product: 3102 Mineral or chemical nitrogenous fertilisers (USD), exported by Russian Federation / URL: https://www.trademap.org/Country_SelProductCountry_TS.aspx?nvpm=1%7c643%7c%7c%7c%7c3102%7c%7c%7c4%7c1%7c2%7c2%7c2%7c1%7c2%7c1%7c1%7c1

3. Obzor otrasli mineral'nyh udobrenij v 2019-2021 gg. // Departament promyshlennoj politiki Evrazijskoj jekonomicheskoj komissii. – URL: https://eec.eaeunion.org/upload/iblock/ 5cf/OBZOR_udobreniya_2019_2021_gg..pdf

4. *Morão H*. The economic consequences of fertilizer supply shocks // Food Policy. – 2025. – Vol. 133. – Article number 102835. Available at: https://doi.org/10.1016/j.foodpol.2025.102835

5. ITC / Product: 3102 Mineral or chemical nitrogenous fertilisers (tons), import, world data / URL: https://www.trademap.org/Country_SelProduct_TS.aspx?nvpm= 1%7c%7c%7c% 7c%7c3102%7c%7c%7c4%7c1%7c2%7c2%7c2%7c1%7c2%7c2%7c1%7c1

6. ITC / Compare tariffs and other market access indicators across different destination markets / For product 3102 – Mineral or chemical fertilisers, nitrogenous. Exported from Russian Federation / URL: https://www.macmap.org/en/query/compare-market?reporter=All&partner=643&product=3102

7. Struktura kvot na jeksport mineral'nyh udobrenij v Rossii // Pravitel'stvo Rossii. Kvota na vyvoz mineral'nyh udobrenij. – URL: http://government.ru/sanctions_measures/measure/148/

ANALYSIS OF RESOURCE USAGE AT THE ENTERPRISE OF JSC KUZBASS FUEL COMPANY

Y. M. Morozova

Research advisor: E. I. Muzyko, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
morozovay.m.04@gmail.com

Abstract. Based on the data received from the Kuzbass Fuel Company, a financial and economic analysis of the use of resources was carried out. As a result, a decrease in the main economic performance indicators of the enterprise was revealed and possible causes of this condition were identified. In addition, the problems of KTK JSC were considered and ways to solve them were proposed with an analysis of the future positive effect of their implementation.

Keywords: financial and economic analysis, enterprise, resource use analysis, performance indicators, problems and solutions, fectiveness.

АНАЛИЗ ИСПОЛЬЗОВАНИЯ РЕСУРСОВ НА ПРЕДПРИЯТИИ АО «КУЗБАССКАЯ ТОПЛИВНАЯ КОМПАНИЯ»

Ю. М. Морозова

Аннотация. На основании данных, полученных от предприятия "Кузбасская топливная компания", был произведен финансово-экономический анализ использования ресурсов. В результате было выявлено снижение основных экономических показателей эффективности деятельности предприятия и были выявлены возможные причины данного состояния. Помимо этого, были рассмотрены проблемы АО "КТК" и предложены пути их решения с анализом будущего положительного эффекта от их внедрения.

Ключевые слова: финансово-экономический анализ, предприятие, анализ использования ресурсов, показатели эффективности, проблемы и пути решения, эффективность.

KTK is one of the most significant producers of thermal coal in Russia, which has been operating on the market for more than 20 years and has proven itself well both in the domestic and foreign markets. Before the sanctions were imposed, the organization actively cooperated with various countries of the world, mainly Europe, supplying significant volumes, including enriched coal.

The main activities of Kuzbass Fuel Company are: open-pit mining of thermal coal at deposits located in the Kemerovo region of the Russian Federation; wholesale coal supplies to domestic and foreign markets; mining and processing of coking and brown coal extracted by open-pit mining. In 24 years of operation, the company has produced 180 million tons of coal.

Coal mining is carried out at four sections located on the territory of the Kuznetsk basin. In addition to its mining facilities, the company has a well-developed production and transport infrastructure, including its own railway network and related facilities, which allows it to transport 100% of the coal produced from the mines to the main railway hub, which is part of the Russian Railways railway. In addition, the location of the sections at a distance of 5 km from each other allows many operations to be carried out centrally, which helps to reduce overhead and costs.

During the analyzed period, there were various changes in the indicators of KTK JSC, which were largely influenced by the crisis in the coal industry.

Next, we will analyze the company according to the main coefficients and performance indicators, the comparison will be made between 2023 and 2024 [1, 240].

Based on the results of the calculations, it can be concluded that revenue for 2024 amounted to 11,714,949 thousand rubles, which is 9,919,552 tons lower than in 2023. The cost of production in 2024 decreased by 8,125 363 thousand rubles compared to 2023 and amounted to 10,181 591 thousand rubles, which indicates the optimization of the company's production process. Thus, the gross profit in 2024 amounted to 1,533,358 thousand rubles, which is 53.919% lower than in 2023, and the pre-tax loss of CPC JSC in 2024 amounted to 3,639,238 thousand rubles, which is 160,114 thousand rubles more than a year earlier. Consequently, the net loss also increased and amounted to 2,830,630 thousand rubles in 2024, which is 3.949% more than in 2023.

However, in 2024, there was a decrease in the efficiency of using fixed assets, if in 2023 there were 2 rubles 159 kopecks for each ruble of fixed assets, then in 2024 this figure decreased to 1 ruble 294 kopecks, which is mainly due to a decrease in the company's revenue. Thus, the efficiency of using fixed assets decreased by 40%. There was also a decrease in fund profitability by 6.002%, which indicates a deterioration in the efficiency of using fixed assets [4, 34].

Considering the efficiency of the company's working capital use, it is possible to see a decrease in working capital by 2,139,918 thousand rubles (15.027%) over the period under review, thus, their amount amounted to 12,100,334 thousand rubles in 2024. In addition, there was a decrease in the value of the turnover ratio by 36.274%, which indicates a deterioration in the efficiency of the use of working capital, as well

as a decrease in efficiency is indicated by an increase in the load factor by 56.923% in 2024, an increase in the duration of turnover by 135 days and a decrease in the profitability of current assets by 12.725%.

Table 1– Performance indicators of KTK JSC for 2023-2024 [2].

Indicator	2023	2024	change	Growth rate, %
Revenue, thousand rubles.	21634501	11714949	-9919552	54,149
Cost price	(18306954)	(10181591)	-8125363	55,616
Gross profit	3327547	1533358	-1794189	46,081
Profit from sales	(3635283)	(3206300)	-428983	88,199
Average registered number,people	2325	1969	-356	84,688
Fixed assets, thousand rubles.	10022339	9056394	-965945	90,362
Return on funds, rub/rub.	2,159	1,294	-0,865	59,925
Fund capacity, rub/rub.	0,463	0,773	0,310	166,876
Cost-effectiveness , %	(37,909)	(40,184)	-2,275	106,002
Profit (loss) before taxation, thousand rubles	(3799352)	(3639238)	-160114	95,786
Net profit	(3105197)	(2830630)	-274567	91,158
Working capital, thousand rubles.	14240252	12100334	-2139918	84,973
Turnover ratio of current assets, turnover	1,519	0,968	-0,551	63,726
Turnover time of current assets (360), days	236,959	371,843	134,884	156,923
Profitability of current assets, %	(26,680)	(30,076)	-3,395	112,725
Load factor, rub/rub	0,658	1,033	0,375	156,923

Thus, it is possible to conclude that the indicators of the final profitability of Kuzbass Fuel Company JSC deteriorated in 2024 and to trace the decline in revenue, profit from sales, cost and other estimated indicators for the period under review. In addition, it can be concluded that there is a fairly strong decrease in the efficiency of using fixed and working capital, which is quite an expected result for a crisis situation in the industry and, consequently, in the company, but not exceeding critical values and having a chance to improve over time, taking into account the factor of the organization's ownership of "rich" mineral deposits.

In general, these changes indicate the need to review the company's business strategy, find new ways to improve operational and financial efficiency, as well as improve cost and investment management [3, 74]. This comprehensive approach will

allow us to correct the current negative trends and return the company to the path of sustainable growth and increased profitability.

Table 2 – Problems and solutions in KTK JSC [5, 172].

Problem	Description	Solutions	The positive effect of implementing recommendations
Low profitability	Recently, there has been a decline in profits relative to expenses	Conduct a cost analysis, implement modern cost management methods, and review the pricing strategy	Increase in profitability and net profit of the enterprise
The crisis of the coal industry	Lower cost of coal, increased transaction costs for transportation, overloaded railway tracks	Search for alternative ways to transport goods, attract investments, optimize production	Successful exit from the crisis and continued work in the market
Closure of the main sales markets	Closure of the external sales market (Europe) due to sanctions	Search for new buyers, new sales markets, transition to coal transportation	Improving the company's market position

REFERENCES

1. Aksenov V. P. Financial analysis: theory and practice. — 3rd ed. — M.: Finance and Statistics, 2022. — 480 p. (in Russian).

2. JSC "Kuzbass Fuel Company" [website]. URL: https://www.ktk.company/company (date of reference: 07/24/2025) (in Russian).

3. Efimov R. S. Comprehensive analysis of the financial stability of the enterprise. Novosibirsk: Siberian University Publishing House, 2024. 290 p. (in Russian).

4. Sidorov A. N. Econometric analysis of financial data. Moscow: Infra-M, 2023. 395 p. (in Russian).

5. Khokhlov L. R., Demidov S. V. Financial analysis in conditions of market instability. Moscow: Delo i Service, 2024. 340 p. (in Russian).

BLOCKCHAIN AS A TOOL FOR ENHANCING TRUST IN PUBLIC ADMINISTRATION

K. N. Nausharipova

Astana, Astana IT University,
nausharipovak@gmail.com

Abstract. The article examines the role of blockchain technology as a strategic tool for restoring trust and enhancing accountability within the framework of the digital transformation of public administration. In the context of a systemic crisis of institutional trust, blockchain offers a transition from traditional hierarchical mediation models to a decentralized system of "algorithmic confidence." Drawing on international experience, including cases from Estonia, Sweden, and South Korea, the author explores the potential of smart contracts in combating corruption, ensuring the integrity of public registries, and protecting citizens' digital identity. Particular attention is paid to the multi-level challenges of technology implementation: from technical scalability issues to ethical and legal barriers, such as regulatory uncertainty and the risk of a "digital divide." The paper emphasizes that blockchain is not only a technological but also a deeply political tool that requires a systemic adaptation of the institutional environment.

Keywords: blockchain, public administration, e-government, institutional trust, smart contracts, transparency, accountability, anti-corruption mechanisms.

БЛОКЧЕЙН КАК ИНСТРУМЕНТ ПОВЫШЕНИЯ ДОВЕРИЯ К ГОСУДАРСТВЕННОМУ УПРАВЛЕНИЮ

К. Н. Наушарипова

Аннотация. В статье рассматривается роль технологии блокчейн как стратегического инструмента восстановления доверия и повышения подотчетности в рамках цифровой трансформации государственного управления. В условиях системного кризиса институционального доверия блокчейн предлагает переход от иерархических моделей посредничества к децентрализованной системе «алгоритмической уверенности». На основе анализа международного опыта, включая кейсы Эстонии, Швеции и Южной Кореи, автор исследует потенциал смарт-контрактов в противодействии коррупции, обеспечении целостности публичных реестров и защите цифровой идентичности граждан. Особое внимание уделяется многоуровневым вызовам внедрения технологии: от технических проблем масштабируемости до этических и правовых барьеров, таких как регуляторная неопределенность и риск возникновения «цифрового разрыва». Работа подчеркивает, что блокчейн является не только технологическим, но

и глубоко политическим инструментом, требующим системной адаптации институциональной среды.

Ключевые слова: блокчейн, государственное управление, цифровое правительство, институциональное доверие, смарт-контракты, прозрачность, подотчетность, антикоррупционные механизмы.

Digital transformation and the crisis of institutional trust

The modern era is characterized by large-scale digital transformation, which, according to research by [4], is radically changing the very nature and functioning of democracy, government, and the state [7]. In the context of the Fourth Industrial Revolution, technological shifts are challenging traditional organizational structures, forcing state institutions to adapt to new forms of governance focused on creating public value [7, 11]. However, despite the development of e-Government, there is a deep crisis of legitimacy: research by [5] shows that only 14% of citizens consider the government to be trustworthy, and data from the Pew Research Center [10] show that trust in the US government is at an all-time low of 19% [12]. The lack of trust, which is a key mechanism of social integration [15], determines the alienation of citizens from the state and reduces the level of compliance with legal norms [2, 12].

The conceptual role of blockchain in restoring trust

Blockchain technology, operating as a sophisticated form of distributed ledger technology (DLT), facilitates a paradigm shift by offering a strategic transition from traditional, centralized hierarchical models to a robust system of “algorithmic certainty” [14]. This transition redefines the nature of institutional interactions, replacing human-dependent verification with automated, code-based reliability. The fundamental advantage of this technological framework lies in its sophisticated cryptographic architecture; the creation of unique encrypted keys for each individual transaction ensures a level of security and irreversibility that is virtually unattainable in conventional administrative systems [7, 13]. Such cryptographic primitives guarantee that once a transaction is executed, it remains a permanent part of the digital narrative, shielded from retroactive alteration.

In stark contrast to traditional centralized databases, which often remain vulnerable to internal manipulation, blockchain is characterized by a high degree of decentralization and the absolute immutability of records, often referred to as persistency. This structural design effectively eliminates the possibility of unauthorized interference or fraudulent modifications by system administrators, who in traditional settings possess the "master keys" to data entry [1]. By removing these single points of failure, the technology provides an unprecedented layer of data integrity.

Consequently, this systemic shift allows for a profound socio-technical transformation: the historical reliance on subjective trust in individual officials and bureaucratic intermediaries is transformed into an objective trust in mathematical protocols and immutable program code. By anchoring the legitimacy of the process in the precision of the algorithm rather than the discretion of the agent, the technology ensures a new standard for the transparency and auditability of all government processes [8, 12]. This evolution not only streamlines administrative oversight but also provides citizens with the verifiable evidence required to hold public institutions to a higher standard of functional excellence.

Practical accountability tools and anti-corruption mechanisms

Smart contracts–self-executing algorithms that automatically ensure compliance with regulatory standards without human intervention [8] are particularly important for public administration. In the field of public procurement, the use of these mechanisms minimizes the risks of favoritism and bribery, as confirmed by the successful experience of implementing similar platforms in South Korea [8]. The effectiveness of the technology is also evident in land resource management and digital identification. In particular, the experience of Sweden and Georgia in creating blockchain property registries has made it possible to protect citizens' rights from bureaucratic errors and corrupt manipulations [3]. In Estonia, the technology forms the basis of the X-Road infrastructure, which guarantees the integrity of medical records and the security of citizens' personal data as part of the digital residency program [6, 9].

Implementation challenges and institutional barriers

Despite the transformative potential and high expectations surrounding its adoption, the integration of blockchain technology into the public sector is fraught with a complex array of multifaceted challenges. According to the conceptual framework established by researchers, these obstacles can be systematically classified into three distinct tiers: micro-level (technical architecture), meso-level (network community interactions), and macro-level governance issues [14]. Each level represents a significant hurdle that requires strategic coordination and specific institutional responses.

From a strictly technical perspective, fundamental issues such as limited scalability and suboptimal performance remain primary obstacles. The current processing capabilities of many blockchain networks struggle to handle the immense volume of real-time transactions required by large-scale government operations [3]. Furthermore, the environmental impact of certain consensus mechanisms, characterized by high energy consumption and substantial computational costs, continues to pose a dilemma for sustainable public administration and green policy goals [3].

At the macro-level, a pervasive sense of regulatory uncertainty remains one of the most significant deterrents for policymakers. There is a lack of global consensus regarding the formal legal status of smart contracts, which raises questions about liability and judicial enforcement in cases of technical failure or dispute. Moreover, the inherent immutability of blockchain–one of its greatest strengths–creates a direct tension with existing data protection frameworks. For instance, the "right to be forgotten" enshrined in the General Data Protection Regulation (GDPR) stands in fundamental contradiction to a permanent, non-deletable ledger, necessitating complex legal and technical compromises [14].

Finally, the transition to blockchain-based governance introduces profound socio-political risks. There is a justified concern regarding the emergence of a new "digital divide," characterized by an asymmetric concentration of power. If the design and oversight of these systems fall exclusively into the hands of a narrow circle of technical experts and private developers, it could foster a new type of democratic alienation. Such a shift risks distancing the average citizen from the mechanisms of control, potentially undermining the very transparency and inclusivity that the technology was intended to provide [3].

Conclusion

To sum up the study, it should be emphasized that blockchain in the context of public administration is evolving from a highly specialized technological solution into a fundamental socio-technical paradigm. In an era of global digital transformation, when traditional institutions of power are facing an erosion of legitimacy, this technology offers not just process automation, but a radical rethinking of the very architecture of trust. The transition from “trust in individuals” to “trust in protocols” allows for the creation of a transparent environment in which the accountability of authorities is ensured not by declarations, but at the level of immutable program code.

The practical implementation of blockchain initiatives in countries such as Estonia, Sweden, and South Korea clearly confirms that data decentralization and the introduction of smart contracts can effectively level out long-standing bureaucratic pathologies – from corruption and favoritism to operational inefficiency. Nevertheless, blockchain is not a magic solution capable of autonomously transforming social reality. Its effectiveness remains directly dependent on the quality of institutional design, the readiness of the regulatory framework, and the state's ability to overcome the risk of digital alienation of citizens.

Ultimately, the future of blockchain in the public sector lies in the synergy between technological innovation and humanistic values. The success of this

transformation will be determined by how harmoniously the "lex cryptography" fits into the existing legal landscape and how decisively the state can relinquish its monopoly on control in favor of a transparent, horizontal, and accountable dialogue with society. Blockchain is not just a transaction ledger; it is a manifesto for a new type of statehood, where trust is not a scarce resource but a natural result of a flawlessly designed system.

REFERENCES

1. Ahmad, D., Lutfiani, N., Ahmad, A. D. A. R., Rahardja, U., & Aini, Q. (2021). Blockchain technology immutability framework design in e-government. *Jurnal Administrasi Publik* (*Public Administration Journal*), 11(1), 32-41.

2. Bodó, B., & Janssen, H. (2022). Maintaining trust in a technologized public sector. *Policy and Society*, 41(3), 414-429.

3. Cagigas, D., Clifton, J., Diaz-Fuentes, D., & Fernández-Gutiérrez, M. (2021). Blockchain for public services: A systematic literature review. *IEEE access*, 9, 13904-13921.

4. Cepik, M., Canabarro, D. R., & Possamai, A. J. (2014). Do novo gerencialismo público à governança da era digital. In M. S. Pimenta & D. R. Canabarro (Eds.), *Governança de TI – transformando a administração pública no Brasil*. Porto Alegre: UFRGS/CEGOV.

5. Ipsos, M. O. R. I. (2018). *Annex D Public Value*.

6. Jalakas, P. (2018). *Blockchain from public administration perspective*: *Case of Estonia*. Tallinn University of Technology: Tallinn, Estonia.

7. Moura, L. M. F. D., Brauner, D. F., & Janissek-Muniz, R. (2020). Blockchain and a technological perspective for public administration: A systematic review. *Revista de Administração Contemporânea*, 24, 259-274.

8. Muhdiarta, U. (2025). Blockchain technology for public administration: enhancing accountability and good governance. *International Journal of Innovation and Thinking*, 2(1), 39-50.

9. Mukkamala, R. R., Vatrapu, R., & Dinesh, B. (2020). Blockchain in e-Governance: A case study of Estonia's digital initiatives. *Digital Government*: *Research and Practice*, 1(2), 1-18. https://doi.org/10.1145/3369781

10. Pew Research Center. (2015, November 23). *Trust in government*: *1958–2015*. https://www.peoplepress.org/2015/11/23/1-trust-in-government-1958-2015/

11. Schwab, K. (2016). *A quarta revolução industrial* (1st ed.). São Paulo: Edipro.

12. Shahaab, A., Maude, R., Hewage, C., & Khan, I. (2020). Blockchain-a panacea for trust challenges in public services? A socio-technical perspective. *The Journal of the British Blockchain Association*.

13. Swan, M. (2015). *Blockchain*: *blueprint for a new economy* (1st ed.). Sebastopol: O'reilly.

14. Tan, E., Mahula, S., & Crompvoets, J. (2022). Blockchain governance in the public sector: A conceptual framework. *Government Information Quarterly*, 39(1), 101625.

15. Zucker, L. G. (1985). Production of trust: Institutional sources of economic structure, 1840 to 1920. In L. L. Cummings & B. Staw (Eds.), *Research in organizational behavior* (pp. 1840–1920). JAI Press.

COORDINATION MECHANISMS IN DIASPORA-ORIENTED AGRI-FOOD SUPPLY CHAINS: AN ENTREPRENEURIAL PERSPECTIVE

Abdul Quadir Basirat Oluwatosin

Research advisor: S. D. Kapelyuk, Cand. Sc. (Econ.)

Novosibirsk, Novosibirsk State University of Economics and Management,
basiratoluwatosinabdulquadir@gmail.com

Abstract. Diaspora food markets represent a distinct segment in which demand is culturally driven and relatively stable, while supply chains often operate informally, relying on trust-based personal networks. This paper examines coordination mechanisms employed by entrepreneurs managing informal agri-food supply chains in Russian regions. Drawing on transaction cost economics and network governance literature, the study identifies trust-based relationships, informal information exchange, and partial formalization as key mechanisms for coordination. Challenges related to information asymmetry, role ambiguity, and scalability constraints are analyzed. The paper concludes that hybrid governance structures combining relational trust with limited formal procedures enhance supply reliability while preserving entrepreneurial flexibility.

Keywords: diaspora markets, agri-food supply chains, coordination mechanisms, informal networks, entrepreneurship, trust-based governance.

МЕХАНИЗМЫ КООРДИНАЦИИ В ДИАСПОРНО-ОРИЕНТИРОВАННЫХ АГРОПРОДОВОЛЬСТВЕННЫХ ЦЕПОЧКАХ ПОСТАВОК: ПРЕДПРИНИМАТЕЛЬСКИЙ ВЗГЛЯД

Абдул Квадир Басират Олуватосин

Аннотация. Диаспорные рынки представляют собой особый сегмент, где спрос обусловлен культурными факторами и относительно стабилен, однако цепи поставок часто функционируют неформально, опираясь на доверие и личные связи. В статье рассматриваются механизмы координации, которые предприниматели используют для управления такими неформальными агропродовольственными цепочками поставок в российских регионах. Опираясь на теорию транзакционных издержек и литературу по сетевому управлению, анализ выделяет отношения, основанные на доверии, обмен информацией и частичную формализацию в качестве ключевых механизмов. Обсуждаются такие проблемы, как информационная асимметрия, неоднозначность ролей и ограничения масштабируемости. Делается вывод, что гибридные структуры

управления, сочетающие реляционное доверие с минимальными формальными процедурами, повышают надежность поставок, сохраняя при этом предпринимательскую гибкость.

Ключевые слова: диаспорные рынки, агропродовольственные цепи поставок, механизмы координации, неформальные сети, предпринимательство, доверительное управление.

Introduction

Diaspora communities maintain a strong demand for traditional food products, as food functions as a carrier of cultural identity and social cohesion. In the Russian Federation, this demand is often met through informal supply chains, particularly outside major metropolitan areas. Entrepreneurs active in these markets face coordination challenges arising from geographic dispersion, reliance on personal networks, and the absence of formal contractual arrangements. Understanding coordination mechanisms in such contexts is essential for improving supply reliability and supporting migrant entrepreneurship.

Theoretical Background

Coordination in economic exchange has been extensively examined within management and institutional economics. Transaction cost economics emphasizes that under conditions of uncertainty and asset specificity, informal governance mechanisms such as trust and relational contracting may substitute for formal contracts. The concept of social embeddedness highlights that economic action is deeply rooted in social relations, with trust emerging through repeated interactions within networks. Informal institutional arrangements frequently dominate in environments where formal institutions are weak.

Coordination Mechanisms in Diaspora Agri-Food Supply Chains

Empirical observations of diaspora food distribution in Russian regions, particularly in Siberia, indicate several recurring coordination mechanisms. Entrepreneurs rely on trust-based relationships with suppliers, transport providers, and retailers sharing common ethnic or regional backgrounds. Information is exchanged primarily through informal channels such as phone calls and messaging platforms. Partial formalization, including basic written records and shared schedules, is applied to reduce misunderstandings. Network stabilization through long-term partnerships further enhances coordination efficiency.

Challenges and Entrepreneurial Responses

Despite these mechanisms, challenges persist. Information asymmetry leads to misaligned expectations and delivery delays. Role ambiguity arises when individuals perform multiple functions, complicating accountability. Scalability constraints limit business growth, as trust-based networks are difficult to expand beyond a certain size. Entrepreneurs respond by selectively formalizing recurring transactions, adopting digital communication tools, and stabilizing partner networks.

Conclusion

Coordination in diaspora-oriented agri-food supply chains is achieved through a combination of trust-based relationships, informal communication, and limited formalization. These hybrid governance arrangements enable entrepreneurs to operate effectively under institutional uncertainty while maintaining flexibility. The findings contribute to understanding coordination practices in migrant entrepreneurship and offer insights for policymakers supporting diaspora-oriented businesses.

REFERENCES

1. Granovetter M. Economic action and social structure: The problem of embeddedness. *American Journal of Sociology*. 1985;91(3):481–510.

2. Mintzberg H. *Structure in Fives*: *Designing Effective Organizations*. Englewood Cliffs: Prentice Hall; 1983.

3. North D.C. *Institutions*, *Institutional Change and Economic Performance*. Cambridge: Cambridge University Press; 1990.

4. Porter M.E. *Competitive Advantage*. New York: Free Press; 1985.

5. Scott W.R. *Organizations and Organizing*: *Rational*, *Natural*, *and Open Systems Perspectives*. London: Routledge; 2008.

6. Williamson O.E. *The Economic Institutions of Capitalism*. New York: Free Press; 1985.

7. Fayol H. *General and Industrial Management*. London: Pitman; 1949.

8. Drucker P.F. *Management*: *Tasks*, *Responsibilities*, *Practices*. New York: Harper & Row; 1974.

ANALYSIS OF THE EFFECTIVENESS OF AN INVESTMENT PROJECT: THEORETICAL ASPECTS AND PRACTICAL CALCULATION USING THE EXAMPLE OF KARACHINSKY SOURCE LLC

I. Yu. Platonova

Research advisor: E. I. Muzyko, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
iplatoha38@gmail.com

Abstract. This paper discusses the theoretical aspects of evaluating the effectiveness of investment projects, including project classification, types of effectiveness, and basic calculation methods. Special attention is paid to the practical application of dynamic and static assessment indicators using the example of the KARACHINSKY SOURCE LLC investment plan. The paper analyzes financial flows, as well as calculates net present value (NPV), internal rate of return (IRR), profitability index (PI) and return on investment (ROI), on the basis of which conclusions are drawn about the feasibility of the project.

Keywords: investment project, efficiency, net present income, internal rate of return, sensitivity analysis, financial flows.

АНАЛИЗ ЭФФЕКТИВНОСТИ ИНВЕСТИЦИОННОГО ПРОЕКТА: ТЕОРЕТИЧЕСКИЕ АСПЕКТЫ И ПРАКТИЧЕСКИЙ РАСЧЕТ НА ПРИМЕРЕ ООО “КАРАЧИНСКИЙ ИСТОЧНИК”

И. Ю. Платонова

Аннотация. В данной статье рассматриваются теоретические аспекты оценки эффективности инвестиционных проектов, включая классификацию проектов, виды эффективности и основные методы расчета. Особое внимание уделяется практическому применению динамических и статических показателей оценки на примере инвестиционного плана компании ООО “Карачинский источник”. В работе проведен анализ финансовых потоков, а также выполнены расчеты чистой приведенной стоимости (NPV), внутренней нормы доходности (IRR), индекса рентабельности (PI) и окупаемости инвестиций (ROI), на основе которых сделаны выводы о целесообразности реализации проекта.

Ключевые слова: инвестиционный проект, эффективность, чистый приведенный доход, внутренняя норма доходности, анализ чувствительности, финансовые потоки.

Investments are investments of capital in various objects of activity for the purpose of making a profit or other beneficial effect. In modern economic practice, the concept of investment is inextricably linked to the category of investment project. The latter is a set of interrelated activities aimed at achieving the goals set under time and resource constraints. The relevance of the research topic is due to the need for a thorough study of the effectiveness assessment methodology, which minimizes risks and ensures maximum return on invested funds. The purpose of this article is to systematize knowledge about approaches to evaluating investment projects and demonstrate practical calculations based on real enterprise data.

Investment projects are classified according to a variety of criteria. Short-term (1-2 years), medium-term (3-5 years) and long-term (more than 5 years) projects are distinguished by duration. In terms of scale, there are mono—projects (a separate enterprise), multi-projects (a complex of mono-projects) and megaprojects (targeted programs). By focus, there are projects to increase production efficiency, explore new markets, create new capacities, and research and development [2, 45].

Project effectiveness is a category that reflects the alignment of costs and results with the goals of the participants. Economic, social, environmental, and defense effectiveness are highlighted. Economic, social, and financial efficiency are highlighted. From the point of view of project analysis, the following are of interest [1, 64]:

1) The effectiveness of the project as a whole (public and commercial), assessing the attractiveness of the project for potential participants.

2) The effectiveness of participation in the project, which determines the feasibility of the project and the interest of each investor in it.

Efficiency assessment methods are divided into static (simplified) and dynamic (time-sensitive) methods. The static ones include a simple payback period (PP) and a return on investment (ROI) ratio. However, dynamic indicators are used to obtain an objective picture:

1) Net discounted income (NPV) is the sum of discounted cash flows minus initial investments. The positive NPV value indicates the expediency of investments.

2) The internal rate of return (IRR) is the discount rate at which NPV is zero. Shows the maximum allowable cost level for the project.

3) The profitability index (PI) is the ratio of discounted cash flows to investments. The project is accepted if PI > 1.

The object of surveillance is Karachinsky Source LLC, a large Siberian mineral water production company that supplies products from the Urals to the Far East. The analysis of the financial statements for 2022-2023 shows a positive trend: revenue increased by 17.26%, gross profit increased by 411,934 thousand rubles, and business expenses were significantly reduced.

The efficiency indicators for the use of fixed and working capital have also improved. The return on equity increased from 3.30 to 3.50, and the turnover of current assets accelerated, which led to an increase in their profitability from 18% to 27%. These data indicate the stable financial position of the company and the potential for investment initiatives such as expansion of production and development of the resort area.

An investment project of an enterprise with a life cycle of 5 years was considered for evaluation. The analysis of financial flows shows that the main investment costs are incurred in the first year (purchase of fixed assets), which is reflected in negative cash flow. Starting from the second year, the project generates steady positive cash flow.

Based on the presented data, key performance indicators were calculated at a discount rate of 16% [3].

1) Net discounted income (NPV): The calculation showed that the present value of future income significantly exceeds the initial investment. A positive NPV value is the main indicator of project acceptability

2) Internal rate of return (IRR): IRR = 78%. Since the internal rate of return (78%) significantly exceeds the accepted discount rate (16%), the project has a high margin of safety and is cost-effective.

3) Profitability index (PI): the ratio of discounted income to investments is 2.89, which indicates a high investment attractiveness, since each invested ruble brings 2.89 rubles of the present value of future income, the value of PI > 1

4) Return on investment (ROI): this indicator, obtained by the ratio of net profit to investment volume, is 16.91, and demonstrates high efficiency in using invested capital.

The results of the evaluation of the investment project's performance indicators demonstrate the positive impact of the implementation of this project, expressed in the further growth of the company's capital and the achievement of its strategic goals.

REFERENCES

1. Igonina L. L. Investments: a textbook / L. L. Igonina. – 2nd ed., revised and add. – Moscow: Magister: INFRA-M, 2021. – 752 p.

2. Assessment of investment opportunities [text] : theory and practice / Q. L. Wilenskyy MB, Vol. N. Livshitz, S. A. Small MBC; in-T System. analysis run, Centr. jmbcon.- Matt. in-T ran, Akkad. NAR. Hoz-VA PRI Pravitel Mjtstve RF. - 3-E ED., ISPR. and DOP. - Moscow: Delo, 2015. 888 p.

3. The Karachin source. – Text: electronic // Karachinskaya: [website]. – URL: https://karachinskaya.ru / (date of access: 26/06/2026).

GRANT SUPPORT IN THE SYSTEM OF INNOVATION DEVELOPMENT INSTITUTIONS

D. Yu. Ponomarev, R. S. Bisultanov

Research advisor: D. S. Polikarpov

Taganrog, Southern Federal University,
daponomarev@sfedu.ru

Abstract. The article examines the role of early-stage investments in the form of grants in the development of scientific and entrepreneurial projects. It analyzes the characteristics of grant funding at the initial stages of the project, as well as its impact on risk reduction, improvement of research quality, and the creation of conditions for subsequent commercialization of results. The importance of grants as a tool for supporting organizations focused on innovative activities is highlighted.

Keywords. Grant funding, early-stage investment, scientific projects, entrepreneurial projects, innovation activity, commercialization.

ГРАНТОВАЯ ПОДДЕРЖКА В СИСТЕМЕ ИНСТИТУТОВ РАЗВИТИЯ ИННОВАЦИЙ

Д. Ю. Пономарев, Р. С. Бисултанов

Аннотация. В статье рассматривается роль ранних инвестиций в форме грантов в развитии научных и предпринимательских проектов. Анализируются особенности грантового финансирования на начальных стадиях проектов, а также его влияние на снижение рисков, повышение качества научных исследований и формирование условий для последующей коммерциализации результатов. Показана важность грантов в качестве инструмента поддержки организаций, ориентированных на инновационную деятельность.

Ключевые слова. Грантовое финансирование, ранние инвестиции, научные проекты, предпринимательские проекты, инновационная деятельность, коммерциализация.

The growing influence of scientific and technological innovations explains the increasing attention to various types of support for scientific and commercial projects at early stages of development. Early stages of development are characterized by a high level of uncertainty and limited resources, which together make the project significantly less attractive for financing. As D. V. Dergachev notes, the existing grant system in Russia, despite its importance, faces a number of institutional limitations

that reduce its potential effectiveness [1]. In these conditions, grants act as one of the key tools in the system of development institutions, allowing project initiators to conduct research, create the first product prototypes, and form a team for further activities on a commercial basis.

Grants have significant advantages compared to other sources of financing. They do not involve transferring a share in the project or returning the funds used for development. This approach enables the team to make independent decisions and focus on scientific results. This is particularly relevant in the context of scientific research, which is characterized by lengthy research cycles and often unclear, delayed prospects for generating profit.

In the early stages of project development, financial support in the form of grants proves invaluable for minimizing a multitude of associated risks. It gives teams the opportunity to conduct necessary validation of core assumptions, carry out research, and develop a basic, functional version of the product. Moreover, grants often provide access to advanced laboratories, specialized equipment, and highly qualified specialists, which in turn directly affects the quality of the results achieved. The structured and targeted nature of grant funding also contributes to the development of a more organized strategy for planning and executing the work.

In addition to these obvious benefits, the initial receipt of grant funding offers another significant advantage: it serves as a compelling signal to a wide range of stakeholders, increasing their confidence in the project's potential. Passing the competition and receiving funding from public or private grant-issuing organizations serves as a kind of indicator of the scientific and practical significance of the project, enhancing its investment attractiveness and simplifying the further attraction of venture capital or corporate partners. Grants demonstrate to investors that the project is trustworthy and reduce uncertainty.

In addition to funds, grant programs often include mentorship support, reporting, and monitoring of task completion. All these elements help teams work in a more organized and open manner. At the same time, researchers draw attention to the fact that excessive formalization of reporting can shift the focus from the content of scientific work to its formal documentation [1]. Nevertheless, with a reasonable balance, participants develop skills in project management, budget planning, and results evaluation, which is especially important for research teams beginning to explore entrepreneurial activities.

If a project receives a grant at an early stage, it increases the chances of its successful completion and subsequent market realization. Projects that have received grant support demonstrate a higher degree of technological readiness, especially in the field of digital solutions. As researchers note, the institution of innovation in the digital economy performs the function of a connecting link, facilitating not only the

development but also the adaptation of technologies to the requirements of digital markets [2]. Such projects are characterized by a better-developed business model and greater resilience to external changes. In this regard, grants should be viewed not only as a source of start-up capital, but also as a full-fledged tool for the development of innovation activities within the system of development institutions.

As a result, investments in the form of grants play an important role in the development of scientific and commercial projects, providing a resource base for conducting research, reducing risks, and building potential for further growth. Their effectiveness can be seen both in the short term, associated with the launch and testing of projects, and in the long term, expressed in increasing the competitiveness and sustainability of innovative initiatives in the modern economy.

REFERENCES

1. Dergachev D. V. Potential and Limitations of the Grant System in Russia / D. V. Dergachev // International Scientific Student Readings - 2025 : Collection of Articles of the III International Scientific and Practical Conference, Petrozavodsk, May 22, 2025. – Petrozavodsk: International Center for Scientific Partnership "New Science" (IE Ivanovskaya I.I.), 2025. – pp. 265-270.

2. Kudryavtseva S. S. The Institution of Innovation in the Development of the Digital Economy: Role and Features in Russia / S. S. Kudryavtseva, M. V. Shinkevich, T. I. Klimenko // Modern Science: Actual Problems of Theory and Practice. Series: Economics and Law. – 2021. – No. 5-2. – pp. 19-22. – DOI 10.37882/2223-2974.2021.05-2.08.

IDENTIFICATION OF FACTORS INFLUENCING THE PRICE LEVEL OF AGRICULTURAL PRODUCERS IN THE SIBERIAN FEDERAL DISTRICT

A. V. Rafalskij, K. D. Vinnikov, N. A. Shcherbakova

Novosibirsk, Siberian State University of Engineering and Biotechnology,
Artemrafalskij32@yandex.ru

Abstract: The article provides an analysis of the levels and key factors of prices for agricultural products in the Siberian Federal District. A noticeable differentiation across regions is identified, and the factors determining these differences are highlighted. The study concludes that price predictability is crucial for agrarian businesses, as it enables the formation of long-term contracts and helps minimize the risks of seasonal shortages. The results of the study can be used in the development of regional policy, marketing research and in planning investments in the agricultural sector.

Keywords: agricultural producer of goods, agriculture, agro-industrial complex, price trends, agricultural products, Siberian Federal District.

ВЫЯВЛЕНИЕ ФАКТОРОВ, ВЛИЯЮЩИХ НА УРОВЕНЬ ЦЕН СЕЛЬСКОХОЗЯЙСТВЕННЫХ ТОВАРОПРОИЗВОДИТЕЛЕЙ В СИБИРСКОМ ФЕДЕРАЛЬНОМ ОКРУГЕ

А. В. Рафальский, К. Д, Винников, Н. А. Щербакова

Аннотация: В статье представлен анализ уровней и ключевых факторов цен на сельскохозяйственную продукцию в Сибирском федеральном округе. Выявлена заметная дифференциация между регионами и определены факторы, обусловливающие эти различия. В исследовании сделан вывод о том, что предсказуемость цен имеет решающее значение для аграрного бизнеса, поскольку позволяет заключать долгосрочные контракты и минимизировать риски сезонного дефицита. Результаты исследования могут быть использованы при разработке региональной политики, проведении маркетинговых исследований и планировании инвестиций в сельскохозяйственный сектор.

Ключевые слова: сельскохозяйственный товаропроизводитель, сельское хозяйство, агропромышленный комплекс, ценовые тенденции, сельскохозяйственная продукция, Сибирский федеральный округ.

Nowadays one of the indicators of the economic stability and investment attractiveness of the agricultural business, as well as the high efficiency of state support mechanisms, is the dynamics of producer prices.

Despite severe natural and climatic conditions, the Siberian Federal District (hereinafter – SFD) accounts for 10,4% of the total agricultural production in Russia, which indicates a high level of adaptation of the regional agro-industrial complex to the specific characteristics of the territory [1].

The largest contribution to agricultural production in the district is made by the Novosibirsk Oblast, the Omsk Oblast, and Altai Krai, where a high level of mechanization and the introduction of modern agrotechnologies are observed.

To analyze the level and current key trends in prices for agricultural products, it is proposed to consider such a macroeconomic indicator as the «Producer Price Index (PPI)». Currently, this indicator is used in agriculture for comparative analysis of price changes for individual types and groups of agricultural products. The producer price index (PPI) characterizes price changes over a specific period for comparable products, while the sales structure remains unchanged.

Table 1 presents the producer price indices for agricultural products for 2024 and the first quarter of 2025.

According to the data presented in Table 1, a noticeable regional differentiation can be observed within the Siberian Federal District.

Table 1 – Producer price indices for agricultural products in the first quarter of 2025 at the end of the period, as a percentage of the end of the previous period.

Region	I quarter 2025	Quarterly 2024				
		I quarter	II quarter	III quarter	IV quarter	Year
SFD	100,2	99,7	96,5	99,8	109,5	105,1
Republic of Altai	101,0	101,9	99,2	101,9	115,2	118,6
Republic of Tuva	103,0	100,7	100,2	103,3	101,4	105,6
Republic of Khakassia	109,9	99,7	99,6	102,8	99,6	101,7
Altai Territory	101,6	100,1	97,2	101,0	107,1	105,2
Krasnoyarsk Territory	103,8	99,8	100,1	101,8	109,5	111,2
Irkutsk Region	99,8	101,9	98,1	98,8	103,0	101,6
Kemerovo Region	93,9	96,8	93,2	98,9	113,3	101,2
Novosibirsk Region	97,9	96,6	93,7	100,8	114,1	104,1
Omsk Region	97,9	102,5	97,1	98,6	108,3	106,3
Tomsk Region	104,9	105,6	96,4	92,3	109,2	102,6

Source: compiled by the authors based on data on the production of goods and services in the first quarter of 2025 provided by the Federal State Statistics Service [2-3].

1. The Republic of Tuva (103,0%) and Krasnoyarsk Territory (103,8%) demonstrate the highest price growth, which indicates increased production costs and the probable influence of transport and logistics factors. In these regions, agriculture is highly dependent on climatic conditions and the remoteness of sales markets.

2. The Altai Republic is characterized by an indicator of 101,0%, which indicates a positive trend.

3. 97,9% in the Omsk and Novosibirsk regions may indicate saturation of regional markets and optimization of production chains.

The above differences in indexes can be explained by the following factors:

1. Climatic conditions. The long winter period in the northern and mountainous regions prolongs the growing season and increases the need for energy resources for greenhouses.

2. Logistics. Production facilities (divisions) are located at a great distance from the product sales market, which leads to an increase in unit transportation costs.

3. Production structure. Large-scale commodity farms capable of ensuring price stability have been more developed in the region. An example of such farms are the farms of the Omsk and Novosibirsk regions. If we take the example of the mountainous regions of Altai and Tuva, then they are mainly home to small farms and subsidiary farms, which are more sensitive to market fluctuations than large farms.

4. Investment activity. Increasing efficiency and curbing price spikes is currently possible because in a number of Siberian regions, digital technologies for crop accounting are being actively introduced, and modernization of the agricultural infrastructure is underway.

Thus, the Siberian Federal District demonstrates a typical combination of moderate growth and regional contrasts. The general trend indicates a stabilization of the price environment and a decrease in inflation expectations. This price predictability is important for the agricultural business, as it allows for the formation of long-term contracts and minimizes the risks of seasonal shortages.

REFERENCES

1. Obukhov A. A., Obukhova E. A., Shcherbakova N. A. (2025) Primenenie tekhnologij iskusstvennogo intellekta v APK dlya povysheniya urovnya prodovol'stvennogo obespecheniya [Application of artificial intelligence technologies in the agro-industrial complex to improve the level of food security]. Ekonomika sel'skohozyajstvennyh i pererabatyvayushchih predpriyatij [Economics of Agricultural and Processing Enterprises], 1, 54-58 (in Russian).

2. Official website of the Federal State Statistics Service. Socio-economic situation of the Siberian Federal District in the first quarter of 2025. Available at: https://rosstat.gov.ru/compendium/document/50801 (accessed 20.02.2026).

3. Official website of the Federal State Statistics Service. Methodological explanations. Available at: https://24.rosstat.gov.ru/storage/mediabank (accessed 21.02.2026).

CLASSIFICATION OF CONTROL COSTS IN EXPORT OPERATIONS

A. P. Rudneva

Research advisor: I.G. Chirkova, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
anna@neraconsult.com

Abstract. The organization and management of export activities within an enterprise is more difficult than in domestic markets. The global reorganization of international product flows and the existing sanction restrictions have made it necessary for Russian companies to pay special attention to the costs of control that arise in the process of fulfilling export obligations. The monitoring process is viewed as an internal management mechanism.

Keywords: export management, control costs, export of goods.

КЛАССИФИКАЦИЯ КОНТРОЛЬНЫХ ЗАТРАТ В ЭКСПОРТНЫХ ОПЕРАЦИЯХ

А.П. Руднева

Аннотация. Организация и управление экспортной деятельностью на предприятии сопряжены с большими сложностями, чем на внутренних рынках. Глобальная реорганизация международных товаропотоков и существующие санкционные ограничения обусловили необходимость уделять особое внимание контрольным затратам, возникающим в процессе выполнения экспортных обязательств. Процесс контроля рассматривается как внутренний управленческий механизм.

Ключевые слова: управление экспортом, контрольные затраты, экспорт товаров, экспорт.

The *cost of control* (monitoring) is the cost of resources, time and money to ensure compliance with the terms of contracts, product quality control, monitoring the behavior of employees or counterparties, as well as related costs incurred during the conclusion of transactions. The management of export activities is more complicated than in the domestic market. The exporting company interacts with a number of intermediary commercial and government organizations in the process of implementing an export transaction, while contractual obligations under export transactions require compliance with agreements at the level of the parties to the transaction, consistency of regulatory requirements for the export product. Therefore,

control costs in the export of goods from industrial enterprises will differ from the costs of control in the domestic market.

In the literature the issue of classification of control costs is investigated by many authors. Oliver Williamson [6] in his classification of transaction costs classifies control costs as ex-post (actual) costs. The North-Eggertsson classification identifies 2 groups of control costs: external (control of counterparty actions) and internal (control of employees). This classification notes that monitoring (control) is not only obtaining information but also the costs associated with obtaining it. External costs include the paid costs of obtaining information and the opportunity cost of the time spent searching for information, while internal costs include the mental effort spent searching and sorting incoming information.

Taking into account the fact that quite often export documents must be issued in a foreign language, this entails additional control costs. If the company's employees cannot organize such a process on their own, the company will involve third-party expert organizations for this. The North-Eggertsson classification is more suitable for the export activities of an enterprise, as it takes into account the scope of the administrative services of the exporting company itself (internally), as well as external interaction with regulatory authorities and the involvement of intermediaries.

N. V. Shuvalova [5] notes that it is very difficult and almost impossible to fully measure transaction costs, since they are divided into measurable (direct transaction execution, information search) and non-measurable (time spent searching for goods/services, losses from insufficient control, costs of legal protection of the contract, etc.). The following events can be attributed to insufficient control during the export of goods: the manufacture of goods that do not comply with the terms of the export contract or the requirements of the foreign partner country, fines from regulatory authorities, errors in processing export documents, delay of goods at the border for the purpose of inspection, etc. All of these lead to additional financial costs. In other words, insufficient control is associated with information that is incomplete or inconsistent. Thus, the costs of control are aimed at reducing the risks arising from incomplete information.

N. V. Shuvalova also considers approaches for measuring transaction costs, which include control costs: *ordinal* and *cardinal* approaches.

The essence of the *ordinal* approach is that costs do not need to be quantified; instead, it is necessary to compare and arrange all possible alternatives in descending (or ascending) order of transaction costs. That is, this approach shows that one option is better (or worse) than another. The *cardinal* approach is based on measuring the value of transaction costs.

We believe that the costs of control during the export of goods are more aligned with the *ordinal* approach. Since control costs form part of the enterprise's organizational and managerial process, they can be classified through comparison and ordering based on the stages of the export transaction.

Accordingly, we propose classifying control costs according to the stages of the export transaction and information monitoring processes, as shown in Table 1.

Table 1 **–** Control costs at the stages of an export transaction.

Stages of the export	Control costs
Pre-exports stage: - search for a foreign partner - international negotiations - discussion and conclusion of a foreign trade contract	- monitoring the frequency of exchange of information, its reliability, relevance, including correct translation from a foreign language of documentation for export transaction; - monitoring the time for agreement and search of information; - monitoring the consistency of actions and obligations of the parties; - monitoring the risk of legislative and regulatory changes during the preparation process for a deal and its implementation; - monitoring the opportunistic behavior of employees and foreign partners.
The stage of implementation of the export transaction: - production of goods - customs clearance - logistics	- monitoring the correct transmission of information to reduce production costs: product manufacturing; packaging, labeling and marking (for export); - monitoring the performance of obligations by a foreign buyer; - monitoring the relevance of legislative and regulatory requirements for export documents.
Post-export stage: - financial statements	- monitoring the reliability and completeness of reported data and information on export transaction to regulatory authorities: customs and tax authorities; currency control.

Thus, the table shows that control costs during the examination of goods are primarily aimed at assessing the timeliness, reliability, and relevance of information on the export transaction. The pre-export stage is the most complex in terms of control costs. Information completeness at this stage, as well as its reliability and relevance, affects the risks and errors of subsequent stages of the entire export transaction.

Conclusions

To effectively manage the costs of control over goods exports, the enterprise needs to develop criteria for assessing the completeness of information on an export transaction, determine how information is affected at each stage, organize the process of its transfer within the enterprise, and create a monitoring system.

Improved control cost management can be achieved by analyzing current export experience, which a company is able to structure and organize according to the type of product and the export market.

REFERENCES

1. Kosorlukova O. E. Classification of costs of an industrial enterprise // Scientific database. - 2012. - URL: https://openalex.org/W2239786427 (date of access: 02/26/2026)

2. Ostaev, G. Ya. Regulatory and methodological support for planning the audit of foreign economic activity / G. Ya. Ostaev, E. V. Markovina, I. A. Mukhina // Bulletin of Udmurt University. Series Economics and Law. - 2016. - Vol. 26, No. 4. - P. 134-142. – EDN WLBDMZ.

3. Shastitko, A. Ye. Novaya institutsional'naya ekonomicheskaya teoriya [New institutional economic theory]. – 3-ye izd., pererab. i dop. – M.: Ekonomicheskii fakul'tet MGU, TEIS, 2002. – 591 p.

4. Sheven L.N. Organization of management of foreign economic activity of the enterprise // Economy and management of innovative technologies. 2016. No. 12 [Electronic resource]. URL: https://ekonomika.snauka.ru/2016/12/13251 (date of access: 03/07/2026). (In Russ.)

5. Shuvalova N.V. Transaction costs for providing services to a participant in foreign economic activity for connecting to the electronic declaration system of the federal customs service of Russia. Vestnik Universiteta. 2020;(7):128-134. (In Russ.) https://doi.org/10.26425/1816-4277-2020-7-128-134

6. Williamson O. Ekonomicheskie instituty kapitalizma. Firmy, rynki i otnoshencheskaya kontraktatsiya [Economic institutions of capitalism. Firms, markets, and relationship contracting]. St. Petersburg, Lenizdat, CEV Press, 1996. 702 p.

NEW BUSINESS MODELS IN RETAIL TRADE FOR BUSINESS DIGITALIZATION

A. R. Sadykova, M. A. Tenenev

Research advisor: S. Y. Budovskaya

Novosibirsk, *Novosibirsk State Technical University*,
Misha022007@gmail.cjm

Abstract. This paper examines new business models emerging from digital transformation in the retail sector. The study explores the financialization of trade, where IT giants compete with traditional banks. It investigates omnichannel strategies and data-driven retail, demonstrating that automating analytics and logistics yields measurable economic effects worth billions of rubles. The role of ERP System software as a bridge between physical business, digital platforms, and state systems is highlighted.

Keywords: digital transformation, business models, marketplaces, data-driven retail, omnichannel, 1C, logistics automation.

НОВЫЕ БИЗНЕС-МОДЕЛИ ДЛЯ ЦИФРОВИЗАЦИИ БИЗНЕСА

А. Р. Садыкова, М. А. Тененев

Аннотация В данной статье рассматриваются новые бизнес-модели, возникающие в результате цифровой трансформации в розничной торговле. Исследование изучает финансиализацию торговли, где IT-гиганты конкурируют с традиционными банками. В работе исследуются омниканальные стратегии и управление розничной торговлей на основе данных, демонстрируя, что автоматизация аналитики и логистики дает измеримый экономический эффект, исчисляемый миллиардами рублей. Подчеркивается роль ERP-систем как моста между физическим бизнесом, цифровыми платформами и государственными системами.

Ключевые слова: цифровая трансформация, бизнес-модели, маркетплейсы, управление розничной торговлей на основе данных, омниканальность, 1С, автоматизация логистики.

Digital transformation is not just about implementing technologies; it is about changing how companies create value. The digital economy focuses on managing flows: data, customers, partners, unlike the industrial economy [1].

Marketplaces as Ecosystems: The Two-Sided Market Model. Classical trading businesses earn through trade margins. A marketplace works differently. Its business

model is a two-sided market. The platform does not own the goods; it connects sellers and buyers and earns through commissions, advertising, and additional services [1].

In the industrial model, growth requires a proportional increase in assets. In the platform model, assets belong to the participants: sellers invest in goods, customers come on their own, and the platform merely organizes the interaction. This enables growth without a proportional increase in costs [1].

Two-Sided Competition. Competition on marketplaces occurs not only between sellers for customers but also between platforms for sellers. This creates a "commission war" and investments in logistics at the platform's expense [2].

The Impact of Platforms on Small Businesses. What is freed up when working with marketplaces. For small businesses, entering a marketplace represents a radical change in the cost structure.

Final Calculation. Classical retail requires operating costs of ~45-50%, while working through a marketplace requires ~20-25%. Up to 25% of turnover is freed up, which the entrepreneur can direct towards product development or price dumping, gaining an advantage over traditional competitors [2] (table 1).

Table 1 – Example of calculating benefits from marketplaces

Cost Item	Classical Retail	Working through Marketplace	What is Freed Up
Retail space rental	15–20% of turnover	0%	Fully
Sales staff salaries	10–15% of turnover	0%	Fully
Advertising budget	5–10% of turnover	3–7% (internal advertising)	Partially (up to 3–5%)
"Last mile" logistics	8–12% of turnover	Included in commission	Partially
IT infrastructure	2–3% of turnover	0%	Fully

The Downside: Dependence and Risks. The downside of this model is complete dependence on the platform. The seller does not own the customer base (data belongs to the marketplace), does not control promotion rules (algorithms can change at any moment), and must accept the commission set by the platform. The business turns into a "tenant" on the platform, rather than an independent player (for an entrepreneur to counter this, they need to devise "workarounds").

Financialization of Trade. A key trend of recent years is the transformation of marketplaces into financial institutions. They have three assets that traditional banks lack:

Other people's working capital. Customers' money "sits" in the platform's accounts for the period from payment to transfer to the seller. This amounts to billions of rubles in free financing [1].

Sales data. The marketplace knows everything about the seller's business, which simplifies the loan issuance process [2].

Customer base. The customer is already within the ecosystem and doesn't need to go to a bank.

Wildberries, Ozon, and Yandex are launching their own bank cards and installment services. This is direct competition with traditional banks [1].

Evolution of Offline Retail: Digital Inside the Physical Store.

Omnichannel as a New Business Model. Omnichannel means that all channels operate from a single system, and the customer does not notice the transition [5]. The store ceases to be just a "point of sale."

Data-Driven Retail: Management Based on Data. Traditionally, analytics in retail chains were handled by people: they manually collected data and performed analysis. However, this method carries quite a few problems [6].

The Logic of the Data-Driven Approach. Modern systems collect and analyze information in real-time.

Instead of hiring dozens of analysts, a company configures algorithms that perform the same work faster, more accurately, and more cheaply. The economic effect is extremely high [3, 6].

Significance of Abolishing the Analytics Staff: Conclusions. What actually happens: analysts are not fired — they requalify. Instead of manually collecting figures, they configure systems that automatically collect these figures. Their work becomes more intellectual and less routine. This is not job cuts, but a change in the quality of labor and the freeing up of human potential for strategic tasks [6].

Digitalization of Logistics and Warehouse Processes. Logistics is the most resource-intensive part of retail. The budget for supply chain management can exceed 50% of the budget.

Warehouse Management (WMS). Modern systems make it possible to optimize goods placement, manage employee tasks via terminals, and monitor expiration dates [9].

Route Optimization (TMS). Systems plan routes considering traffic jams, time windows, and vehicle load, which reduces delivery costs [2].

Demand Forecasting. This is especially important for goods with a short shelf life. The system analyzes the first days of a promotion and automatically adjusts orders, avoiding both shortages and write-offs. Reducing the write-off of perishable goods from 3% to 1.5% for a chain with a turnover of 100 billion rubles yields 1.5 billion rubles in net profit annually [6].

The Instrumental Base: The Role of Software (Using the Example of 1C Company)

1C as an ERP System: The Digital Foundation of Business.

ERP (Enterprise Resource Planning) is an enterprise resource management system. It is the "brain" of the company, knowing how much goods are in the warehouse, how much money is in the accounts, who needs to be paid how much, and what needs to be purchased [8].

Without an ERP, digitalization of small and medium-sized businesses is impossible because data resides in different places. An ERP consolidates everything [8].

1C is a Russian company that is the de facto standard for Russian small and medium-sized businesses. Main modules:

- goods accounting and warehouse logistics,
- accounting, procurement, and payroll,
- reporting [8].
- The Role of 1C as a "bridge"
- 1C becomes a bridge between three worlds:
- Physical Business (warehouses, goods, employees),
- Digital Platforms (marketplaces, delivery services),
- The State (tax authorities, labeling, reporting) [4, 7, 8].

Without this bridge, small businesses would not be able to connect to the new digital economy — it would be too complex and expensive.

Conclusion

Digitalization radically changes the cost structure, allowing a greater concentration of funds on truly important aspects of business for its development.

The line between online and offline is blurring. Omnichannel is becoming a mandatory requirement.

Automation of analytics and logistics yields a measurable effect in billions of rubles. Digitalization is a tool for direct savings [2, 3, 6, 7].

REFERENCES

1. Business Model Analyst (2026) Edinaia kommertsiia: formirovanie potrebitel'skogo povedeniia i ravnovesiia [Unified Commerce: Shaping Consumer Behavior and Equilibrium]. Available at: https://businessmodelanalyst.com/ (accessed 26.02.2026).

2. TAdviser (2025) "Ashan" vnedriaet A.TMS ["Auchan" Implements A.TMS]. Available at https://www.tadviser.ru/ (accessed 26.02.2026).

3. Retail Life (2025) "Magnit" vnedril kompleksnuiu sistemu rascheta chislennosti personala ["Magnit" Implements a Comprehensive Personnel Calculation System]. Available at: https://retail-life.ru/ (accessed 26.02.2026).

4. RBC Companies (2025) Brend odezhdy SINAR vnedril modul' ot IT-integratora "InfoSoft" [Clothing Brand SINAR Implements Module from IT Integrator "InfoSoft"]. Available at: https://companies.rbc.ru/ (accessed 26.02.2026).

5. X5 Dialog (2024) Karolina Sokolova, X5 Media: Za omnikanal'nost'iu i Total Retail Media stoit budushchee [Karolina Sokolova, X5 Media: The Future Lies Behind Omnichannel and Total Retail Media]. Available at: https://dialog.x5.ru/ (accessed 26.02.2026).

6. Retail.ru (2025) Kak sekonomit' milliard na optimizatsii tsepochek postavok? [How to Save a Billion by Optimizing Supply Chains?]. Available at: https://www.retail.ru/ (accessed 26.02.2026).

7. Retail.ru (2025) Kak set' "ArtFlora" vyshla na marketpleisy i poluchila bolee 500 novykh zakazov [How the "ArtFlora" Chain Entered Marketplaces and Received Over 500 New Orders]. Available at: https://www.retail.ru/ (accessed 26.02.2026).

8. Retail.ru (2024) OMNI Rating Award 2024. Available at: https://www.retail.ru/ (accessed 26.02.2026).

9. Retail.ru (2025) Keisy trekh kompanii po optimizatsii logistiki i snizheniiu zatrat [Case Studies of Three Companies on Optimizing Logistics and Reducing Costs]. Available at: https://www.retail.ru/ (accessed 26.02.2026).

ANALYSIS OF VIDEO CONFERENCING ARCHITECTURES FOR THE IMPLEMENTATION OF SYNTHETIC VIDEO CONTENT DETECTION MODULES

V. D. Savinova, A. S. Serova

Moscow, National Research Nuclear University MEPhI,
vikushonok2004@gmail.com

Abstract. The paper analyzes the architectures of corporate videoconferencing systems with the aim of implementing synthetic video content detection modules. Approaches to creating deepfakes and vulnerabilities in client-server, peer-to-peer, and hybrid solutions are considered. Based on a comparative analysis of accuracy, latency, and scalability criteria, the feasibility of integrating a server-side detection module into a hybrid architecture is discussed.

Keywords: deepfake, video conferencing, hybrid architecture, microservice, detection, cybersecurity.

АНАЛИЗ АРХИТЕКТУР ВИДЕОКОНФЕРЕНЦСВЯЗИ ДЛЯ ВНЕДРЕНИЯ МОДУЛЕЙ ОБНАРУЖЕНИЯ СИНТЕТИЧЕСКОГО ВИДЕОКОНТЕНТА

В. Д. Савинова, А. С. Серова

Аннотация. В работе анализируются архитектуры корпоративных систем видеоконференцсвязи с целью внедрения модулей обнаружения синтетического видеоконтента. Рассмотрены подходы к созданию дипфейков и уязвимости клиент-серверных, пиринговых и гибридных решений. На основе сравнительного анализа критериев точности, задержки и масштабируемости обоснована целесообразность интеграции серверного модуля детектирования в гибридную архитектуру.

Ключевые слова: дипфейк, видеоконференцсвязь, гибридная архитектура, микросервис, детектирование, кибербезопасность.

Modern corporate video conferencing systems have become a basic tool for business interaction, which is why threats associated with synthetic video content are becoming particularly relevant [1]. A deepfake is a generated video image of a person with a face and voice replaced using neural network methods, and it is already possible to create such a stream in near real time, which undermines trust in digital interaction [4][6]. Russian legislation does not yet contain specific requirements for protecting video conferencing systems from synthetic video content, and the draft law on criminal liability for its use does not formulate requirements for technical detection methods [5]. This creates a regulatory vacuum and justifies the need to study architectures and integrate detection modules into typical corporate platforms [2].

Modern deepfake technologies rely on step-by-step processing of the video stream, preliminary image stabilization, extraction of biometric features of appearance, synthesis of a new face based on these features, and subsequent integration of the result into the video frame. The output is a synthetic video stream that looks like a normal broadcast of the participant [6]. Video conferencing systems use approaches to deepfake synthesis such as face replacement, facial expression transfer, and real-time facial expression control. In the first case, the face is completely replaced while preserving movements; in the second, facial expressions and movements from one video are superimposed on another face; in the third, the facial expressions of the synthetic image are controlled by external signals [9].

From the point of view of data transmission organization, there are three video conferencing architectures: client-server, peer-to-peer, and hybrid [7]. In the client-server model, the video stream is formed on the client and sent to the server for

routing, so the deepfake substitution occurs before encryption and the server perceives the stream as legitimate [8]. In peer-to-peer architecture, streams are transmitted directly between participants, which deprives the system of a centralized point of control and also leaves the point of loading synthetic content on the client side [6]. Hybrid architecture combines both approaches. In it, the points of possible substitution are distributed, and the presence of server components creates the conditions for the integration of detection modules [9].

To select the optimal placement option for the detection module, a comparative analysis of approaches to video stream validation was conducted. The criteria used were the accuracy of deepfake detection, the delay in analysing a single frame, scalability in terms of the number of simultaneous sessions, the cost of computing resources, and the extent of changes to existing platforms. Table 1 reflects the weights of these criteria, which prioritise accuracy and latency while maintaining acceptable requirements for scalability, resources, and integration. Summary ratings for server, client, and hybrid approaches are shown in Table 2.

Table 1. Key criteria for evaluating options for deploying a video stream validation module in video conferencing systems

Criterion	**Description**	**Weight**
Detection accuracy	Probability of detecting deepfakes	35%
Analysis latency	≤ 200-300 ms/frame	25%
Scalability	Processing of more than 1000 sessions simultaneously	20%
Resource cost	GPU/CPU load and licences	15%
Integration	Changes to existing platforms	5%

Table 2. Comparative assessment of options for placing the video stream validation module in video conferencing architectures

Criterion	**Server-side**	**Client-side**	**Hybrid**
Detection accuracy	9	6	8
Analysis delay	5	9	7
Scalability	6	8	9
Resource cost	4	8	7
Integration	8	4	6
Final score	**6.95**	**7.35**	**8.05**

The analysis results show that the client option provides minimal delay, but requires deep changes in all applications and does not support centralised algorithm updates. The server option provides high accuracy and controllability, but in a monolithic implementation it overloads the media server. The most balanced approach was found to be a hybrid approach with a dedicated server-side detection microservice integrated into a hybrid video conferencing architecture.

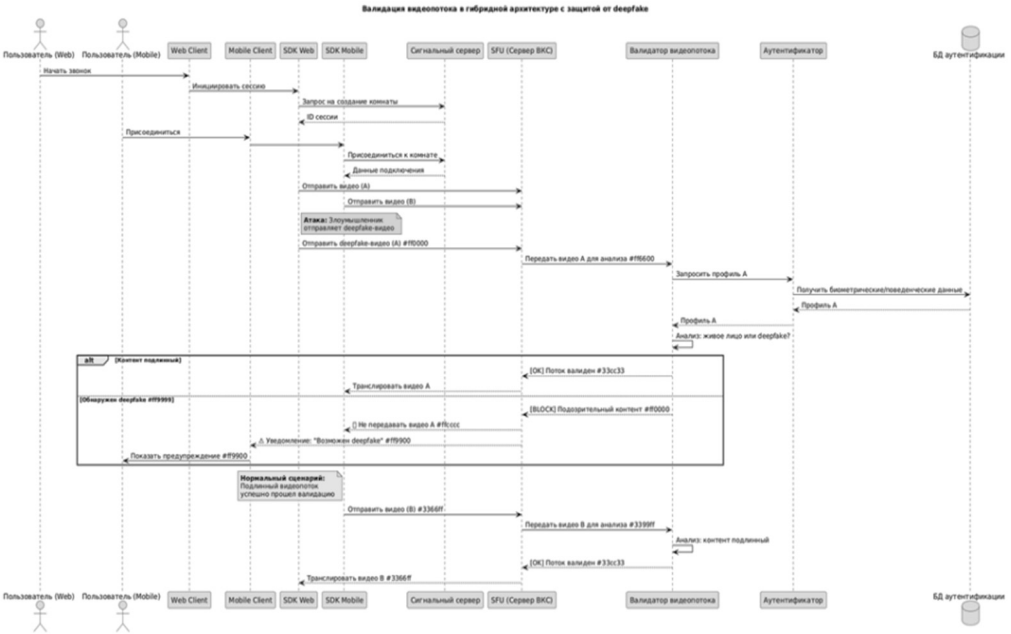


Figure 1. Structural and functional diagram of video stream organization in an optimized VCS architecture

The optimized architecture with an integrated synthetic video content detection module is shown in the video stream exchange diagram (Figure 1). After authentication, the client application establishes a media connection with the server and begins transmitting an encrypted video stream. The media server uses a mirroring mechanism to send a copy of the stream to the validation microservice before routing it to other participants [9]. The microservice analyses the video stream for signs of synthetic origin and, if the risk threshold is exceeded, generates a security signal based on which the platform can block the broadcast, request additional identity verification, or display a warning about the possible synthetic nature of the image [6].

The optimized architecture scenario allows you to clearly fix the point of loading synthetic content on the client side and place the detection module in the link of the

data processing chain where it gets access to the video signal before it is distributed throughout the conference [8]. The microservice functions as an independent component, which simplifies its scaling, updating, and adaptation to new attack methods. This approach strikes a balance between accuracy and analysis latency requirements, scalability capabilities, and resource constraints, while minimizing the amount of changes required in client applications and underlying server infrastructure.

The analysis showed that synthetic video content generated by neural network technologies in near real time increases the threats to corporate video conferencing systems [4]. In the absence of specific requirements for technical means of detecting deepfakes in Russian legislation, responsibility for trust in digital interaction effectively falls on platform developers [5]. A study of typical video conferencing architectures revealed that in all models, vulnerability is associated with the lack of standard video stream validation mechanisms [7]. Substitution is carried out on the client side before the encryption stage. A comparative analysis of validation module placement options based on accuracy, latency, scalability, resource cost, and integration complexity showed the advantage of implementing detection functions as a separate server component embedded in a hybrid video conferencing system. This solution allows analyzing video streams of active speakers before they are distributed, centrally updating detection algorithms and models, and localizing vulnerable data processing points, creating a technical basis for future regulatory requirements for protecting video conferencing systems from deepfakes [2][9].

REFERENCES

1. Anti-Malware.ru. Rossiyskiy rynok videokonferentssvyazi [Russian video conferencing market]. 2025. URL: https://www.anti-malware.ru/analytics/Market Analysis/ Russian- video-conferencing-2025 (in Russian).

2. Chhabra S. et al. Real-Time Deepfake Detection Limitations, Challenges, and Defenses. arXiv. 2022. URL: https://arxiv.org/abs/2210.06186.

3. Digital Samba. Decoding WebRTC Architectures P2P, SFU, and MCU Simplified. 2023. URL: https://dev.to/digitalsamba/decoding-webrtc-architectures-p2p-sfu-and-mcu-simplified-362m.

4. Feoktistov A.G. Metody obnaruzheniya falsifikatsii informatsionnogo kontenta [Methods of detecting falsification of information content]. Vestnik Voronezhskogo gosudarstvennogo universiteta. Seriya: Sistemnyy analiz i informatsionnye tekhnologii. 2023. No. 3. P. 119–124 (in Russian).

5. 718538-8. Federal'nyy zakon RF [Federal Law of the Russian Federation]. 2024. URL: https://base.garant.ru/76869955 (in Russian).

6. Metered. SFU vs MCU vs P2P WebRTC Architectures Explained. 2024. URL: https://www.metered.ca/blog/sfu-vs-mcu-vs-p2p-webrtc-architectures-explained.

7. Multipoint Control Unit MCU and its Role in Video Conferencing. Digital Samba. 2024. URL: https://www.digitalsamba.com/blog/understanding-multipoint-control-unit-mcu.

8. Paris B., Donovan J. Deepfakes and Cheap Fakes. New York: Data Society Research Institute, 2019. 47 p.

9. Resemble AI. Q1 2025 Deepfake Threat Report. 2025. URL: https://www.resemble.ai/wp-content/uploads/2025/04/ResembleAI-Q1-Deepfake-Threats.pdf.

DIGITAL GOVERNANCE AND ECONOMIC SECURITY: BRIDGING INFORMATION GAPS IN CONFLICT-AFFECTED ECONOMIES (THE SYRIAN CASE STUDY)

M. Shreteh[1], A. E. Efremova[2]

[1] *Syrian Virtual University, Damascus, Syria,*
[2] *Transbaikal State University, Chita, Russia,*
allapersona@mail.ru

Abstract. The research investigates the structural relationship between digital governance and economic security in fragile and conflict-affected economies, focusing on the Syrian Arab Republic. The paper argues that economic fragility in post-conflict contexts is frequently rooted in systemic informational disruption rather than solely in physical destruction of assets. The study demonstrates how structural information gaps generate fiscal inefficiency and market distortion. The paper proposes digital solutions that contribute to long-term economic resilience.

Keywords: digital governance, economic security, institutional economics, information asymmetry, fragile states, Syria.

ЦИФРОВОЕ УПРАВЛЕНИЕ И ЭКОНОМИЧЕСКАЯ БЕЗОПАСНОСТЬ: ПРЕОДОЛЕНИЕ ИНФОРМАЦИОННЫХ РАЗРЫВОВ В ЭКОНОМИКАХ, ЗАТРОНУТЫХ КОНФЛИКТАМИ (НА ПРИМЕРЕ СИРИЙСКОЙ АРАБСКОЙ РЕСПУБЛИКИ)

М. Шретех, А. Е. Ефремова

Аннотация. В исследовании рассматривается структурная взаимосвязь между цифровым управлением и экономической безопасностью в нестабильных и затронутых конфликтами экономиках, с акцентом на Сирийскую Арабскую Республику. В статье утверждается, что экономическая нестабильность

в постконфликтных условиях часто коренится в системных информационных сбоях, а не только в физическом уничтожении активов. Исследование демонстрирует, как структурные информационные пробелы порождают фискальную неэффективность и искажение рынка. В статье предлагаются цифровые решения, способствующие долгосрочной экономической устойчивости.

Ключевые слова: цифровое управление, экономическая безопасность, институциональная экономика, информационная асимметрия, хрупкие государства, Сирия.

Introduction

Economic security in fragile and conflict-affected states increasingly depends on institutional information capacity rather than solely on material reconstruction. While physical infrastructure rehabilitation remains essential, contemporary governance scholarship emphasizes that sustainable recovery is closely linked to the ability of institutions to collect, verify, process, and distribute reliable data across administrative systems [7]. In post-conflict contexts such as Syria, prolonged institutional fragmentation has weakened public financial management systems, disrupted statistical reliability, and increased macroeconomic uncertainty. Institutional economics provides a robust analytical framework for understanding these structural dynamics. According to North [4], institutions reduce uncertainty by structuring incentives and lowering transaction costs within economic interactions. When governance systems lack reliable data and operate through fragmented paper-based reporting, transaction costs increase substantially. Suppliers embed precautionary risk premiums in their bids, public authorities allocate excessive financial buffers, and contractual arrangements become unstable. Over time, these distortions accumulate and translate into systemic fiscal inefficiency. Information asymmetry theory further clarifies how unequal or distorted access to information generates adverse selection and moral hazard within markets [2]. In fragile environments, central administrative authorities frequently lack accurate field-level data, while private actors possess incomplete knowledge of regulatory enforcement capacity. This mutual uncertainty undermines trust, distorts price signals, and reduces the predictability of public expenditure. International comparative assessments of fragile states consistently demonstrate that weak digital infrastructure correlates with fiscal leakage, inefficient expenditure allocation, and delayed recovery programs [6]. Digital governance, understood as the integration of digital technologies into administrative decision-making and verification processes, therefore represents a structural intervention capable of strengthening institutional resilience. Rather than functioning merely as technological modernization, digital integration reshapes incentive structures, reduces information asymmetry, and enhances traceability across governance domains.

Methods

This study employs a qualitative case study methodology focusing on Syria as a representative conflict-affected economy. The research combines analysis of publicly available macroeconomic reports, institutional governance documentation, and field-informed observations derived from procurement and infrastructure management practices [8]. The analytical framework integrates three complementary theoretical perspectives. Digital governance theory examines how integrated digital systems enhance transparency, accountability, and traceability in public administration [7]. Institutional economics explains how reliable information reduces uncertainty and transaction costs across contractual relationships [4]. Information asymmetry theory provides insight into how incomplete or distorted administrative data generates structural market inefficiencies [2]. By applying these frameworks to procurement governance, infrastructure budgeting, logistics coordination, agricultural regulation, and monitoring systems, the study evaluates how digital integration may mitigate systemic vulnerabilities characteristic of fragile economies. The objective is not technological advocacy but institutional analysis of how digital tools alter risk exposure and fiscal predictability.

Empirical case evidence is informed by documented operational practices observed in Syria across procurement and infrastructure delivery cycles, including tender documentation, compliance screening checklists, phase-completion acceptance certificates, and technical verification notes. To protect confidentiality and enable open publication, organizations and individuals are anonymized and described only by functional role (e.g., contracting authority, technical committee, supplier/contractor). This approach preserves the explanatory mechanisms while avoiding disclosure of sensitive operational identifiers.

Discussion of Results

Procurement governance represents a critical domain where informational fragility directly influences economic outcomes. In volatile post-conflict environments, suppliers face uncertainty related to exchange rate fluctuations, fuel scarcity, regulatory enforcement, and liquidity risks. Institutional theory predicts that elevated uncertainty increases transaction costs and incentivizes defensive pricing strategies [4]. In the absence of centralized digital registries capable of verifying supplier solvency, compliance history, and prior performance in real time, procurement systems remain exposed to adverse selection and documentation inconsistencies [2]. Digital procurement platforms integrating financial guarantees, contract histories, and compliance verification into unified databases would significantly reduce informational asymmetry. OECD (Organization for Economic

Co-operation and Development) digital government research highlights that integrated e-procurement systems improve fiscal discipline, enhance transparency, and reduce corruption risks in fragile contexts [5]. In the Syrian context, such systems would enable cross-referencing of supplier documentation across ministries and reduce delays caused by manual verification.

In observed procurement practice, high-value tenders typically rely on cross-functional review structures intended to reduce single-person discretion. A tender opening and evaluation process is commonly conducted by a committee that includes logistics (document completeness and delivery feasibility), finance (budget alignment and cash-flow risk), and technical/program staff (specification compliance). However, when these checks are paper-based, verification quality depends heavily on fragmented files and manual follow-up. A recurrent risk point is the validation of financial solvency documents and bank guarantees: without a shared digital registry or standardized verification workflow, contracting authorities may be unable to rapidly confirm authenticity, validity dates, or the supplier's previous performance. A digital due-diligence spine –where solvency checks, committee decisions, and award rationale are logged as auditable events reduces discretionary uncertainty and strengthens accountability across the procurement lifecycle.

Contract execution in high-inflation environments further illustrates how governance mechanisms depend on timely, reliable data. A commonly applied mitigation is phase-based payment design, where projects are broken into two to six verifiable work packages and payments are released only after each phase is completed and formally accepted. This reduces abandonment risk during price shocks by providing periodic liquidity while maintaining enforceable unit prices for each phase. Yet, when phase completion is recorded through delayed paper engineering reports, payment approvals slow down and suppliers price in additional uncertainty. Digitizing acceptance certificates (geo-tagged evidence, standardized progress checklists, and time-stamped approvals) can shorten payment cycles, reduce disputes, and improve contract stability.

Infrastructure budgeting further demonstrates the economic cost of inaccurate technical data. Reconstruction projects frequently rely on preliminary site assessments conducted under logistical constraints. In one documented case involving school debris removal in Syria, preliminary excavation depth projections significantly exceeded verified operational requirements, resulting in an 87 percent discrepancy between projected and actual cost levels. Such variance immobilizes capital, delays reallocation, and constrains additional recovery initiatives. World Bank analysis indicates that weak public financial management systems in fragile

states frequently lead to inefficient capital deployment and project stagnation [8]. The integration of geospatial mapping technologies, digital surveying instruments, and centralized audit platforms would enable more precise cost estimation prior to budget approval. Real-time verification reduces uncertainty and prevents the long-term immobilization of recovery funds. Beyond financial savings, such digital tools enhance institutional credibility and donor confidence in post-conflict reconstruction programs.

Logistics volatility constitutes another structural vulnerability within fragile economies. In Syria, fuel scarcity and parallel market pricing mechanisms significantly affect transportation costs. When institutions lack real-time monitoring systems, budget projections rely on precautionary safety coefficients that inflate overall project expenditure. IMF (International Monetary Fund) research emphasizes that predictive analytics and adaptive monitoring instruments enhance macroeconomic stabilization in fragile and conflict-affected states [3]. Observed operationally, sudden fuel price spikes can shift incentives: suppliers may pause deliveries and absorb delay penalties if continued execution becomes loss-making, which contributes to contract paralysis and repeated renegotiation. Digital logistics dashboards integrating dynamic fuel price data, route optimization algorithms, and cost-per-kilometer calculations would improve fiscal predictability and reduce contractual renegotiation frequency.

Agricultural regulation and trade management provide an additional illustration of informational fragility. The domestic supply disruption known as the 'Onion Crisis' demonstrates how inaccurate crop production statistics can distort export decisions and create severe domestic shortages. In the absence of integrated digital agricultural registries and satellite monitoring systems, trade authorities relied on incomplete paper-based estimates. Digital crop monitoring systems combining satellite imagery, production registries, and predictive analytics would enable more accurate forecasting and reduce market volatility [9].

Across procurement, budgeting, logistics, and statistical management domains, a consistent pattern emerges: economic fragility is amplified by informational fragility. Digital governance strengthens institutional resilience by embedding automated verification mechanisms, audit trails, and traceable workflows within administrative systems. However, digital integration operates most effectively within accountable and inclusive institutional frameworks. As Acemoglu and Robinson argue, sustainable development depends on inclusive institutions capable of enforcing rules impartially [1]. Digital systems reinforce, but cannot substitute effective governance structures.

Conclusion

The Syrian case study illustrates that economic security in conflict-affected contexts is fundamentally associated with information integrity. Fragmented administrative systems generate structural asymmetries that distort procurement, inflate infrastructure costs, destabilize logistics networks, and weaken macroeconomic predictability. Digital governance provides a structural response by reducing transaction costs, enhancing transparency, strengthening fiscal discipline, and embedding verification within administrative workflows. Real-time data integration, geospatial auditing, centralized procurement databases, and predictive analytics constitute practical mechanisms through which fragile institutions may reinforce economic resilience. In the digital era, economic security is inseparable from informational capacity. The transition from fragmented paper-based administration to integrated digital governance systems represents not merely technological modernization but a foundational transformation toward precision economic management in fragile and post-conflict states. Prioritizing digital integration within public financial management and statistical systems should therefore form a central pillar of post-conflict recovery strategies.

REFERENCES

1. Acemoglu D., Robinson J. Why Nations Fail: The Origins of Power, Prosperity, and Poverty. Crown Publishers. New York. 2012. 571 p. (in English).

2. Akerlof G.A. The Market for 'Lemons': Quality Uncertainty and the Market Mechanism // Quarterly Journal of Economics. 1970. Vol. 84, No. 3. P. 488-500. https://link.springer.com/chapter/10.1007/978-1-349-24002-9_9 (Access 27.02.2026). (in English).

3. IMF. Macroeconomic Policy in Fragile and Conflict-Affected States // International Monetary Fund. 2021. – URL: https://www.imf.org/en/Publications/Policy-Papers/Issues/ 2021/03/05/Macroeconomic-Policy-in-Fragile-and-Conflict-Affected-States-50129 (Access 26.02.2026). (in English).

4. North D.C. Institutions, Institutional Change and Economic Performance. Cambridge University Press. 1990. 159 p. (in English).

5. OECD. Public Procurement and Infrastructure Governance // OECD Publishing. 2019. – URL: https://www.oecd.org /gov/public-procurement/ (Access 26.02.2026). (in English).

6. OECD. States of Fragility 2022 // OECD Publishing. 2022. URL: https://www.oecd.org/dac/states-of-fragility-2022-1e5f7b11-en.htm (Access 26.02.2026). (in English).

7. United Nations. E-Government Survey 2022: The Future of Digital Government // UN Department of Economic and Social Affairs. 2022. – URL: https://publicadministration.un.org/egovkb/en-us/reports/un-e-government-survey-2022 (Access 26.02.2026). (in English).

8. World Bank. Syria Economic Monitor. Washington, DC: World Bank, 2023. – URL: https://www.worldbank.org /en/country/syria/ publication/syria-economic-monitor (Access 26.02.2026). (in English).

9. World Bank. World Development Report 2021: Data for Better Lives. Washington, DC: World Bank, 2021. – URL: https://www.worldbank.org/en/publication/wdr2021 (Access 26.02.2026). (in English).

EFFECTIVE IMPLEMENTATION OF WAREHOUSE MANAGEMENT SYSTEMS AS A FACTOR OF BUSINESS PROFITABILITY GROWTH

V. V. Shumskaya

Research advisor: E.O. Pochko

Brest, *Brest State Technical University*,
vladasatohina966@gmail.com

Abstract. This article analyzes the impact of various warehouse management systems on improving business profitability. Key technologies for automating warehouse processes are discussed: the FEFO principle for perishable goods, the kaizen system based on continuous improvement and employee engagement, analytics systems for inventory optimization, including ABC analysis, and innovative RFID technologies.

Keywords: warehouse management systems, warehouse process automation, kaizen, FEFO, RFID technologies, business profitability, warehouse logistics.

ЭФФЕКТИВНОЕ ВНЕДРЕНИЕ СИСТЕМ УПРАВЛЕНИЯ СКЛАДОМ КАК ФАКТОР РОСТА ПРИБЫЛЬНОСТИ БИЗНЕСА

В. В. Шумская

Аннотация. В статье анализируется влияние различных систем управления складом на повышение прибыльности бизнеса. Рассматриваются ключевые технологии автоматизации складских процессов: принцип FEFO для скоропортящихся товаров, система кайдзен, основанная на постоянном совершенствовании и вовлечении сотрудников, аналитические системы для оптимизации запасов, включая ABC-анализ, а также инновационные RFID-технологии.

Ключевые слова: системы управления складом, автоматизация складских процессов, кайдзен, FEFO, RFID-технологии, прибыльность бизнеса, складская логистика.

Traditionally, a warehouse was perceived as an unavoidable expense, including rent, staffing, taxes, and losses from spoilage. However, with a modern management approach, the warehouse ceases to be a passive link in the supply chain and is transformed into a strategic unit capable of directly impacting a company's financial performance. Warehouse Management Systems (WMS) are a key tool for this transformation, enabling not only automated accounting but also a fundamental change in the operational logic of the entire warehouse complex. Implementing a WMS opens up opportunities for businesses that extend beyond the traditional warehouse: from reducing operating costs and freeing up working capital to increasing customer loyalty and, consequently, increasing long-term profits.

Before automation, many companies faced a host of problems caused by human error and a lack of transparency in accounting processes. 20% of all orders were sent to customers with errors due to manual data entry, and the accounting gap between the warehouse and sales departments led to systematic mis-sorting and direct losses reaching 7% of inventory. Implementing a WMS on the 1C platform enabled real-time data synchronization and automation of key receiving and shipping processes, virtually eliminating losses from defective and mis-sorting, directly impacting gross profit growth. According to statistics and certain studies, 83% of distributors who have implemented a WMS report profit growth within the first twelve months of the project [1].

The issue of direct losses is particularly acute in business segments that handle goods with limited shelf lives. In a warehouse with such goods, simply recording inventory availability is not enough; inventory rotation management based on the FEFO (First-Expire, First-Out) system becomes crucial, requiring that batches with the closest expiration date be shipped first. Implementing FEFO in warehouse operations requires end-to-end batch-level control, system integration, and clear standard operating procedures. The impact of such measures can be measured in millions of rubles in savings. A case in point is the agroholding Eco-Cultura, whose products have a shelf life of three to fifteen days. Before implementing the 1C: WMS system, the write-off rate at one of the large distribution centers in the Moscow region reached 4.5%, due to untimely inventory rotation. The implementation of expiration date rotation management algorithms reduced write-offs to 0.7%, resulting in monthly savings of over 40 million rubles for the company. These funds, which were previously a direct loss, now remain within the company, generating net profit. FEFO is essential for this industry, as it automatically prompts the picker which products with the closest expiration date should be selected, and any quality concerns should result in the product being blocked for assembly [2; 3].

Another effective warehouse management system is kaizen, which translates from Japanese as "continuous improvement." The kaizen system makes small daily

improvements that yield significant cumulative effects over the long term. Kaizen optimizes virtually every aspect of operations: organizing the workspace according to the 5S system, which includes sorting, order, cleanliness, standardization, and improvement, reduces the time spent searching for necessary tools and goods, minimizes unproductive movement of personnel and equipment, and reduces the risk of damage to goods and injuries. Standardization of operations creates clear, repeatable algorithms for receiving, placing, picking, and shipping, eliminating the dependence of results on human error and variability in the performance of the same actions by different employees. This optimization system directly increases business profitability. Eliminating waste (unnecessary movements, waiting times, defects) directly reduces operating costs without additional investment. Reducing picking errors reduces losses from returns and defects, maintaining gross profit. Reducing staff turnover through employee engagement in management saves money on the constant search and training of new employees. Taken together, all these factors create an effect in which the company begins to earn more and spend less [4].

Implementing inventory management systems provides real-time visibility into inventory balances, enables product categorization based on sales volume and forecasts, and automatically alerts customers to items that have been sitting in storage for extended periods and are not selling. Thanks to integrated analytics tools such as ABC analysis and automatic identification of items with critical inventory levels, WMSs enable purchasing planning based on actual turnover, significantly reducing the cost of purchasing low-demand items and preventing excess inventory. A prime example of the effectiveness of this approach is provided by the Kazakhstani retail chain ANVAR, which comprises 56 stores in six cities. Before implementing an automated inventory management system, a significant portion of working capital was frozen in excess inventory, and managers spent two days manually compiling Excel reports, which were already out of date by the time they were completed, leading to delayed decision-making. The company's management set a goal of reducing overall excess inventory by 30% within six months. To achieve this, they implemented a specialized solution that radically changed the way they operated, replacing manual reports and intuitive decisions with a transparent, automated digital process. The system began to independently analyze sales and inventory for each product in each store, generating pre-defined tasks for managers specifying which stores and what items needed to be sold, moved, returned to the supplier, or rescheduled, and automatically calculating the optimal discount for quickly clearing shelves of unsaleable items. In just 38 days, the company reduced excess inventory of top products by 37%, decreased the overall volume of surplus inventory across the entire chain by 12.2%, and decreased the overall inventory per store by 1.6%, demonstrating inventory optimization and increased turnover [5].

A warehouse management system based on radio-frequency identification technology, known as an RFID system, is an innovative solution that fundamentally changes the approach to inventory control and tracking by using electromagnetic fields to automatically identify and track special tags attached to each item. Each tag contains a microchip with unique product information that requires no line of sight to read, allowing for the simultaneous processing of hundreds of items in seconds. Goods are accepted without opening the packaging by simply driving past the pallet with a handheld or stationary reader, reducing the time required for this operation from hours to minutes. Items are placed into storage automatically and the exact location is determined by the tags, which the system can see remotely. Thus, order picking and assembly are accelerated by the ability to instantly locate the required items using a tag signal. Inventory control, which traditional methods require a warehouse shutdown for several days or manual counting by shift, is completed in a matter of hours or even minutes by simply walking an employee with a reader along the shelves. The reader simultaneously records all items within the access zone and checks them against the inventory data. The impact of this system on business profitability is direct and multifaceted. Inventory accuracy increases to 98 – 99%, virtually eliminating situations where an item is listed in the system but physically out of stock, or vice versa. This avoids both losses from undetected theft and lost goods, as well as lost profits from orders that cannot be fulfilled due to data discrepancies. Employee productivity increases dramatically, as the time required to complete key operations is significantly reduced. For example, inventory counts that would otherwise take several days for an entire team are now performed by a single employee per shift, freeing up staff for other tasks or processing a larger volume of orders without increasing headcount, directly reducing operating costs per unit. Losses from theft and pilferage are reduced through continuous monitoring of product movements and the option of installing portal readers at exits that automatically alert when an attempt is made to remove unpaid or unaccounted for goods, a particularly critical feature for warehouses with open access to high-value products. Optimized warehouse space utilization is achieved through precise knowledge of the location of each product and the ability to store products more compactly, eliminating aisles for visual search and manual barcode scanning, which increases storage density and delays the need to expand warehouse space as turnover increases [6].

Thus, modern warehouse automation technologies are not just an accounting tool, but a powerful driver of business profitability, operating in several key areas simultaneously. The implementation of WMS systems and FEFO principles dramatically reduces direct losses, transforming them into net profit. RFID technologies enable the processing of growing order volumes without a proportional

increase in staff or warehouse space, reducing operating costs per unit and paving the way for business scaling without additional capital expenditures. The use of analytical tools such as ABC analysis and automated inventory management systems frees up significant amounts of working capital previously locked up in slow-moving or excess inventory, redirecting them toward business development. The implementation of a kaizen system creates a long-term, sustainable increase in efficiency, which subsequently leads to a significant increase in profits.

REFERENCES

1. Kak vybrat' i avtomatizirovat' sistemu upravleniya skladom – obzor TOP-10 luchshih WMS dlya upravleniya skladom (How to choose and automate a warehouse management system – a review of the top 10 best WMS for warehouse management) Available at: https://craftum.com/blog/upravlenie-skladom/ (accessed 25.02.2026)

2. 1S dlya skladskoj logistiki (1C for warehouse logistics) Available at: https://binavigator.ru/articles/servisy-1s/1s-dlya-skladskoy-logistiki/ (accessed 25.02.2026)

3. Princip FEFO v skladskoj logistike: pravila rotacii i organizaciya sklada (The FEFO principle in warehouse logistics: rotation rules and warehouse organization) Available at: https://www.cleverence.ru/articles/sklad-i-logistika/-printsip-fifo-v-logistike-pravila-rotatsii-i-organizatsiya-sklada/ (accessed 25.02.2026)

4. Primery vnedreniya kajdzen-podhoda na sklade: effektivnost' i uluchshenie proizvoditel'nosti (Examples of implementing the kaizen approach in a warehouse: efficiency and productivity improvement) Available at: https://journalovirus.ru/primery-vnedreniya-kaydzen-podhoda-na-sklade-effektivnost-i-uluchshenie-proizvoditelnosti (accessed 25.02.2026)

5. Analiz skladskih zapasov ABC/XYZ: chto eto i kak provesti (ABC/XYZ Inventory Analysis: What It Is and How to Conduct It) Available at: https://upr.ru/article/analiz-skladskikh-zapasov-abc-xyz-chto-eto-i-kak-provesti/ (accessed 25.02.2026)

6. Primenenie RFID-tekhnologii dlya inventarizacii na sklade (Using RFID technology for warehouse inventory control) Available at: https://scanport.ru/blog/primenenie-rfid-tehnologii-dlya-inventarizaczii-na-sklade/ (accessed 25.02.2026)

LEAN MANUFACTURING TOOLS FOR MODERN BUSINESS IN THE CONTEXT OF DIGITAL TRANSFORMATION

V. V. Sichkarev

Research advisor: M. P. Maslov, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
vladimirsichkarev@yandex.ru

Abstract: This article examines contemporary methods for implementing lean production tools in the era of the "Industry 4.0" concept. Modern tools are also analyzed through real-world cases that demonstrate the effectiveness of their implementation. Furthermore, the article presents approaches for evaluating the impact resulting from the adoption of these tools.

Keywords: lean, lean production, efficiency, kanban, andon, economic.

ИНСТРУМЕНТЫ БЕРЕЖЛИВОГО ПРОИЗВОДСТВА ДЛЯ СОВРЕМЕННОГО БИЗНЕСА В КОНТЕКСТЕ ЦИФРОВОЙ ТРАНСФОРМАЦИИ

В. В. Сичкарев

Аннотация: В данной статье рассматриваются современные способы внедрения инструментов бережливого производства в эпоху развития концепции «Индустрия 4.0». Современные инструменты рассмотрены также на примере реальных кейсов, которые показывают эффективность внедрения. Приведены также варианты того, каким можно оценивать эффект от внедрения данных инструментов.

Ключевые слова: бережливое производство, эффективность, канбан, андон, экономика.

Introduction

In the era of digital transformation, modern enterprises must adapt to current realities. Businesses are interested in ensuring that the tools they employ deliver maximum efficiency in their operations.

Lean production is also adapting to contemporary conditions. In an environment where the speed of managerial decision-making is becoming a crucial competitive factor, classical lean production tools, despite having proven their effectiveness, require modernization and innovation.

This article examines contemporary methods for integrating lean production tools into business operations.

Integration of Lean and Digital Technologies

The methods and tools of lean production are also adapting to modern technologies. In the era of Big Data, AI, and IoT, contemporary solutions are needed. The "Industry 4.0" concept presupposes the digitalization of all stages of the product lifecycle. In their article "The Application of Digital Tools in the Field of Lean Production at Industrial Enterprises," M. O. Shalnev and Ya. V. Denisova [1] discuss the transformations affecting lean production in the Industry 4.0 paradigm. Currently, digital tools enable companies not only to record waste but also to predict their occurrence at early stages. Let us examine the tools that have been transformed through modern technologies.

Workflow Management Tools (Kanban)

Kanban is a tool for the visual management of work processes [2]. Kanban boards enable the tracking of work tasks within departments and across the entire organization. Companies are actively integrating Kanban boards into their operations, with the most popular ones including Jira, Asana, and Trello. In the Russian market, Yougile, Kaiten, and Bitrix24 are also widely used. The effectiveness of their application can be analyzed through specific examples.

In 2025, the company Fork-Tech conducted a pilot implementation of the Kanban tool during the development of trading and clearing systems for the Moscow Exchange [3]. As a result, the company was able to accelerate the development process by more than a third and also identify a growth opportunity.

Another example is the case of the company Superkassa [4]. The company had prior experience with inefficient processes using the Waterfall model. It also faced the withdrawal of foreign software from the Russian market. Superkassa transitioned to the Kaiten service to manage its projects using the Kanban tool. As a result, the company was able to reduce downtime by half and switch to the flexible Scrum methodology.

Performance Monitoring and Analysis Systems (Andon)

In addition to Kanban, there are other tools for improving the efficiency of company processes. One such tool is Andon.

Andon is a visual system that alerts operators to emerging problems in the production process [5]. Through various signals, it enables the identification of the location where problems arise and determines the characteristics of these problems. The impact of applying this tool can be assessed through examples of its implementation.

The case of the company Gazelle demonstrates the effectiveness of this tool [6]. Royal Dutch Gazelle is a bicycle manufacturing company. They implemented a system that allows employees to stop the assembly line using a tablet if a problem is detected. This enabled the company to reduce downtime by 35% and increase the number of bicycles produced by 3,500 per year.

Allied Motion Technologies Inc. is an international company that designs, manufactures, and sells precision components and custom parts used in mechanical engineering, electronics, and equipment manufacturing [7]. The company replaced its previously implemented Andon system with a modern one, which made it possible to identify bottlenecks in processes and reduce both reaction time and problem-solving time by 10%.

How to Evaluate the Effectiveness of Lean Production Tools?

Any changes and improvements to the production process must yield economic benefits or demonstrate some form of effectiveness. How, then, can the effectiveness of implemented tools be assessed?

Indicators that can objectively demonstrate the effectiveness of implementing lean production tools can be divided into two categories: indicators of the tools' own performance and general indicators of economic efficiency. Table 1 lists the performance indicators for the tools themselves [8].

Table 1 **–** Performance Indicators for Lean Tools

Indicator	Formula	Value
(Cycle Time)	Cycle Time = T completion time − T start	The time that a team spends on a task from the start to the end
Units of work per hour	Mh = X * T	A unit of time accounting that corresponds to one hour of work by one person
Production downtime	Tdowntime = = Tc – (Ttech + Tserv)	A period during which equipment is not working or producing products for various reasons

There are also general indicators of economic efficiency that allow for the evaluation of the results obtained relative to the costs incurred. These indicators are listed in Table 2 [9].

Neither of these two categories of indicators is exhaustive; however, together they can form a comprehensive understanding of the effectiveness and feasibility of the production process improvements being implemented at an enterprise.

Table 2 – General Indicators of Economic Efficiency

Indicator	Formula	Value
ROI	$\frac{Profit}{IC}$	It shows how effectively the project's investments have turned into profits
Economic effect	$Ee = R_1 - R_0 - Ac$	The result of economic activity, the net gain from economic activity
Profit margin	$\frac{Profit}{C}$	It reflects how effectively various enterprise resources are used

Conclusion

In the course of this work, the transformations in lean production tools were examined in the context of evolving modern technologies. Using the examples of Kanban and Andon tools, successful cases of lean production implementation that yielded positive effects were demonstrated. Additionally, methods for evaluating the effectiveness of the implemented tools were considered, which allow for an assessment of the necessity and feasibility of introducing particular tools.

This can potentially assist employees and organizations in determining, based on their own experience, the impact of implementing lean production tools. Effectiveness must be evaluated using specific indicators to make sound managerial decisions.

Thus, it can be concluded that new technologies significantly simplify the production processes of an enterprise. When implemented properly, they can deliver maximum economic benefit.

REFERENCES

1. Shalnev M. O., Denisova Ya. V. Application of digital tools in the sphere of lean production at industrial enterprises. Omsk Scientific Bulletin. 2025. No. 4 (196). P. 35–42. DOI: 10.25206/1813–8225-2025-196-35-42. EDN: WHYNSQ.

2. Cupo M. The 10 Best Kanban Tools to Boost Your Team's Productivity [Electronic resource] / Mayra Cupo // monday.com Blog. – Oct 16, 2025. – Development Section. – Access mode: https://monday.com/blog/es/desarrollo/herramientas-kanban/ (accessed: 24.02.2026).

3. Moscow Exchange (IT Outsourcing Projects) [Electronic resource] // TAdviser: [portal]. – Apr 10, 2013. – Access mode: https://www.tadviser.ru/ index.php/ Project: Moscow_ Exchange_(IT_Outsourcing_Projects) (accessed: 25.02.2026). (Title translated from Russian)

4. Superkassa: How to Cut Task Downtime in Half and Switch to Scrum [Electronic resource] // Kaiten: [blog]. – Aug 28, 2025. – Access mode: https://kaiten.ru/blog/case-superkassa/ (accessed: 25.02.2026). (Title translated from Russian)

5. Andon – A Visual Problem Notification System [Electronic resource] // Lean konsult: [website]. – URL: https://www.lean-consult.ru/blog/andon-vizualnaya-sistema-opoveshheniya-o-voznikayushhih-problemah/ (accessed: 25.02.2026). (Title translated from Russian)

6. How Gazelle is reducing downtime by 35% using Workerbase [Electronic resource] // Workerbase: [website]. — May 13, 2025. — Access mode: https://workerbase.com/success-stories/gazelle/ (accessed: 25.02.2026).

7. Allied Motion Boosts Efficiency with 10% Faster Response Times [Electronic resource] // SmartSights: [website]. – Feb 2, 2026. – Access mode: https://smartsights.com/industries/case-studies/allied-motion/ (accessed: 25.02.2026).

8. The Power of Key Performance Indicators [Electronic resource] // Rememo: [website]. – URL: https://ru.rememo.io/blog/key-performance-indicators-in-lean-manufacturing (accessed: 25.02.2026). (Title translated from Russian)

DIRECTIONS OF DIGITAL TRANSFORMATION AS A FACTOR IN IMPROVING THE EFFICIENCY OF RUSSIAN RAILWAYS

A. A. Vershinskaya

Research advisor: G. P. Litvintseva, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
vershinskaya.anas@mail.ru

Abstract. This article examines the key directions of digital transformation at Russian Railways and their outcomes. Based on the analysis, three main areas are identified: the adoption of artificial intelligence and predictive analytics technologies, including comprehensive automation of railway stations; the digitalization of administrative, managerial, and support functions; and the development of digital customer services. An expert assessment of the company's digital maturity was carried out using an adapted version of the methodology developed by the Accounts Chamber of the Russian Federation. The results show that digital transformation not only enables the company to improve operational efficiency and reduce costs but also to generate new revenue streams. Together, these factors provide the basis for maintaining a strategic advantage.

Keywords: digital transformation, Russian Railways, artificial intelligence, smart station, digital maturity, operational efficiency, customer services.

НАПРАВЛЕНИЯ ЦИФРОВОЙ ТРАНСФОРМАЦИИ КАК ФАКТОР ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ДЕЯТЕЛЬНОСТИ ОАО «РЖД»

А. А. Вершинская

Аннотация. В статье исследуются направления цифровой трансформации ОАО «Российские железные дороги» и их результаты. На основе анализа выделены три ключевых направления: внедрение технологий искусственного интеллекта и предиктивной аналитики, включая комплексную автоматизацию железнодорожных станций; цифровизация административно-управленческих и обеспечивающих функций; а также развитие цифровых сервисов для клиентов. Проведена экспертная оценка цифровой зрелости компании по адаптированной методологии Счетной палаты РФ. Сделан вывод о том, что цифровая трансформация позволяет компании не только повышать операционную эффективность и сокращать издержки, но и создавать новые источники дохода, что в совокупности формирует основу для поддержания стратегического превосходства.

Ключевые слова: цифровая трансформация, ОАО «РЖД», искусственный интеллект, умная станция, цифровая *зрелость*, *операционная эффективность*, *клиентские сервисы*.

As the country's largest carrier and infrastructure holding company, Russian Railways (RZD) is compelled to seek new sources of increased efficiency in its operations. RZD's digital transformation strategy has been implemented since 2019. The total economic effect of introducing digital technologies over six years has reached 60 billion rubles due to revenue growth, increased labor productivity, and cost savings [1].

The article highlights three key areas of RZD's digital transformation and presents the results of an expert assessment of the organization's level of digital maturity.

The most rapidly developing area of digitalization at RZD is the introduction of artificial intelligence (AI) technologies to optimize production processes. AI elements are used in 38 of the company's automated systems.

Notable examples include intelligent inspection of railcars (when scaled to 33 inspection points, the costs were recouped two times over; it is now used at 61 points, with an effect of 1 billion rubles over five years) and the dispatcher's assistant (tests have shown a 20% reduction in transit railcar downtime) [1].

The Digital Railway Station (DRS) project was a logical next step in the application of comprehensive digital solutions. It has been underway at the Chelyabinsk-Glavny marshalling yard since 2019 and is scheduled for completion in 2026.

The uniqueness of the project lies in its end-to-end integration. A high-speed LTE data transmission network has been deployed at the station. Key technological solutions cover the following elements: an infrastructure control module, automated cars, and the "Automatic Driver" system.

The economic effect here is achieved by speeding up cargo delivery, flexibly managing the transportation process, reducing injuries, and optimizing operating costs. Based on the results of 2025, a decision was made to replicate the key components of the Digital Railway Station (DRS) at other key stations in the network, such as Yekaterinburg-Sortirovochny, Inskaya, and Taishet [8].

The automation of transport document processing using the Autoagent system has resulted in savings of approximately 1 billion rubles [1].

The second area is the automation of internal business processes. An automated system has been created to manage the Russian Railways' fleet of vehicles (29,500 units, 21% of which are leased from contractors). As part of import substitution, the transition to the domestic solution "1C: Motor Transport Management" has been implemented [5].

The project covered 52 branches consisting of 2,200 responsibility centers. Key results of the implementation include: a 10% efficiency improvement of the fleet since the system was launched, a transition to electronic document management using electronic signatures, automation of applications for motor transport services (more than 538,000 applications in 2024), rapid generation of waybills and automatic generation of reports [2]. In addition, TransTeleCom (Moscow) equips vehicles with satellite navigation devices and fuel level sensors, optimizing mileage, avoiding downtime, and reducing fuel consumption, avoidance of downtime, and reduction of fuel consumption [7].

A key aspect of Russian Railways' digital transformation is its focus on import substitution. Today, the Unified Register of Russian Computer Programs and Databases already includes 284 systems owned by Russian Railways [3].

The third area of digitalization is related to creating added value for passengers and shippers.

The RZD Passengers app (installed on 8 million devices) is a multifunctional assistant for all stages of travel. Its key feature is the Waiting List service with auto-purchase, which provides access to 13–15% of tickets for long-distance trains [1].

In the field of freight transportation, the key achievement was the new generation ETRAN system. Today, 90% of shippers interact with Russian Railways entirely in electronic format. Last year, this shift to digital formats in freight transportation generated savings of 8 billion rubles. The electronic trading platform "Freight Transportation" also brought in additional revenue of 1.8 billion rubles [4].

RZD's digital solutions have export potential. The company's export portfolio includes 20 digital services. The Express system operates in seven partner countries [1].

To quantitatively assess the level of the company's digital transformation, an expert assessment of the digital maturity of Russian Railways was conducted using an adapted methodology developed by the Center for Prospective Management Solutions and tested by the Accounts Chamber of the Russian Federation in 2020. This methodology allows for a comprehensive assessment of eight key areas: digital culture, human resources, processes, digital products, models, data, infrastructure, and tools [9].

The assessment was conducted with the participation of company employees.

The result of the assessment across seven blocks, taking into account weighting coefficients, is a final index of 2.49, which falls between the average (2) and high (3) assessment levels. Thus, it can be concluded that Russian Railways demonstrates a level of digital maturity above average.

The most developed blocks are “Digital Products” and “Data” (2.65), which is confirmed by successful customer services and analytics systems. The ratings for the “Human Resources,” “Models,” and “Digital Culture” blocks are relatively lower (2.33), which indicates the need to develop staff competencies and transform the corporate culture.

The analysis allows us to draw the following conclusions about the effectiveness of key areas of digital transformation at Russian Railways.

First, the introduction of artificial intelligence and predictive analytics technologies, including comprehensive “Digital Station” solutions, contributes to the optimization of production processes, reduction of train processing time, reduction of operating costs, and improvement of safety.

Second, the digitization of administrative and management functions on platform solutions increases operational efficiency, reduces costs, and ensures import substitution of critically important software.

Third, the development of digital services for customers increases engagement, improves service quality, and creates additional opportunities for monetization.

An expert assessment of digital maturity confirms that the company is above average, successfully developing products, infrastructure, and data management. The untapped opportunities in the areas of human resources and digital culture require a comprehensive approach that takes into account the human aspects of transformation.

To sum up, digital transformation is a must for Russian Railways to maintain its leading position. The positive dynamics of economic indicators (an economic effect

of 60 billion rubles – RUB) and the achievement of digital maturity targets confirm the validity of the chosen innovation development strategy and the effectiveness of capital investments in digital infrastructure.

REFERENCES

1. Champion tsifrovoy transformatsii: Kak vysokie tekhnologii stanovyatsya na rel'sy [Champion of Digital Transformation: How High Technologies Get on Track]. (2025) Spetsproekt Kommersant [Special Project of Kommersant]. URL: https://special.kommersant.ru/rzhd-express/digital.html (accessed 18.02.2026). (in Russian)

2. Sozdanie avtomatizirovannoy sistemy upravleniya avtotransportom dlya 2200 podrazdeleniy TsAT "RZhD" [Creation of an Automated Vehicle Management System for 2200 Subdivisions of the "Russian Railways" Central Motor Transport Department]. (2025) 1S:Konsalting [1C:Consulting]. URL: https://consulting.1c.ru/cases/386681.html (accessed 18.02.2026). (in Russian)

3. RZhD preodolela polovinu puti razrabotki proektov ITsK pervoy volny [Russian Railways Has Reached the Halfway Point in Developing First-Wave IDC Projects]. (2025) ComNews.ru. URL: https://www.comnews.ru/content/238966/2025-04-24/2025-w17/1008/ rzhd-preodolela-polovinu-puti-razrabotki-proektov-ick-pervoy-volny (accessed 20.02.2026). (in Russian)

4. Bolee 60 mlrd rubley sostavil pryamoy effekt ot realizatsii tsifrovykh proektov RZhD [The Direct Effect from the Implementation of Russian Railways' Digital Projects Amounted to More Than 60 Billion Rubles]. (2025) RZhD Tsifrovoy [Russian Railways Digital]. URL: http://RZDDigital.ru/events/bolee-60-mlrd-rubley-sostavil-pryamoy-effekt-ot-realizatsii-tsifrovykh-proektov-rzhd-/ (accessed 18.02.2026). (in Russian)

5. «1S:Predpriyatie» pomogaet RZhD kontrolirovat' rabotu 29,5 tysyach edinits transporta [1C:Enterprise Helps Russian Railways Control the Operation of 29.5 Thousand Vehicles]. (2025) 1S:Predpriyatie [1C:Enterprise]. URL: https://v8.1c.ru/news/1s-predpriyatie-pomogaet-rzhd-kontrolirovat-rabotu-29-5-tysyach-edinits-transporta.htm (accessed 21.02.2026). (in Russian)

6. RZhD na polputi k tsifrovoy transformatsii: analiz promezhutochnykh rezul'tatov ITsK [Russian Railways Halfway to Digital Transformation: Analysis of Interim Results of IDCs]. (2025) CFO Russia. URL: https://www.cfo-russia.ru/novosti/?article=91660 (accessed 18.02.2026). (in Russian)

7. Proekt Kompanii TransTeleKom i Tsentra upravleniya avtotransportom RZhD – laureat premii ComNews Awards-2025 [The Project of TransTeleCom Company and the Russian Railways Vehicle Management Center is the Winner of the ComNews Awards-2025]. (2025) Kompaniya TransTeleKom [TransTeleCom Company]. URL: https:// company.ttk.ru/ news/tpost/ar62xve9f1-proekt-kompanii-transtelek om-i-tsentra-u (accessed 18.02.2026). (in Russian)

8. Umnaya stantsiya [Smart Station]. (2026) RZhD Tsifrovoy [Russian Railways Digital]. URL: https://rzddigital.ru/projects/umnaya-stantsiya-/ (accessed 19.02.2026). (in Russian)

9. Adaptiruemaya metodologiya otsenki tsifrovoy zrelosti organizatsii na primere Schetnoy palaty Rossiyskoy Federatsii [Adaptable Methodology for Assessing the Digital Maturity of an Organization on the Example of the Accounts Chamber of the Russian Federation]. Tsentr perspektivnykh upravlencheskikh resheniy [Center for Advanced Management Solutions]. URL: https://cpur.ru/digitalconsulting/ (accessed 21.02.2026). (in Russian)

INNOVATIVE PROJECT'S FOREIGN TRADE POTENTIAL

S. A. Vozhdaeva

Research advisor: E. I. Muzyko, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
lady.svozhd@yandex.ru

Abstract: The paper presents a systematization of methods of assessing innovative project's foreign trade potential. The author has performed the following tasks: 1) conduct comparative analysis of approaches to the definition of foreign trade potential and formulate the author's definition of this term; 2) define the term 'innovative project'; 3) develop a sequence of analysis innovative project's foreign trade potential; 4) develop indicators of assessing innovative project's foreign trade potential; 5) describe the algorithm of foreign trade potential development managing.

Keywords: foreign trade potential, innovative project, internal foreign trade potential, external foreign trade potential, export operations efficiency, import operations efficiency, managing the development of foreign trade potential.

ВНЕШНЕТОРГОВЫЙ ПОТЕНЦИАЛ ИННОВАЦИОННОГО ПРОЕКТА

С. А. Вождаева

Аннотация: В статье систематизированы методики оценки внешнеторгового потенциала инновационного проекта. Реализованы следующие задачи: 1) сравнительный анализ подходов к определению внешнеторгового потенциала и формулирование авторского определения данного понятия; 2) определение понятия «инновационный проект»; 3) разработка последовательности анализа внешнеторгового потенциала инновационного проекта; 4) разработка показателей оценки внешнеторгового потенциала инновационного проекта; 5) описание алгоритма процесса управления развитием внешнеторгового потенциала.

Ключевые слова: внешнеторговый потенциал, инновационный проект, внутренний внешнеторговый потенциал, внешний внешнеторговый потенциал, эффективность экспортных операций, эффективность импортных операций, управление развитием внешнеторговым потенциалом.

Introduction

The chosen research topic is highly relevant due to the urgent need for import substitution in Russia and the challenge of stimulating the demand for Russian products on foreign markets, which can be facilitated by the implementation of innovative projects by enterprises and organizations.

Currently, the scientific literature does not sufficiently disclose the term «foreign trade potential».

The article will provide the author's definitions of the terms '*foreign trade potential*' (FTP) and *'innovative project'* (Project) and systematize methods of assessing innovative project's foreign trade potential.

Research Methods

The study employed the following methods:

- induction and deduction;
- systems analysis;
- comparative analysis.

After comparing existing approaches to the definition of FTP, this paper formulates the author's own definition of the term, defines the "innovative project," and presents the relationship between the Project's FTP and that of its initiator (the organization). The stages of analyzing the Project's FTP will be outlined, and indicators for its assessment, along with an algorithm for managing the development of foreign trade potential, will be proposed.

Results and Discussion

The scientific literature offers various definitions of FTP, including: 1) 'the aggregate of all material and intellectual resources and opportunities of an enterprise that are necessary for foreign economic activity' [2]; 2) 'the maximum volume of trade a country can achieve' assuming open borders and the absence of trade barriers, given the current level of production, transport, and industrial technologies [7].

In the first definition, the authors provide a broad interpretation of the term as a set of resources and opportunities of an enterprise as on economic entity while referring to foreign economic activity, but foreign trade activity (FTA) is only a component part of foreign economic activity. The second definition is narrower, emphasizing the maximum possible volume of country's trade, while specifying certain limitations that affect the achievement of this trade volume.

So, to avoid ambiguity, we shall define FTP and Project.

Foreign trade potential (FTP) is a portfolio of an organization's resources and opportunities, which are necessary for conducting foreign trade activity.

An innovation project (Project) is defined as a type of investment project [4, c. 34], the purpose of which is to implement a new or significantly improved product or process, a new sales method, or a new organizational method in business practice [1, p. 18; 5, p. 20].

Methods of assessing Project's FTP, which influences innovative project initiator's (organization's) FTA, include an analysis of the internal and external FTP [2].

Figure 1 presents the stages of analyzing the Project's FTP.

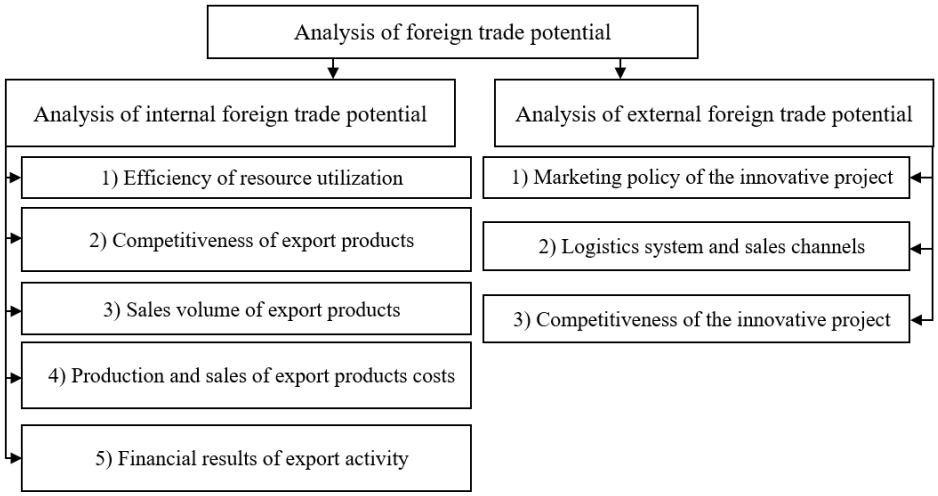


Figure 1 – Analysis of innovative project's foreign trade potential

Source: compiled by the author based on [2].

According to Figure 1, the analysis of internal FTP includes the analysis of resources necessary for the production of goods intended for export, and the management of these resources for the development of the Project and innovative project initiator's activity. The analysis of external FTP is related to the analysis of the actual process of selling competitive products. The analysis of FTP leads to a forecast scenario for the development of enterprise's FTA and the Project itself.

Next, it is necessary to assess the FTP of the Project using a system of indicators characterizing the efficiency of export and import operations. For example, export revenue as a percentage of total revenue; the economic efficiency of exports, determined by the ratio of the export volume at domestic average annual prices to the production cost of export products; the efficiency of imports, determined by the ratio of the benefits from imports, expressed in the sales volume of products using import assets, to the costs of import assets [6, p. 275–277]. If the indicators of economic efficiency of exports and efficiency of import share are greater than 1, the export and import operations are considered efficient.

We shall describe the algorithm of foreign trade potential development managing (Figure 2). We introduce the following notation: foreign economic activity – FEA.

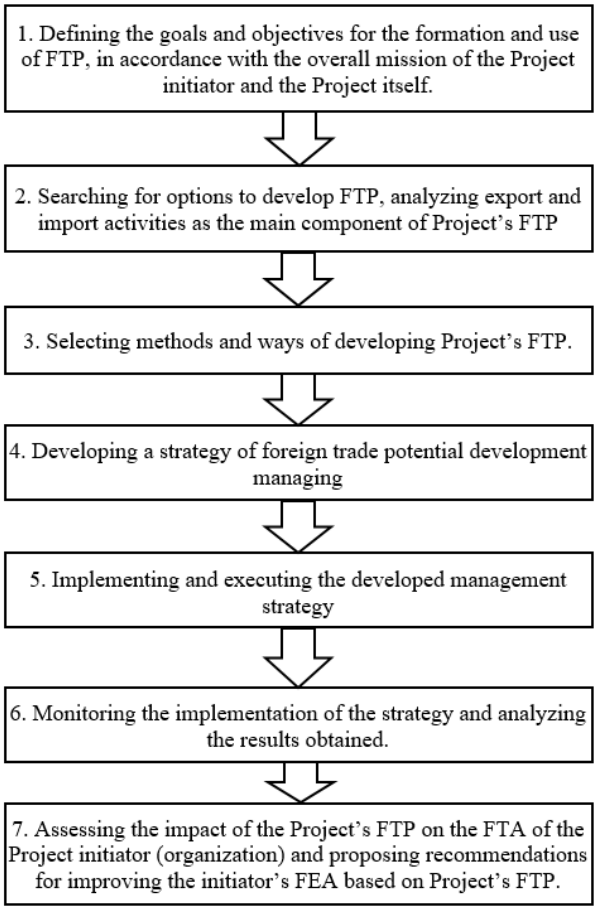


Figure 2. The algorithm of foreign trade potential development managing

Source: compiled by the author based on [2; 3].

According to Figure 2, the presented mechanism of foreign trade potential development managing enables the effective development and improvement of Project's FTP, which has a positive impact on innovative project initiator's FTA.

Conclusion

We have systematized the approaches to assessing innovative project's foreign trade potential. Methods of assessing innovative project's foreign trade potential include, firstly, the analysis of the internal and external foreign trade potential and, secondly, the evaluation of innovative project's foreign trade potential.

The analysis of internal and external foreign trade potential leads to the formation of a forecast scenario for the development of company's foreign economic activity and the innovative project itself.

Within the scope of this study, we have examined the methods of evaluating innovative project's foreign trade potential, which is defined by the system of indicators characterizing the export and import operations efficiency.

In accordance with the algorithm of foreign trade potential development managing proposed by the author, it becomes possible to effectively develop and improve innovative project's foreign trade potential, that has a positive effect on innovative project initiator's foreign trade activity.

REFERENCES

1. Bursa I. A., Takhumova O. V. Innovatsionno-investitsionnyy analiz i otsenka proyektov: uchebnoye posobiye [Innovation and investment analysis and project evaluation: a textbook]. 2nd ed. Krasnodar: Print-Terra Publ., 2021. 113 p. (in Russian)

2. Kobilev A. G., Seredin M. I. Kriterii otsenki vneshnetorgovogo potentsiala promyshlennogo predpriyatiya [Criteria for assessing the foreign trade potential of an industrial enterprise]. Vestnik RGEU RINKh, 2016, No. 3 (55). Available at: https://cyberleninka.ru/article/n/kriterii-otsenki-vneshnetorgovogo-potentsiala-promyshlennogo-predpriyatiya (accessed 21.02.2026). (in Russian)

3. Manukalo A. V. Metodicheskiye podkhody k otsenke effektivnosti vneshneekonomicheskoy deyatelnosti agropromyshlennykh kompaniy [Methodological approaches to assessing the effectiveness of foreign economic activity of agro-industrial companies]. Ekonomika, predprinimatelstvo i pravo, 2024, Vol. 14, No. 10, pp. 5801-5810. DOI: 10.18334/epp.14.10.121874 (in Russian)

4. Petrova E. E., Arapov S. V., Bikesina T. V. Investitsionnyy analiz: uchebnoye posobiye [Investment analysis: a textbook]. Saint Petersburg: RSHMU Publ., 2021. 220 p. (in Russian)

5. Salimyanova I. G., Valiakhmetov I. R. Innovatsionnyy menedzhment: uchebnoye posobiye [Innovation management: a textbook]. Ed. by A. G. Bezdudnaya. 2nd ed. Saint Petersburg: SPbSEU Publ., 2023. 265 p. (in Russian)

6. Shashlo N. V., Kuzubov A. A. Vneshneekonomicheskaya deyatelnost predpriyatiya: uchebnoye posobiye [Foreign economic activity of an enterprise: a textbook]. Vladivostok: VSUES Publ., 2017. 304 p. (in Russian)

7. Shved A. V. Kategorii vneshney torgovli: definitsii i podkhody k statisticheskoy otsenke [Categories of foreign trade: definitions and approaches to statistical assessment]. Voprosy statistiki, 2018, No. 25 (8), pp. 43–51.

THE IMPACT OF THE INTRODUCTION OF A FAST PAYMENT SYSTEM ON REDUCING THE COSTS OF TRADE ORGANIZATIONS

V. K. Zaplatinskaya, A. V. Nosanova

Research advisor: A. V. Shmakov, Cand. Sc. (Econ.)

Novosibirsk, Novosibirsk State Technical University,
Vzaplatinskay@mail.ru

Abstract. This article examines the impact of the transition to QR code payment on retailer cost dynamics. It focuses on the economic impact of implementing the Faster Payment System as an alternative to traditional cashless payment methods. Using current data from the Bank of Russia on pricing policy and transaction volumes, a comparative analysis of payment service costs is conducted, identifying potential for reducing costs for small and medium-sized businesses. In conclusion, the implementation of the Faster Payment System in cash management services creates the conditions for optimizing cash flows and increasing the profitability of retail businesses.

Keywords: fast payment system, cost optimization, tariff policy, small and medium-sized businesses.

ВЛИЯНИЕ ВНЕДРЕНИЯ СИСТЕМЫ БЫСТРЫХ ПЛАТЕЖЕЙ НА СНИЖЕНИЕ ИЗДЕРЖЕК ТОРГОВЫХ ОРГАНИЗАЦИЙ

В. К. Заплатинская, А. В. Носанова

Аннотация. В статье рассматривается трансформация структуры издержек торговых предприятий под влиянием перехода на оплату по QR-кодам. Основное внимание уделяется анализу экономического эффекта от внедрения Системы быстрых платежей как альтернативы традиционным методам безналичных расчетов. На основе актуальных данных Банка России о тарифной политике и объемах операций проводится сравнительный анализ стоимости платежных услуг, который выявляет резервы для снижения размера издержек субъектов малого и среднего предпринимательства. В заключении получаем, что внедрение Системы быстрых платежей в расчетно-кассовое обслуживание формирует условия для оптимизации финансовых потоков и повышения доходности торгового бизнеса.

Ключевые слова: Система быстрых платежей, оптимизация затрат, тарифная политика, малый и средний бизнес.

The settlement infrastructure in the conditions of modern economic reality is becoming a significant factor of competitiveness for trade organizations, especially for small and medium-sized businesses. A significant item of operating expenses is the cost of servicing non-cash payments, which directly affects the final marginality of the business.

A qualitative shift in the structure of the national payment ecosystem has led to the introduction of a Fast Payment System by the Bank of Russia. The fast payment system is not just a technological innovation, but also a new payment instrument of the national payment system, which is focused on reducing the cost of money transfer operations. [4] This factor is especially important when observing the growing share of non-cash payments in retail turnover, as well as the tightening of the tax burden on banking services, including the abolition of VAT benefits for card transactions. [2]

The key difference between the traditional card acceptance system and payments through the Fast Payment System is the commission fee that is charged to the trading organization.

The main difference between the classic method and transactions through the Fast Payment System is the scheme of charging a commission from the seller. The primary difference between the traditional method and transactions through the Faster Payment System is the way the merchant charges the commission. Processing bank card payments requires the merchant to pay a commission, which ranges from 1.5% to 2.5% of the transaction amount, and in certain segments, such as e-commerce, can reach 5%. Experts point out that the significant commission is primarily due to banks' need to cover the costs of loyalty programs. These programs, which include cashback and bonus points, cost banks over 500 billion rubles in 2025 alone. [5]

The Faster Payments system offers a fundamentally different pricing model. The maximum commission for transfers to legal entities or sole proprietors is set at 0.7% of the transaction amount. For microenterprises, defined by an annual turnover of up to 30 million rubles, the commission threshold is reduced to 0.4%. [1] The fast payment system does not cancel other payment methods, customers can also pay with cards. [3] When switching to a Fast Payment System, the current regulations do not imply a complete abandonment of cash registers. This factor somewhat reduces the expected effect of saving on equipment.

As a result, the Fast Payment System becomes the main tool for business optimization. Trade organizations can use the saved funds to develop and increase competitiveness in the digital environment.

REFERENCES

1. Tikhonov, R. QR code instead of terminal: how the fast payment system is changing the economy of small businesses and how much entrepreneurs actually save / R. Tikhonov. — Text: electronic // Clerk.ru: [website]. — URL: https://www.klerk.ru/buh/articles/ 654487/ #chapter-ot-10-do-30-oborota-qr-platezhi-v-malom-biznese-nabirayut-ve (date of access: 02.24.2026).

2. Sberbank warned about an increase in tariffs for small and medium-sized businesses due to the cancellation of the acquiring privilege. — Text: electronic // Center for Entrepreneurship Development of the Moscow Region: [website]. — URL: https:// mspmo.ru/news/sberbank-predupredil-o-roste-tarifov-dlya-msp-iz-za-otmeny-lgoty-na-ekvayring / (date of access: 02.24.2026).

3. Kontur clients.Banks can save on fees by accepting payments through the Fast Payment System. — Text: electronic // Contour Bank: [website]. — URL: https://kontur.ru/bank/ news/82648-sekonomit_na_komissiyah (date of access: 02/24/2026).

4. Khromchenko, M. D. Financial and legal regulation of the fast payment system / M. D. Khromchenko. — Text: electronic // LAWYER publishing group: [website]. — URL: https://lawinfo.ru/articles/8871/finansovo-pravovoe-regulirovanie-sistemy-bystryx-platezei (date of access: 02.24.2026).

5. For small businesses, they ask to limit the commission for acquiring. — Text: electronic // Clerk.ru: [website]. — URL: https://www.klerk.ru/buh/news/673417 / (date of access: 02.24.2026).

BUSINESS ADMINISTRATION AND ENTREPRENEURSHIP

METHODOLOGY FOR COMPREHENSIVE DIAGNOSTICS OF THE PERSONNEL ADAPTATION SYSTEM IN THE INDUSTRIAL SECTOR: A QUALITATIVE-QUANTITATIVE APPROACH

Y. A. Akhmadulina

Research advisor: T. Y. Kaloshina, Cand. Sc. (Sociology)

Novosibirsk, *Novosibirsk State Technical University*,
yulia.akhmadulina@yandex.ru

Abstract. In conditions of high competition for qualified personnel and increasing staff turnover in manufacturing enterprises, the task of objective and in-depth diagnostics of new employee adaptation systems is particularly acute. The article presents a comprehensive research methodology that combines quantitative and qualitative methods for a comprehensive assessment. The proposed methodology can be applied in other industrial enterprises.

Keywords: personnel adaptation, industrial sector, research methodology, personnel assessment, staff turnover, qualitative-quantitative approach, comprehensive diagnostics.

МЕТОДОЛОГИЯ КОМПЛЕКСНОЙ ДИАГНОСТИКИ СИСТЕМЫ АДАПТАЦИИ ПЕРСОНАЛА В ПРОМЫШЛЕННОМ СЕКТОРЕ: КАЧЕСТВЕННО-КОЛИЧЕСТВЕННЫЙ ПОДХОД

Ю. А. Ахмадулина

Аннотация. В условиях высокой конкуренции за квалифицированные кадры и роста текучести персонала на производственных предприятиях особенно остро встает задача объективной и глубокой диагностики систем адаптации новых сотрудников. В статье представлена методология комплексного исследования, сочетающая количественные и качественные методы для всесторонней оценки. Предложенная методология может быть применена на других промышленных предприятиях.

Ключевые слова: адаптация персонала, промышленный сектор, методология исследований, оценка персонала, текучесть кадров, качественно-количественный подход, комплексная диагностика.

Despite the widespread recognition of the importance of adaptation in the theory of personnel management, in practice many industrial enterprises still use fragmented, informal or universal approaches that do not take into account the specifics of different categories of employees. At the same time, the traditional method of assessing staff turnover often does not allow us to identify the underlying causes of unsuccessful adaptation, limiting ourselves only to stating the fact of the employee's departure.

Modern research in the field of HR analytics increasingly points to the need for complex, multi-level methodologies combining quantitative and qualitative methods to obtain a holistic picture of organizational processes.

Personnel adaptation is traditionally considered in the scientific literature as a multi-level process that includes the professional, organizational, socio-psychological and cultural integration of a new employee into the work process [1]. An effective adaptation process minimizes the psychological discomfort of a new employee, directly leads to faster achievement of full productivity and contributes to the formation of a positive attitude towards the organization, which together is a key factor in reducing the level of early staff turnover [2]. In industrial production conditions, where novice mistakes can lead to equipment downtime, lower product quality, or even safety risks, the structuring of this process is of particular importance.

In the modern practice of HR diagnostics, various research approaches are used to evaluate the adaptation system, each of which has its own unique resolution and limitations.

Quantitative methods such as the analysis of operational metrics and standardized questionnaires are the most common. Their key advantage is their objectivity and scalability. They allow to [3-6]:

– organize mass research;

– get numerical indicators suitable for statistical analysis, comparisons between departments or tracking dynamics over time;

– identify common, statistically significant trends and correlations.

In turn, qualitative methods such as semi-structured interviews, focus groups and observation, on the contrary, are designed to find answers to the «how» and «why» questions. They provide contextualized material and [3-4, 7]:

– reveal the subjective experiences, motives, emotions and informal practices of the participants in the process;

– allow to explore norms and «unwritten rules», which are often more important than formal regulations;

– provide an opportunity to hear from employees themselves, which is crucial for designing solutions.

In the context of the diagnosis of an adaptation system in an industrial enterprise, a mixed approach is a methodological necessity, since it provides a transition from a superficial statement of problems to the formation of a holistic, evidence-based and, most importantly, practically applicable diagnostic picture that serves as a reliable foundation for designing changes.

To assess the effectiveness of the personnel adaptation system of the industrial enterprise «R», which is focused on government defense orders, a system of indicators has been developed that reflects various aspects of the adaptation process and its results. The system of indicators is grouped into functional blocks, each of which reflects a different aspect of staff adaptation and is presented in table 1.

Table 1 – System of indicators for evaluating the effectiveness of adaptation of personnel of the enterprise «R»

Indicator group	Indicator	Content indicator
Personnel	Staff turnover rate	Reflects the intensity of staff outflow
	Staff turnover rate due to unsuccessful adaptation	Characterizes the proportion of layoffs related to adaptation
Adaptive	Time for an employee to return to stable performance of duties	Reflects the speed of professional entry
Socio-organizational	Availability of adaptation regulations	Characterizes the formalization of the adaptation process
	Feedback during the adaptation period	Reflects the manageability of the adaptation process

The analysis of the indicator system shows that personnel indicators, primarily staff turnover rate and staff turnover rate due to unsuccessful adaptation are important in assessing the effectiveness of personnel adaptation at the enterprise «R». It is these indicators that make it possible to quantify the consequences of the shortcomings of the adaptation process. At the same time, the inclusion of adaptation and organizational indicators ensures a comprehensive assessment and allows you to take into account not only the result, but also the conditions in which personnel adaptation is carried out.

Therefore, to study the problem of an inefficient personnel adaptation system in a manufacturing enterprise, it is most appropriate to use a mixed approach

combining quantitative and qualitative methods. The chosen methodology is effective because it directly corresponds to the practice-oriented task of the study: qualitative methods provide material for designing specific improvements and quantitative methods provide measurable metrics for substantiating decisions and subsequent evaluation of the results of implementation, ensuring the integrity, evidence-based and practical applicability of the conclusions of the work.

REFERENCES

1. Buleev I., Bryukhovetska N., Korytko T., Piletska S., Patlachuk V. (2023) Evaluation of the levelof personnel adaptation to enterprises intellectualization in termes of the economy digitalization. Management theory and studies for rural business and infrastructure development, 45 (1), 94-104.

2. Smirnov V. V., Semenov V. L., Zakharova A. N., Patianova A. O., Yaklashkin M. N. (2019) Improvement of the personnel adaptation system of Russian enterprises. Advances in social science, education and humanities research, 333, 768-772.

3. Zolotina O. A., Filatova A. M. (2021) Rezervy ispol'zovaniya kadrovoy analitiki dlya povysheniya effektivnosti motivatsii personala v organizatsiyakh [Reserves for using HR analytics to increase the effectiveness of staff motivation in organizations]. Epomen [Epomen], 58, 73-80 (in Russian).

4. Pyatsheva E. N., Orlova A. F. (2023) Perspektivnye napravleniya razvitiya kadrovoy analitiki na predpriyatiyakh [Promising areas for the development of HR analytics in enterprises]. Vestnik RGGU. Seriya «Ekonomika. Upravlenie. Pravo» [Bulletin of RSUH. The series «Economics. Management. Right»], 2, 29-41 (in Russian).

5. Vozmilkina E. N. (2017) Spetseficheskie metody issledovaniya v sotsial'noy rabote [Specific research methods in social work]. Novaya nauka: Problemy i perspektivy [New science: problems and prospects], 2 (3), 105-108 (in Russian).

6. Bodrova Y. N. (2019) Anketirovanie kak metod nauchnogo issledovaniya [Questioning as a method of scientific research]. Ponyatiynyy apparat nauchnogo issledovaniya: sbornik nauchnykh statey. Ekaterinburg [The conceptual framework of scientific research: a collection of scientific articles. Ekaterinburg], 3, 20-25 (in Russian).

7. Gasiev V. I., Kabisov S. A., Nugzarova M. R. (2017) Preimushchestva interv'yu kak metoda sotsiologicheskikh issledovaniy [Advantages of interviews as a method of sociological research]. Professional goda 2017 [Professional of the year 2017], 118-121 (in Russian).

ANALYSIS OF STRENGTHS AND WEAKNESSES OF THE INNOVATION POTENTIAL OF THE NOVOSIBIRSK REGION

D. D. Chebotar

Research advisor: E. S. Gorevaya, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
dariachebotar22@yandex.ru

Abstract. The article provides a comprehensive analysis of the innovation potential of the Novosibirsk Region based on data from leading rating systems (the Higher School of Economics, the National Rating of NTR, the Regional Scale of Innovation Development). The region's sustainable competitive advantages are identified: high quality of innovation policy, developed human resources potential, and an effective system of state financial support. The problems are systematized: the gap between scientific developments and their commercialization, a deficit of extra-budgetary financing, and infrastructural limitations. Special attention is paid to analyzing the consequences of the identified imbalances for the development of youth technological entrepreneurship. The article emphasizes the need for balanced development of all components of the innovation ecosystem to fully realize the unique potential of the region.

Keywords: innovation potential, Novosibirsk Region, commercialization of innovations, technology transfer, youth entrepreneurship, regional innovation policy, innovation development ratings.

АНАЛИЗ СИЛЬНЫХ И СЛАБЫХ СТОРОН ИННОВАЦИОННОГО ПОТЕНЦИАЛА НОВОСИБИРСКОЙ ОБЛАСТИ

Д. Д. Чеботарь

Аннотация. В статье представлен комплексный анализ инновационного потенциала Новосибирской области на основе данных ведущих рейтинговых систем (Высшая школа экономики, Национальный рейтинг НТР, Региональная шкала инновационного развития). Выявлены устойчивые конкурентные преимущества региона: высокое качество инновационной политики, развитый кадровый потенциал и эффективная система государственной финансовой поддержки. Систематизированы проблемы: разрыв между научными разработками и их коммерциализацией, дефицит внебюджетного финансирования и инфраструктурные ограничения. Особое внимание уделено анализу последствий выявленных дисбалансов для развития молодёжного технологического предпринимательства. В статье подчёркивается необходимость сбалансированного развития всех компонентов инновационной экосистемы для полной реализации уникального потенциала региона.

Ключевые слова: инновационный потенциал, Новосибирская область, коммерциализация инноваций, трансфер технологий, молодёжное предпринимательство, региональная инновационная политика, рейтинги инновационного развития.

Introduction

In the current context of the pursuit of technological sovereignty, the problem of creating an effective innovation environment in Russian regions is of particular relevance. The Novosibirsk Region has traditionally been one of Russia's leading scientific and educational centers. According to the results of 2024, the region ranked 5th in the National Science, Technology and Innovation (STI) Development Rating and 6th in the HSE University's Ranking of Innovative Development of Russian Regions [1, 3].

However, as data from various rating systems show, high scientific potential does not always translate into real innovative products. The aim of this article is to identify, based on a comprehensive analysis of current statistical data and rating assessments, the strengths and weaknesses of the innovation potential of the Novosibirsk Region and to pinpoint systemic imbalances.

1. Theoretical foundations: the concept of innovation potential

In modern research, the innovation potential of a region is understood as a system of multiple interrelated elements. An effective method to diagnose it, according to M.A. Barinov, is the graph-analytical method: constructing a polygon of forces that visualizes the strengths and weaknesses of a region and allows tracking their changes over time [2].

In this study, innovation potential is understood as the overall capacity of a region to generate, adopt, and implement innovations, including intellectual, human, financial, infrastructural, and institutional resources, as well as mechanisms for their effective use to achieve socio-economic development goals.

2. Methodology

The work uses data from three authoritative rating systems:

1. HSE University Ranking of Innovative Development of Russian Federation’s Subjects, which includes five sub-indices: socio-economic conditions of innovation activity, scientific and technical potential, innovation activity, export activity, and quality of innovation policy [1].

2. National Science, Technology and Innovation (STI) Development Rating – 43 indicators grouped into three blocks: public authorities, environment for knowledge-intensive businesses, environment for researchers [3].

3. Regional Innovation Development Scale – assessment across six areas: human resources, financial support, infrastructure, research and development, technology transfer and commercialization, and socio-economic effects [4].

This set of sources allows for a comprehensive and objective assessment of the innovation potential of the Novosibirsk Region.

3. Strengths of the region's innovation potential

3.1. Quality of innovation policy. Throughout the entire analyzed period (2015–2024), the Novosibirsk region ranks consistently high in the quality of innovation policy. This indicates that an exemplary institutional environment for entrepreneurship development has been created in the region, the administrative team competently develops strategy and contributes to the federal scientific and technical policy.

3.2. Human resources potential. According to rating systems, the Novosibirsk Region belongs to the group of regions with the highest rank in terms of human resources potential. This is due to the presence of Akademgorodok, strong universities, and a high concentration of researchers.

3.3. Socio-economic effects.

An important positive result is the high assessment of socio-economic effects from innovation activity. The presence of a strong scientific base positively affects the standard of living, employment, and budget revenues of the region in comparison with other subjects of the Russian Federation. The dynamics of socio-economic conditions are also positive: the region made a leap from 38th place in 2017 to 5th place in 2024 according to HSE data, primarily due to the growth of educational potential and lifelong learning coverage.

4. Weaknesses and systemic problems

4.1. Innovation activity: the gap between science and commercialization – The "Achilles' Heel". The most critical problem of the region is the low efficiency of innovation activity with high scientific potential. In the "Innovation activity" sub-index of the HSE University ranking, the region's positions range from 47th place (2018) to 25th place (2024). Technoparks and business incubators do exist, but the mechanisms for transferring technologies to the real sector operate function sporadically.

4.2. Deficit of private financing. The National STI Rating 2024 records a number of indicators with low values:

1. The share of R&D expenditures from the regional budget – despite high policy quality, real budget funds are allocated in small amounts relative to the total expenditures of the region.

2. The share of extra-budgetary investments in university startups – venture investors and businesses do not actively invest in local startups; young teams predominantly rely on grants.

3. The low growth rate of business sector funds in R&D – business does not increase research funding. The region ranked 36th in the country for the share of business in R&D financing in 2024 according to HSE University ranking data.

4.3. Export Activity. According to HSE University data, there is a low share of exports in the volume of innovative products, despite a fairly high overall level of export activity. Either raw materials are exported, or the technologies are sold as services rather than finished innovative products with high added value.

4.4. Infrastructural Limitations. Despite the presence of technoparks and incubators, the technological equipment available to researchers remains at a fairly good level, while the share of new machinery and equipment (in total fixed assets) is low.

5. Consequences for Youth Technological Entrepreneurship

The identified imbalances determine the specifics of youth entrepreneurship development in the region. On the one hand, young people operate in an environment with high scientific potential, state grant support, technoparks, and business incubators, while the high quality of the institutional environment reduces administrative barriers. On the other hand, there are threats and limitations. Large businesses are not ready to finance young startups, capacities for pilot production are becoming obsolete, patents and developments are difficult to commercialize – there are no effective intermediaries.

As a result, although a talent pool exists and ideas are generated with grant support, at the commercialization stage the project either fails during the 'idea to prototype' phase or relocates to a region with private demand and investors (e.g., Moscow, Tatarstan). It is easy to start in the Novosibirsk Region, but scaling and selling innovations is more difficult.

Conclusion

The Novosibirsk Region represents an example of a region with a "broken innovation chain." On the one hand – powerful scientific potential, strong human resources, a high-quality institutional environment, and state support. On the other hand, there is a lag in commercialization, a deficit of private investment, weak technology transfer, and low youth participation.

Science and policy work excellently, but business and production are not ready to absorb and scale innovations. For youth technological entrepreneurship, this creates a situation where it is easy to start, but extremely difficult to grow into a successful business.

Solving the identified problems requires shifting the focus of regional policy from supporting only science to creating effective commercialization mechanisms, attracting private investment, and building a seamless system of "idea – development – prototype – market." Only with balanced development of all components of the innovation system will the region be able to fully realize its unique potential.

REFERENCES

1. Abashkin V. L., Abdrakhmanova G. I., Artyomov S. V., et al. (2025) Reiting innovatsionnogo razvitiya subektov Rossiiskoi Federatsii [Rating of innovative development of the regions of the Russian Federation]. *Natsionalnyi issledovatelscii universitet «Vysshaia shkola economiki»* [*National Research University of Higher School of Economics]*. URL: https://issek.hse.ru/news/1068199937.html (accessed 15.02.2026).

2. Barinov M.A. (2025). Kharakteristika sostovlyaushih innovationnigo potenciala: regionalnyi aspect [Characteristics of the components of innovation potential: regional aspect]. *Vestnik Severo-Kavkazskogo federalnogo universiteta* [*Bulletin of the North Caucasus Federal University]*, No. 3, pp. 45-55. URL: https://vestnikskfu.elpub.ru/jour/article/view/2986 (accessed 10.01.2026).

3. Ministry of Science and Innovation Policy of the Novosibirsk Region (2025). Naucno-technologicheskoe razvitie Novosibirskoi oblasti: itogi, prioritety, zadachi, instrumenty. [Scientific and technological development of the Novosibirsk region: results, priorities, tasks, tools]. URL: https://nauka.nso.ru/sites/nauka.nso.ru/wodby_files/files/wiki/2025/02/ntr_nso_itogi_prioritety_zadachi_instrumenty.pdf (accessed: 09.02.2026)

4. Regionalnaia shkala razvitiai innovatcii (Regional scale of innovation development). Available at: https://iregions.ru/reiting/regionalnyy-indeks-razvitiya-innovatsiy-i-index/I_Scale_2024.pdf (accessed: 09.02.2026)

DEBTOR SEGMENTATION BASED ON PAYMENT BEHAVIOR

E. M. Chernova

Research advisor: B. A. Shakhmanova, Cand Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
big.lisa0115@mail.ru

Abstract. This article examines the segmentation of debtors based on payment behavior as a tool for improving a company's financial stability. Unlike traditional approaches focused on retrospective analysis, it proposes a dynamic model for classifying clients based on regular monitoring of behavioral patterns. Special attention is given to integrating segmentation with the company's pricing policy and using preventive measures before critical overdue payments occur.

Keywords: accounts receivable, payment behavior, dynamic segmentation, pricing policy, financial stability, risk management.

СЕГМЕНТАЦИЯ ДЕБИТОРОВ ПО ПЛАТЕЖНОМУ ПОВЕДЕНИЮ

Е. М. Чернова

Аннотация. В статье рассматривается сегментация дебиторов на основе платежного поведения как инструмент повышения финансовой устойчивости предприятия. В отличие от традиционных подходов, ориентированных на ретроспективный анализ, предлагается динамическая модель классификации клиентов, базирующаяся на регулярном мониторинге поведенческих паттернов. Особое внимание уделяется интеграции сегментации с ценовой политикой компании и использованию превентивных мер до возникновения критической просрочки.

Ключевые слова: дебиторская задолженность, платежное поведение, динамическая сегментация, ценовая политика, финансовая устойчивость, управление рисками.

Introduction

Managing accounts receivable is a critical element of financial management for any modern enterprise operating in the B2B or B2C segment with deferred payment terms [2]. In an environment of market volatility and limited liquidity, accounts receivable is no longer just a bookkeeping line item but becomes an asset requiring active management [1]. Extending trade credit is an effective tool for boosting sales and increasing customer loyalty; however, it inevitably carries credit risks [4].

Traditional methods of managing accounts receivable often boil down to analyzing the average payment period and reacting to overdue payments after they have already occurred [2]. However, this approach does not allow for proactive measures. The aim of this study is to develop and substantiate a dynamic model for debtor segmentation. This model classifies clients not only by their financial indicators but also by their "behavioral profile," enabling flexible adjustments to pricing policy and shipping terms.

1. Limitations of the Traditional Segmentation Model

Traditional debtor segmentation (often based on ABC analysis by debt volume or XYZ analysis by purchase stability) has several critical drawbacks [1]:

Reactivity. Classic monitoring systems only trigger when a payment is already a certain number of days overdue. By that time, the client's financial situation may have deteriorated to the point where collection becomes impossible.

Static Nature. A client's assigned rating or risk group is often reviewed no more than once a quarter or year. In today's reality, a debtor company can go from a reliable partner to bankruptcy within such a period.

Ignoring "Soft" Signals. Traditional models fail to account for factors such as changes in response time to manager calls, delays in signing reconciliation statements, or the splitting of previously consolidated payments into smaller transactions [3].

Disconnect from the Commercial Unit. The accounting and finance departments may identify a risk, but the sales department continues to ship goods under the same terms because their KPIs are tied to revenue volume, not incoming cash flow [5].

2. A Dynamic Model for Debtor Segmentation

A dynamic model implies a continuous analysis cycle. Unlike a static approach where a segment is a "label," in a dynamic model, a segment represents the client's current state within a "risk/profitability" coordinate system [4].

Key principles of the dynamic approach:

- Regular Review: Automated recalculation of a credit score based on each transaction.
- Analysis of Behavioral Vector: Not only the fact of current payment matters, but also whether the client is paying faster or slower compared to the previous period.
- Sensitivity to Communications: Assessing how quickly a client confirms outstanding debt and responds to reminders.

Let us consider several scenarios demonstrating the advantage of dynamic analysis over static analysis.

Example 1: Identifying "Hidden Deterioration"

Company "Alpha" always pays on time (within the 30-day grace period). However, a detailed analysis shows that a year ago they paid on the 20th day, six months ago on the 25th, and in the last month, strictly on the 30th.

- Static Model: Client is in the "green zone," no risk.
- Dynamic Model: Negative trend. The system signals the need to check the counterparty's financial statements or reduce the credit limit, as there are clear symptoms of a liquidity shortage [2; 3].

Example 2: Response to Reminders

Two clients are 5 days overdue on a payment.

- Client A answered the phone call, sent a copy of the payment order, and settled the debt within 2 hours.
- Client B ignored the email and, when contacted by phone, cited "technical errors at the bank."

Result: Despite the same overdue period, the dynamic model immediately places Client B into a higher-risk category, requiring a suspension of subsequent shipments.

3. Debtor Classification and Management Strategies

For effective management, it is necessary to divide the debtor base into groups, each requiring a specific set of tools.

Disciplined Payers

Characteristics: Payments are made strictly on time or ahead of schedule. The overdue rate is near zero [1].

Management Strategy:

- Maximum Loyalty: Offering flexible payment terms.
- Pricing Preferences: Minimal markup, as the cost of servicing this debt for the company is minimal.
- Credit Limit Expansion: Ability to purchase larger volumes or premium goods [4].

Clients with Unstable Behavior

Characteristics: Occasional delays (up to 7–10 days), likely caused by the counterparty's poor cash flow planning rather than insolvency [3]. Often forget to pay until reminded.

Management Strategy:

- Automated Reminders: Using SMS, email, and phone alerts 3 days before the due date and on the first day of delinquency.
- Educational Measures: Strict enforcement of penalties even for minor delays. If penalties are regularly waived, the client gets accustomed to using the supplier as a free bank.
- Monitoring: If the frequency of delinquencies increases, the client is automatically moved to category 3.3.

Habitual Debtors

Characteristics: Regular delinquencies exceeding 15–30 days. The client cites temporary difficulties, but the situation repeats month after month. The average payment period constantly increases [3].

Management Strategy:

- Limiting: Strict enforcement of credit limits. New shipments are only possible after the previous debt is cleared.
- Documentary Control: Switching to legally significant electronic document management to eliminate excuses like "we didn't receive the original invoice".
- Risk Component in Price: Setting special prices 3–5% higher than the base rates. This markup serves as an "insurance fund" to cover future collection costs.
- Legal Prevention: Preparing claim letters immediately upon reaching a critical overdue threshold.

Problem Debtors

Characteristics: Prolonged delinquencies (exceeding 60–90 days), evasion of contact, existence of lawsuits from other creditors [3].

Management Strategy:

- Complete Cessation of Credit Shipments: Operating only on 100% prepayment.
- Active Collection: Immediate referral of the case to the legal department or a collection agency.
- Restructuring: In exceptional cases, signing a repayment schedule with the mandatory provision of a personal guarantee from the owners or collateral.
- Pricing Policy: If cooperation continues (e.g., the client is monopolist in a certain segment), the price must include a maximum risk premium, covering not only legal costs but also the cost of frozen capital at the alternative rate of return.

4. Integrating Segmentation and Pricing Policy

The proposed approach involves incorporating the client's credit risk into the pricing mechanism.

Within the model:

- Standard terms are maintained for disciplined clients.
- An additional price adjustment is introduced for higher-risk clients.
- Terms are reassessed if payment behavior improves.

Thus, accounts receivable management becomes an integral part of the company's overall financial strategy.

5. Preventive Measures and Document Flow Control

Effective segmentation is impossible without quality operational support. The dynamic model requires a special approach to documentation:

1. Legal Soundness. For clients in categories 3.3 and 3.4, contracts must stipulate increased penalties, the possibility of direct debit, and clear conditions for suspending shipments.

2. Control of Primary Documents. Lawsuits are often lost not because the debt doesn't exist, but because acceptance certificates are signed by unauthorized persons. For high-risk segments, enhanced control is required: photographic documentation of shipments, real-time verification of powers of attorney.

3. Information Hygiene. Regular updating of counterparty profiles. A change in legal address or the composition of founders should trigger an automatic temporary reduction of the credit limit pending further investigation.

Conclusion

The transition from static analysis of accounts receivable to dynamic segmentation based on payment behavior allows an enterprise to transform its risk management system from reactive to proactive.

The main conclusions of the study are:

1. Dynamism is Key to Stability. Regularly reviewing a client's status makes it possible to spot signs of a counterparty's financial crisis at an early stage, when effective collection or limit reduction is still possible.

2. Differentiation of Strategies. Each group of debtors requires its own set of tools – from loyalty programs for disciplined payers to strict price surcharges and legal pressure for habitual debtors.

3. Unity of Finance and Sales. Integrating segmentation into pricing policy allows for automated decision-making: a sales manager does not just see a "shipment ban" but understands at what price and payment terms a transaction with a risky client becomes economically viable.

REFERENCES

1. Blank I.A. (2016). Managing Enterprise Accounts Receivable. Nika-Center. (in Russian)
2. Kovalev V.V. (2019). Financial Management: Theory and Practice. Prospekt. (in Russian)
3. Savitskaya G.V. (2020). Analysis of Enterprise Economic Activity. Infra-M. (in Russian)
4. Brigham E., & Ehrhardt M. (2017). Financial Management: Theory and Practice (15th ed.). Cengage Learning.
5. Atrill P. (2021). Financial Management for Decision Makers (9th ed.). Pearson.

ECONOMIC ASPECTS AND MANAGEMENT APPROACHES TO THE IMPLEMENTATION OF TEMPERATURE-CONTROLLED CARGO TRANSPORTATION SYSTEMS

I. V. Guzhentsev

Research advisor: V. A. Poluektov, Cand Sc. (Econ.)

Novosibirsk, Novosibirsk State Technical University,
gujence-ivan@rambler.ru

Abstract. The article examines the economic and managerial aspects of organizing temperature-sensitive cargo transportation. It analyzes modern business models, including the "Cold Chain as a Service" (CaaS) concept. Special attention is paid to the

economic efficiency of implementing digital solutions in cold chain management. It is concluded that temperature-sensitive logistics is transforming from a cost center into a strategic factor for ensuring quality and competitiveness.

Keywords: Transport logistics, Refrigerated transportation, Cold chain, Digitalization.

ЭКОНОМИЧЕСКИЕ АСПЕКТЫ И УПРАВЛЕНЧЕСКИЕ ПОДХОДЫ К ВНЕДРЕНИЮ СИСТЕМ ТРАНСПОРТИРОВКИ ГРУЗОВ С ПОДДЕРЖАНИЕМ ТЕМПЕРАТУРНОГО РЕЖИМА

И. В. Гуженцев

Аннотация. В статье рассматриваются экономические и управленческие аспекты организации перевозок температурно-чувствительных грузов. Анализируются современные бизнес-модели, включая концепцию «холодовая цепь как услуга» (CaaS). Особое внимание уделяется вопросам экономической эффективности внедрения цифровых решений в управление холодовой цепью. Сделан вывод о трансформации логистики температурно-чувствительных грузов из центра затрат в стратегический фактор обеспечения качества и конкурентоспособности.

Ключевые слова: транспортная логистика, рефрижераторные перевозки, холодовая цепь, цифровизация.

Transportation of goods with temperature control is a critically important element of modern logistics infrastructure, ensuring food security and the functioning of the pharmaceutical industry. According to the forecast [1], the global refrigerated transport market will reach USD 194.2 billion by 2032, with a compound annual growth rate (CAGR) of over 6%. The Russian segment is also demonstrating steady positive dynamics [2, 3].

The relevance of researching the economic aspects of implementing temperature-controlled cargo transportation systems is driven by several factors: the high capital intensity of specialized equipment, sensitivity to energy tariffs, tightening regulatory requirements, and the emergence of new business models that are transforming traditional approaches to cold chain organization.

The aim of this work is a comprehensive study of the economic and managerial aspects of organizing temperature-controlled transportation.

The traditional approach to organizing the transportation of perishable goods was based on companies acquiring their own fleet of refrigerated vehicles, which required significant capital expenditures [4]. In modern conditions, a fundamental

shift is being observed towards the service model known as "Cold Chain as a Service" (CaaS). The CaaS concept involves a transition from fixed costs to variable costs based on the actual use of infrastructure. The economic attractiveness of this model is based on a number of key factors:

1. The manufacturer or retailer no longer invests in the construction of their own refrigerated warehouses or the purchase of refrigerated vehicles; instead, they gain access to the infrastructure of specialized operators.

2. Due to the consolidation of volumes, large specialized operators achieve lower specific energy costs per unit of output compared to the in-house services of manufacturers.

3. The model enables efficient management of seasonal demand fluctuations: peak loads (e.g., during harvest season) are accommodated without the need to maintain idle capacity during the rest of the year.

The CaaS concept involves the consolidation of services at the operator's terminal, which provides not only cooling but also shock freezing, repackaging, labeling, and customs clearance. Thanks to this "bundling," intermediate links are eliminated from the logistics chain, which minimizes the risks of temperature regime violations and reduces associated transaction costs.

A comparative analysis of the economic characteristics of the traditional and service-based models is shown in Table 1.

Table 1 – Comparison of economic models for cold chain organization

Metric	Traditional Model	Service Model (CaaS)
Cost structure	Mostly fixed	Variable
Infrastructure investment	Owned	None (capacity leasing)
Seasonality management	Surplus or shortage of capacity	Flexible scaling
Energy efficiency	Average (fragmented facilities)	High (economies of scale)
Risk of obsolescence	On client's balance sheet	On operator's balance sheet

Empirical studies demonstrate the high sensitivity of perishable goods even to short-term temperature deviations, which justifies the feasibility of integrating digital solutions into cold chain management. The implementation of digital technologies in the management of temperature-sensitive cargo transportation is becoming a critical driver for increasing the economic efficiency of the industry. This is confirmed by the dynamics of the global market for Internet of Things (IoT)-based cold chain management systems: by the end of 2024, its volume reached USD 7.21 billion, and by 2032 it is expected to grow to USD 18.85 billion, with a compound annual growth rate (CAGR) of 12.77% [1].

The transition to a service model is made possible precisely by the development of Internet of Things (IoT) tools, telematics, and predictive analytics. It is digital monitoring systems that enable the operator to track the condition of cargo and equipment at remote facilities in real time.

The economic effect of integrating digital solutions into cold chain management (Table 2) comprises several components:

1. Minimizing losses from cargo spoilage. Continuous real-time monitoring of temperature, humidity, and location makes it possible to promptly identify deviations from standard parameters and take timely corrective actions, thereby preventing cargo loss.

2. Optimization of energy consumption. Smart refrigeration management systems contribute to lower fuel usage in reefer trucks, whose consumption rates in conventional setups are substantially higher compared to standard freight vehicles.

3. Improved routing efficiency. The integration of telematics solutions with navigation platforms enables route planning based on current traffic conditions, thereby reducing delivery time and, consequently, lowering energy costs.

4. The automation of document flow and the use of robotic process automation (RPA) technologies for tracking cargo statuses reduce labor costs and minimize the impact of the human factor.

The economic effect of integrating digital solutions is presented in Table 2.

Table 2 – The Economic Effect of Integrating Digital Solutions into Cold Chain Management

Effect Dimension	**Implementation Mechanism**	**Economic Outcome**
Minimizing spoilage	Early detection of temperature deviations	Reduction of write-offs
Energy efficiency	Optimization of refrigeration equipment operation	Reduced fuel consumption
Route optimization	Telematics data analysis	Reduced mileage and delivery time
Labor costs	Automation of data collection and processing	Reduction in administrative payroll
Risk management	Predictive analytics	Prevention of insured events

At the same time, it should be noted that currently, digitalization in cold chain management is most successfully implemented in "long" supply chains involving large manufacturers and retailers. Financial barriers and a lack of expertise constrain the adoption of digital technologies in "short" and alternative chains, where small-scale agricultural producers and businesses operate. This creates a risk of

technological inequality and necessitates the development of simplified, scalable solutions for small and medium-sized enterprises, as well as the promotion of partnership platforms and process standardization.

The conducted analysis allows for the conclusion that there is a profound transformation underway in the temperature-sensitive cargo transportation market, driven by the "Cold Chain as a Service" (CaaS) service model and the pervasive digitalization of processes.

In conclusion, temperature-controlled logistics transcends its traditional role as a mere transportation service, transforming into a strategic instrument that underpins product quality, safety, and global competitiveness in response to rising market expectations.

REFERENCES

1. Refrigerated Transport Market Size. *Global Market Insights*. Available at: https://www.gminsights.com/ru/industry-analysis/refrigerated-transport-market (Accessed 21 February 2026).

2. Gruzy prodovolstvennoi bezopasnosti (Food Security Cargoes) *Index1520*. Available at: https://index1520.com/news/gruzy-prodovolstvennoy-bezopasnosti (Accessed 22 February 2026).

3. Gruzy prodovolstvennoi bezopasnosti (Food Security Cargoes). *NPK Trans*. Available at: https://www.npktrans.ru/media/novosti/gruzy-prodovol-stvennoi-bezopasnosti/ (Accessed 30 January 2026).

4. Kak organizovat perevozku skoropotyasheysya produkstii bez poter (How to Organize the Transportation of Perishable Products Without Losses). *TKS.ru*.Available at: https://www.tks.ru/pr/254950/ (Accessed 27 February 2026).

RISKS AND LIMITATIONS OF IMPLEMENTING LOW-CODE TECHNOLOGIES IN THE ECONOMIC SECTOR

D. Imambekova

Research advisor: G. Mukhanova, PhD (Economics)

Astana, *Astana IT University*, *Kazakhstan*,
dianaimambek@gmaill.com

Abstract. Low-code development platforms are increasingly used in the economic sector to accelerate digital transformation and reduce software development costs. By relying on visual modeling and reusable components, these platforms enhance development speed and organizational participation. However, existing research

highlights substantial risks related to vendor lock-in, scalability limitations, governance complexity, and security concerns. This paper analyzes the key technological, organizational, and economic constraints of low-code adoption and argues that sustainable economic benefits can be achieved only through strategic alignment and hybrid governance approaches.

Keywords: low-code development, economic sector, digital transformation, governance risks, scalability, vendor lock-in.

РИСКИ И ОГРАНИЧЕНИЯ ВНЕДРЕНИЯ LOW-CODE ТЕХНОЛОГИЙ В ЭКОНОМИЧЕСКОМ СЕКТОРЕ

Д. Имамбекова

Аннотация. Low-code платформы все активнее применяются в экономическом секторе для ускорения цифровой трансформации и снижения затрат на разработку программных решений. Использование визуального моделирования и повторно используемых компонентов повышает скорость создания приложений и вовлеченность сотрудников. Вместе с тем исследования выявляют существенные риски, связанные с зависимостью от поставщиков, ограниченной масштабируемостью, сложностями управления и вопросами безопасности. В статье анализируются ключевые технологические, организационные и экономические ограничения low-code подхода и обосновывается необходимость стратегического и гибридного управления для достижения устойчивой экономической эффективности.

Ключевые слова: low-code разработка, экономический сектор, цифровая трансформация, риски, масштабируемость.

1. Introduction

Digital transformation has become a critical driver of competitiveness in the economic sector, influencing finance, manufacturing, logistics, and service industries. Organizations increasingly seek rapid and cost-efficient software development approaches to support process automation and data-driven decision-making. Low-code development platforms (LCDPs) have emerged as a response to these demands by lowering technical barriers and enabling faster application delivery [4], [16].

Despite their growing popularity, the adoption of low-code technologies in economically critical domains raises concerns regarding long-term sustainability, governance, and economic efficiency. Existing studies emphasize that while low-code platforms enhance speed and accessibility, they also introduce structural

limitations that may undermine strategic flexibility and economic resilience [5], [14]. This paper aims to systematically examine the risks and limitations of implementing low-code technologies in the economic sector, drawing on recent multidisciplinary research.

2. Conceptual Foundations of Low-Code Development

Low-code platforms are commonly defined as visual development environments that allow users to create applications with minimal hand-coding through prebuilt components and declarative modeling [15]. From a software engineering perspective, low-code development shares conceptual roots with model-driven engineering, particularly in its emphasis on abstraction and automation [4], [6].

Recent literature conceptualizes low-code platforms not merely as tools, but as platform ecosystems that integrate infrastructure, reusable components, and governance mechanisms [16]. This ecosystem perspective is particularly relevant for the economic sector, where software systems are deeply embedded in organizational processes and inter-organizational value chains. However, the same ecosystem characteristics that enable reuse and rapid development also constrain flexibility and increase dependency on platform providers [17].

3. Economic Risks of Low-Code Adoption

3.1 Vendor Lock-In and Cost Escalation

One of the most frequently identified risks of low-code adoption is vendor lock-in. Many platforms rely on proprietary architectures, limiting portability of applications and data [16], [9]. While initial development costs may be lower, long-term economic consequences include rising licensing fees, restricted bargaining power, and high migration costs [13].

Empirical evaluations of low-code platforms indicate that total cost of ownership (TCO) often increases over time as organizations scale their applications and require advanced platform features [18]. These dynamics challenge the assumption that low-code solutions are inherently more economical than traditional development approaches.

3.2 Scalability and Performance Limitations

Low-code platforms are typically optimized for rapid development of small to medium-scale applications. When applied to high-volume economic systems-such as financial transaction processing or industrial automation-platform limitations may result in performance bottlenecks [14], [11].

Studies in process optimization and enterprise deployment demonstrate that organizations frequently adopt hybrid architectures, combining low-code front-end

components with traditionally coded back-end services to overcome scalability constraints [8]. While effective, this hybrid approach reduces the simplicity and cost advantages originally associated with low-code development.

4. Organizational and Governance Limitations

4.1 Shadow IT and Quality Control

The democratization of development through citizen developers is often presented as a key advantage of low-code technologies. However, research shows that insufficient governance can lead to fragmented application landscapes and shadow IT [17], [1]. In the economic sector, where process integrity and data accuracy are essential, uncontrolled application proliferation poses significant operational risks.

Balancing flexibility and standardization is therefore a central governance challenge. Excessive standardization may undermine innovation, while excessive flexibility increases technical debt and operational risk [17].

4.2 Skills, Capabilities, and Organizational Readiness

Although low-code platforms reduce the need for traditional programming skills, successful implementation still requires digital competencies, process knowledge, and governance capabilities [12]. Empirical studies indicate that organizations lacking these complementary capabilities experience lower adoption success and reduced economic benefits [7].

This finding is particularly relevant for small and medium-sized enterprises, where low-code adoption is often motivated by resource constraints rather than strategic alignment.

5. Technological and Security Constraints

Security and compliance represent critical concerns in the economic sector, especially in regulated industries. While low-code platforms often provide built-in security features, the abstraction of underlying code limits transparency and independent auditing [5], [3].

Additionally, integration with legacy systems remains a persistent challenge. Case studies of document management and enterprise workflow systems show that complex integrations frequently require custom development, reducing the efficiency gains of low-code approaches [8], [2].

6. Implications for the Economic Sector

The analysis indicates that low-code technologies are neither universally beneficial nor inherently risky. Their economic value depends on context, scale, and governance maturity. Low-code platforms are most effective in scenarios requiring

rapid prototyping, internal process automation, and limited scalability demands [13], [10].

For mission-critical economic systems, organizations should adopt hybrid development strategies that combine low-code flexibility with traditional engineering rigor. Such approaches enable organizations to mitigate risks while preserving the economic benefits of accelerated development.

7. Conclusion

Low-code technologies play an increasingly important role in the digital transformation of the economic sector by offering faster development cycles, reduced initial costs, and greater involvement of non-technical personnel in software creation. As demonstrated in this study, these platforms represent a strategic response to the growing demand for flexible and resource-efficient digital solutions in finance, manufacturing, and enterprise management. However, their adoption also introduces a set of significant risks and limitations that challenge the assumption of low-code as a universally optimal development approach.

From an economic perspective, vendor lock-in, long-term cost escalation, and limited strategic flexibility remain critical concerns, particularly due to the proprietary nature of many low-code ecosystems. Scalability and performance constraints further restrict the applicability of low-code platforms in mission-critical systems characterized by complex business logic and high transaction volumes. In addition, organizational risks related to governance, shadow IT, and quality control may undermine operational stability if citizen development is not supported by clear standards and oversight mechanisms. Security, compliance, and integration challenges also reduce transparency and may offset the short-term efficiency gains promised by low-code solutions.

Overall, this study confirms that low-code platforms should be regarded as complementary strategic instruments rather than complete substitutes for traditional software development. To achieve sustainable economic value, organizations must adopt hybrid development strategies that combine low-code flexibility with conventional engineering practices, robust governance frameworks, and realistic cost–benefit assessments. Future research should focus on quantitative evaluation models and industry-specific analyses to better assess the long-term economic impact of low-code adoption.

REFERENCES

1. AlSaadi H. A., Radain D. T., Alzahrani M. M., Alshammari W. F., Alahmadi D., Fakieh B. (2021) Factors that affect the utilization of low-code development platforms: Survey study. *Romanian Journal of Information Technology and Automatic Control*, 31(3), 123–140.

2. Austerjost J., Knöchelmann E., Kruse T., Kilian J., Quaas B., Olszowy M. W. (2025) Low code, high impact: Application of low-code platforms to enable and democratize digitalization and automation. *SLAS Technology*, 35, 100353.

3. Babar A., Sabahat N., Babar A., Qamar N., Abu-Zanona M., Al Khateeb A. M. A., ElZaghmouri B., Ahmed S. M. A., Rahamatalla L. H. (2025) AI in web development: A comparative study of traditional coding and low-code platforms. *International Journal of Advanced Computer Science and Applications*, 16(11), 936–948.

4. Bock A. C., Frank U. (2021) Low-code development and model-driven engineering: Two sides of the same coin? *Software and Systems Modeling*, 21, 437–446.

5. Bock A. C., Frank U. (2021) Low-code platform. *Business & Information Systems Engineering*, 63(6), 733–740.

6. Bucaioni A., Cicchetti A., Ciccozzi, F. (2022) Modelling in low-code development: A multi-vocal systematic review. *Software and Systems Modeling*, 21, 1959–1981.

7. Giraldo L., Laso S. (2025) Democratizing machine learning: A practical comparison of low-code and no-code platforms. *Machine Learning and Knowledge Extraction*, 7, 141.

8. Marian C. V., Neferu M., Mitrea, D. A. (2026) Design and evaluation of a low-code/no-code document management and approval system. *Information*, 17(1), 46.

9. Medeiros H., Moncayo J., Bezerra L., España F., Oliveira J. (2025) Optimizing business efficiency: The strategic potential of low-code tools in developing information management systems. *Journal of the Brazilian Computer Society*, 31(1).

10. Sahay A., Indamutsa A., Di Ruscio D., Pierantonio, A. (2020) Supporting the understanding and comparison of low-code development platforms. *IEEE Software*, 37(6), 43–49.

11. Shi Z., Dong J., Gan Y. (2025) Democratizing digital transformation: A multisector study of low-code adoption patterns, limitations, and emerging paradigms. *Applied Sciences*, 15, 6481.

12. Skandalis K. S. (2025) Digital entrepreneurial capability: Integrating digital skills, human capital, and psychological traits in modern entrepreneurship. *Encyclopedia*, 5, 154.

13. Smith L., de Vries M. (2025) Process optimisation using a low-code platform: Digitising a concession management process. *South African Journal of Industrial Engineering*, 36(4), 32–46.

14. Upadhyaya N. (2022) Low-code/no-code platforms and their impact on traditional software development: A literature review. *ResearchGate Preprint*. DOI: 10.13140/RG.2.2. 12291.92965.

15. Verma V., Shree, S. (2025) Low-code/no-code platforms: From concept to creation. *International Journal of Engineering Research & Technology*, 14(1).

16. Viljoen A., Hein, A., Krcmar, H. (2026) Low-code development platform ecosystems. *Electronic Markets*, 36, 12.

17. Viljoen A., Stelzl B., Yang M., Nguyen J., Hein A., Elshan E., Krcmar H. (2026) Navigating flexibility and standardisation in low-code/no-code development. *Information Systems Journal*, 36(1), 95–109.

18. Waszkowski R. (2025) Evaluating low-code development platforms with the CD score. *Scientific Reports*, 15, 38548.

19. Microsoft Copilot (2026). Enterprise AI–assisted knowledge synthesis and task automation: Capabilities, applications, and emerging practices. Microsoft Documentation & Research Portal.

PROJECT MANAGEMENT FOR BUILDING DATA-DRIVEN SIMULATION PLATFORMS

M. Kabdygaliyeva

Research advisor: G. Mukhanova, PhD (Economics)

Astana, *Astana IT University*,
moldirkabdygalieva@gmail.com

Abstract. This article examines the critical role of project management in developing data-driven simulation platforms for financial risk assessment. Employing a pragmatic, qualitative-dominant explanatory multiple-case study design, the research investigates how predictive, adaptive, and hybrid project management configurations influence the reliability, interpretability, and decision relevance of advanced analytical models. Findings indicate that hybrid methodologies, which integrate continuous validation within structured governance frameworks, successfully bridge the gap between algorithmic complexity and regulatory compliance, thereby ensuring sustainable organizational adoption.

Keywords. Project Management, Financial Risk Assessment, Simulation Platforms, MLOps, Artificial Intelligence, Hybrid Governance, Explainable AI.

УПРАВЛЕНИЕ ПРОЕКТАМИ ПО СОЗДАНИЮ ПЛАТФОРМ ИМИТАЦИОННОГО МОДЕЛИРОВАНИЯ, ОСНОВАННЫХ НА ДАННЫХ

М. Кабдыгалиева

Аннотация. В данной статье рассматривается ключевая роль управления проектами при разработке платформ имитационного моделирования, основанных на данных, для оценки финансовых рисков. Используя прагматичный, преимущественно качественный объяснительный дизайн исследования на основе

множества кейсов, автор анализирует, как предиктивные, адаптивные и гибридные конфигурации управления проектами влияют на надежность, интерпретируемость и релевантность для принятия решений сложных аналитических моделей. Результаты показывают, что гибридные методологии, объединяющие непрерывную валидацию в рамках структурированных систем управления, успешно устраняют разрыв между алгоритмической сложностью и соблюдением нормативных требований, обеспечивая тем самым устойчивое внедрение в организациях.

Ключевые слова. Управление проектами, оценка финансовых рисков, платформы имитационного моделирования, MLOps, искусственный интеллект, гибридное управление, объяснимый ИИ.

1. Introduction

The growing complexity of global financial systems, combined with stricter regulatory oversight and advances in large-scale data analytics, has transformed how financial institutions assess risk and evaluate credit scoring performance. In this context, data-driven simulation platforms have become essential analytical tools for financial risk assessment, macroeconomic stress testing, and scoring efficiency modeling. Unlike traditional static predictive models, these platforms allow institutions to simulate alternative economic scenarios, analyze borrower behavior, and forecast portfolio dynamics under financial stress.

However, traditional project management approaches—characterized by fixed requirements, linear development phases, and predefined deliverables—often fail to accommodate the dynamic nature of advanced analytics (Gay, 2025). When applied rigidly, such methodologies delay the detection of data anomalies and modeling biases. More adaptive and iterative approaches help manage analytical uncertainty through continuous feedback, yet in highly regulated financial environments excessive flexibility may create risks related to documentation, auditability, and regulatory compliance. This tension highlights the need to examine how different project management configurations influence the long-term effectiveness of data-driven simulation platform projects. By positioning project management as a central explanatory mechanism, this study seeks to bridge the gap between data science innovation and governance in the financial sector.

2. Literature Review

2.1 Data-Driven Simulation Platforms in Financial Risk Assessment

Data-driven simulation platforms have become central infrastructure in modern financial risk management. Credit risk assessment increasingly relies on integrating large-scale data systems, predictive analytics, and dynamic simulation environments.

Machine learning methods, including Random Forest, XGBoost, and LightGBM, consistently outperform traditional credit scoring models in predictive accuracy and stability [1]. Within simulation platforms, these models allow institutions to conduct macroeconomic stress testing and evaluate potential changes in credit risk profiles. However, higher predictive accuracy does not guarantee effective use in practice. Complex machine learning models are often perceived as "black boxes," limiting interpretability and potentially leading to flawed decisions [2]. As a result, simulation platforms should be viewed as socio-technical systems shaped by analytical design, organizational processes, and regulatory constraints.

Project management research distinguishes predictive (plan-driven), adaptive (agile), and hybrid approaches [3]. Predictive frameworks offer stability and clear planning but are often unsuitable for analytics projects where objectives evolve during data exploration.

Agile approaches emphasize iterative development and continuous feedback, yet they may conflict with strict documentation and audit requirements in financial institutions. Consequently, recent studies emphasize hybrid models that combine agile experimentation with structured governance. This approach aligns with Machine Learning Operations (MLOps), which integrates iterative model development with compliance and operational control [4].

2.2 The Regulatory and Governance Landscape

Data-driven simulation platforms operate within highly regulated financial environments. The European Banking Authority provides guidance on model risk management, while the EU AI Act introduces strict requirements for high-risk AI systems used in financial decision-making [5], [6]. Similar frameworks exist globally, including guidelines from the Monetary Authority of Singapore and the U.S. Treasury. These regulations require strict lifecycle governance, transparency, and documentation, imposing significant operational constraints on project management and system deployment [7] – [9].

The effectiveness of simulation platforms depends on three dimensions: reliability, interpretability, and decision relevance. Reliability refers to the stability of model outputs and requires continuous monitoring and retraining mechanisms. Interpretability ensures that stakeholders can understand model decisions, supported by explainable AI techniques such as SHAP and LIME. Decision relevance reflects whether simulation results are effectively integrated into organizational decision-making processes. Together, these dimensions highlight that the success of simulation platforms depends not only on analytical performance but also on appropriate project management and governance structures.

3. Methodology and Research Design

3.1 Methodological Paradigm

This study adopts a pragmatic research paradigm, focusing on the practical explanatory value of project management practices within complex and highly regulated financial environments. The research uses a qualitative, explanatory multiple-case study design to examine how data-driven simulation platform projects are managed in real organizational contexts.

The unit of analysis is the project-level management of simulation platform development, including governance structures, project lifecycle organization, validation procedures, stakeholder coordination, and post-deployment monitoring mechanisms. A purposive sampling strategy was applied to select cases involving simulation platforms used for credit scoring evaluation, macroeconomic stress testing, and financial risk assessment. To capture diverse perspectives, participants included project managers, data scientists, risk management specialists, and managerial users.

4. Comparative Analysis of Project Management Approaches

The empirical findings reveal clear differences in how predictive, adaptive, and hybrid project management approaches address the complexity of financial risk simulation. The analysis shows that the chosen management paradigm strongly influences a platform's ability to balance algorithmic innovation with regulatory compliance [2].

Predictive (plan-driven) approaches rely on linear project phases and fixed scope boundaries. While they generate strong governance alignment and detailed audit trails, they assume early data stability and typically delay validation until the final stages of development. This structure limits the ability to detect data drift or adjust models during development, often reducing the practical relevance of the resulting system. Adaptive (agile) approaches operate through iterative cycles and continuous stakeholder collaboration. They allow rapid experimentation and flexible responses to evolving data insights. However, the informal nature of documentation and governance can conflict with strict regulatory requirements, complicating formal validation and internal audit processes. Hybrid configurations combine iterative development with structured governance phases. Uncertainty is managed through experimental cycles during development, while formal validation checkpoints ensure regulatory compliance. Continuous benchmarking, cross-functional coordination, and automated documentation through MLOps practices allow these systems to maintain both analytical flexibility and institutional accountability.

Overall, the comparison suggests that predictive models struggle with the nonlinear dynamics of machine learning development, while purely agile approaches often fail to satisfy regulatory expectations. Hybrid project management emerges as the most effective configuration, balancing innovation with the strict governance requirements of financial institutions. The comparative matrix (Table 1) illustrates those predictive approaches, while deeply comforting to traditional financial auditors due to their linear predictability, fundamentally fail to accommodate the nonlinear reality of machine learning model training

Table 1 – Comparison of Project Management Paradigms in Analytics-Intensive Financial Projects

Analytical Dimension	Predictive (Plan-Driven)	Adaptive (Agile)	Hybrid Configuration
Lifecycle Structure	Linear phases, fixed scope, limited flexibility	Iterative sprints, evolving scope	Iterative development within fixed governance phases
Treatment of Uncertainty	Assumes early data stability; vulnerable to data drift	Embraces uncertainty and rapid experimentation	Flexible exploration during development, fixed assumptions at validation gates
Validation Integration	Formal validation mainly at final stage	Continuous but often informal validation	Continuous testing with formal regulatory checkpoints
Governance Alignment	Very strong auditability and documentation	Often weak documentation and compliance tension	Balanced governance supported by MLOps documentation
Stakeholder Interaction	Periodic, formal interactions	Continuous and informal collaboration	Structured but frequent cross-functional coordination
Decision Relevance	Often limited due to weak iterative alignment	High short-term relevance but possible instability	High relevance with stable governance alignment

5. Results and Discussion

The empirical analysis indicates that the effectiveness of financial risk simulation platforms depends less on algorithmic sophistication than on the project management structures governing their development. Three core mechanisms emerged from the cross-case analysis.

First, hybrid project structures effectively manage uncertainty inherent in credit risk modeling. Iterative development cycles allow early identification of data anomalies and model instability while maintaining formal governance boundaries required by financial regulators [2].

Second, successful projects embed validation as a continuous governance practice. Integrating validation pipelines through MLOps enables ongoing monitoring, retraining, and recalibration when macroeconomic data drift occurs, transforming reliability into a continuous organizational process rather than a static model property [12].

Third, simulation platforms achieve organizational value only when analytical outputs are translated into decision-relevant knowledge. Although explainable AI techniques improve transparency, feature attribution alone rarely ensures practical interpretability for decision-makers [13]. Effective projects therefore rely on structured communication processes that translate algorithmic outputs into economically meaningful insights for credit and risk committees.

These findings challenge the assumption that advances in machine learning alone determine the success of financial risk analytics systems. Predictive project management approaches lack the flexibility required for iterative model development, while purely agile methods often conflict with strict regulatory documentation and audit requirements [4]. Hybrid configurations reconcile this tension by combining iterative experimentation with structured governance checkpoints.

The results also highlight the persistent MLOps deployment gap: many advanced analytical models fail to move from development to operational use due to governance and organizational barriers rather than technical limitations [12]. As regulatory oversight intensifies through frameworks such as the EU AI Act and global AI risk management standards, financial institutions will increasingly require robust project governance structures to maintain continuous oversight of automated decision systems [4], [7], [14].

6. Conclusion

Overall, hybrid project management architectures provide the most effective framework for developing data-driven financial risk simulation platforms. By structuring uncertainty, embedding continuous validation, and ensuring interpretability for organizational stakeholders, hybrid approaches enable institutions to deploy analytically robust and regulatory-compliant AI systems.

This study is limited by its qualitative case-study design and therefore offers analytical rather than statistical generalization. Future research should examine simulation platform projects longitudinally as regulatory frameworks and operational AI governance practices continue to evolve.

REFERENCES

1. Bank Policy Institute. *BPI–OSTP AI RFI Response*. 2025.
2. CFA Institute. *Explainable AI in Finance*. Charlottesville, VA: CFA Institute, 2025.
3. Deltek. *Project Management Trends in 2025*. 2025.
4. European Banking Authority (EBA). *AI Act Implications for the EU Banking Sector*. 2025.
5. European Banking Authority (EBA). *The EBA Guidelines on Internal Governance* (*EBA/CP/2025/20*). 2025.
6. Gay, B. *Choosing the Right Project Management Approach*. Washington, DC: Graduate School USA, 2025.
7. International Monetary Fund (IMF). *AI in Financial Supervisory Authorities*. 2025.
8. Martínez-Fernández, S., et al. *Software Engineering for AI-Based Systems and MLOps*. 2024.
9. Monetary Authority of Singapore (MAS). *Guidelines on AI Risk Management*. 2025.
10. PwC. *AI Predictions*: *Turning AI Experiments into Engines of Growth*. 2025.
11. Refonte Learning. *Project Management in 2026*: *Top Trends and High Demand*. 2025.
12. Serban, A., et al. "An Analysis of the Challenges in the Adoption of MLOps." *Journal of Innovation & Knowledge*, 2024.
13. Shreya and Pathak, H. "Credit Risk Assessment Using Ensemble Machine Learning and Explainable AI." 2025.
14. U.S. Department of the Treasury. *Financial Services AI Risk Management Framework* (*FS AI RMF*). 2025.

MODERN METHODS OF PERSONNEL MANAGEMENT IN THE BANKING SECTOR

M. B. Kazantsev

Research advisor: Y. A. Masalova, Cand Sc. (Econ.)

Novosibirsk State Technical University, *Novosibirsk*,
m.kazancev.2020@stud.nstu.ru

Abstract. In the context of digitalization and intense competition, the banking sector is transforming its traditional approaches to personnel management. The article examines key modern methods: the use of HR analytics (People Analytics) to predict employee performance and identify risks, the implementation of flexible work models (including remote work), the development of continuous learning programs (lifelong learning), and the integration of artificial intelligence into personnel management processes. Special attention is paid to a culture of engagement, management by objectives (OKR), and the formation of customer-centric teams. The analysis demonstrates that integrating these methods increases adaptability,

productivity, and employee loyalty, directly impacting the quality of banking services and business resilience.

Keywords: banking sector, human resource management, HR analytics, digital transformation, artificial intelligence in HR, lifelong learning, OKR (Objectives and Key Results), employee engagement.

СОВРЕМЕННЫЕ МЕТОДЫ УПРАВЛЕНИЯ ПЕРСОНАЛОМ В БАНКОВСКОЙ СФЕРЕ

М. Б. Казанцев

Аннотация. В условиях цифровизации и высокой конкуренции банковский сектор трансформирует традиционные подходы к управлению персоналом. Статья рассматривает ключевые современные методы: применение HR-аналитики (People Analytics) для прогнозирования эффективности и выявления рисков, внедрение гибких моделей работы (удаленный формат), развитие программ непрерывного обучения (Lifelong Learning) и внедрение искусственного интеллекта в рабочие процессы по управлению персоналом. Особое внимание уделяется культуре вовлеченности, управлению по целям (OKR) и формированию клиентоориентированных команд. Анализ показывает, что интеграция данных методов повышает адаптивность, продуктивность и лояльность сотрудников, что напрямую влияет на качество банковских услуг и устойчивость бизнеса.

Ключевые слова: Банковский сектор, Управление персоналом, HR-аналитика, Цифровая трансформация Искусственный интеллект в HR, Непрерывное обучение, OKR (Цели и ключевые результаты), Вовлеченность сотрудников.

In a highly competitive environment, amid the digitalization of financial services and increasingly stringent regulatory requirements, banks are forced to continually refine their approaches to human resource management. Personnel remain a key asset, and their effectiveness directly impact a credit institution's financial performance and reputation. Today's banking environment places special demands on HR policies.

First, the need to quickly adapt to technological changes, such as the widespread adoption of online banking and mobile applications, the automation of routine operations through RPA (Robotic Process Automation), the use of AI for scoring and personalization of offers, and blockchain.

Second, the high requirements for security and compliance, driven by the tightening of cybersecurity requirements (PSD2, GDPR), the need for transparent reporting (Basel III/IV), and the monitoring of ESG compliance.

Third, there is a need for cross-functional competencies and well-developed soft skills (empathy, communication), which is due to changes in consumer behavior, increased demand for contactless services, and the expectation of an instant response (24/7 support).

Fourth, there is increased competition for qualified personnel due to the entry of non-banking BigTech players, such as Yandex, OZON, MTS, and others [9], into the market, as well as the high demand for IT specialists and highly qualified professionals, and the growing expectations of employees regarding working conditions and career growth.

Modern methods of personnel management in the banking sector are actively studied in the scientific literature, reflecting the impact of digitalization, regulatory requirements, and changes in corporate culture. We now consider key approaches based on current research (Table 1).

Table 1 – Modern HR methods in the banking sector (compiled by the author)

Methods	Description	Advantages	Risks/limitations
HR analytics (People Analytics)	Analysis of personnel data to predict turnover, evaluate performance, and identify leaders	Reduction of turnover by 15-25%; optimization of recruitment costs	Risks of data leakage; the need for anonymization
Flexible employment models	Hybrid format, remote work, and asynchronous work patterns	Reduced office costs; access to regional staff	Weakening of corporate culture; supervisory challenges
Lifelong Learning	Continuous learning: micro-modules, personalized trajectories, VR simulators	Increased productivity; reduced errors	High LMS and content costs
AI in HR	Automation of recruitment, adaptation, and evaluation; chatbots	Reducing routine time by 40-60%	Employee distrust; ethical issues
OKR	Management by Objectives: Ambitious Objectives + Measurable Results	Focus on results; transparency	Metric overload; need for regular audits
Customer-oriented teams	Cross-functional groups; Customer Journey Mapping	10-15% increase in customer NPS	Role conflicts; need for facilitation

1. HR analytics

The core is data-driven management (People Analytics). Making HR decisions (development and retention) based on big data analysis: productivity indicators, engagement, predictive analytics of turnover, talent maps allow you to objectively assess the contribution of employees and identify risks. The key difference from traditional HR statistics: moving from descriptive reports ("how many quit") to predictive analytics ("who might leave and why"). The value of HR analytics lies in its versatility. It provides an opportunity to:

- identify employees at risk of dismissal in advance by analyzing a range of factors, from work experience to behavioral patterns in corporate systems;
- evaluate the real return on investment in staff training by comparing costs with specific business results;
- monitor the psycho-emotional state of the team to prevent professional burnout;
- optimize recruitment and adaptation costs.

To implement these tasks, modern technological tools are used, including BI systems (Power BI, Tableau) for visualization of complex data; programming languages (SQL, Python, R) for building predictive models; and NLP technologies for analyzing textual information. Integration with HRIS/ERP systems ensures the consolidation of data from various sources, creating a holistic view of the organization's HR landscape.

The practical experience of banks demonstrates impressive results: the implementation of HR analytics allows for a 15-25% reduction in staff turnover and a 10-15% increase in overall staff productivity [6].

2. Flexible employment models

Modern banks are increasingly turning to flexible employment models that transform traditional notions of the workplace and schedule. These approaches include:

- a hybrid work format that combines the benefits of office and remote work;
- asynchronous mode, where the focus is on the result rather than the time spent;
- temporary cross-functional teams formed to complete specific tasks.
- part-time employment and job-sharing practices.

Such approaches bring significant benefits to the bank: access to a wider pool of talent, including specialists from the regions, reduced costs for office space, and increased employee loyalty due to greater autonomy. However, implementing flexible models requires a careful approach to address potential challenges, from maintaining corporate culture to developing new performance evaluation criteria.

The optimal implementation strategy involves a step-by-step approach: pilot projects in IT and analytical departments, ethical use of activity monitoring tools with employee consent, and regular online synchronization of teams to maintain communication and coordination.

3. Lifelong Learning: a culture of continuous development

The concept of lifelong learning (Lifelong Learning) is becoming the cornerstone of modern HR strategy. It involves creating an environment where professional development becomes an integral part of daily work.

The key elements of this system include:

- Microlearning is a short module of 5-15 minutes that allows you to acquire new knowledge while continuing your main activity;
- personalized educational paths that take into account individual needs and competencies;
- VR simulators that create realistic simulations of customer scenarios;
- an institute of mentoring and onboarding, providing support and transfer of experience
- corporate universities such as SberUniversity and T-Bank Upgrade, offering comprehensive development programs [7].

The technological infrastructure supports these initiatives through LMS with recommendation algorithms, mobile apps for learning anywhere, and gamified mechanics that stimulate engagement. The results of implementation are impressive: a 12-15% increase in customer NPS due to improved service quality, a 20-25% reduction in operational errors, and an increase in employee engagement (eNPS increased by 10 percentage points).

4. Artificial intelligence in HR

The integration of artificial intelligence into HR processes opens up unprecedented opportunities for automation and personalization. In recruitment, AI allows for automated resume screening, the organization of initial interviews using chatbots, and the prediction of candidates' success based on multivariate analysis.

In the adaptation process, intelligent systems create personalized onboarding plans and answer common questions from new employees. In training, AI generates learning materials and adapts the content to the level of each employee. When evaluating and developing NLP technology, 360° feedback is analyzed, and individual development plans are created.

AI is particularly important in the field of well-being, where algorithms can monitor signs of burnout through voice and facial analysis, providing personalized recommendations for stress reduction.

At the same time, the implementation of AI requires strict adherence to ethical principles: transparency in decision-making algorithms, voluntary consent to the collection of personal data, and mandatory human auditing of critical decisions.

5. OKR: Management through ambitious goals

The OKR (Objectives and Key Results) methodology offers an effective tool for synchronizing employees' efforts with the organization's strategic goals. Its essence lies in setting inspiring, high-quality objectives and specifying them through measurable key results.

The cyclical nature of the process (quarterly or semi-annual periods) ensures regular updating of priorities, while the principle of transparency (making objectives accessible to the entire team) helps create a unified information landscape.

In the banking sector, OKR is successfully used for:

- reducing the number of mobile bank failures (IT department);
- reducing customer service time (front office);
- reducing the share of non-performing loans (risk management).

The benefits of the methodology are clear: shifting the focus from processes to results, synchronizing departmental goals with the overall business strategy, and increasing personal accountability. However, successful implementation requires avoiding information overload with metrics and regularly reviewing targets.

6. Customer-oriented teams

The transition from a functional approach to customer-centric teams involves a fundamental transformation of the organizational structure. Instead of isolated departments, cross-functional teams are created, bringing together IT, marketing, and risk management specialists to work together on customer cases.

Key practices include:

- Customer Journey Mapping is a detailed analysis of a customer's journey to identify pain points;
- cross-functional teams — integrating specialists from different fields to solve complex problems;
- customer feedback is a regular analysis of complaints and suggestions;
- rapid response teams — prompt resolution of common problems;
- customer-centric metrics are a system of indicators that reflect the quality of customer interaction.

Implemented cases at leading banks demonstrate impressive results (Table 2). Alfa-Bank's "Voice of the Customer" program includes monthly case reviews, VTB's "Flexible Cells" facilitate the digitalization of customer processes, and NLP analysis of correspondence at Sberbank enables to predict customer dissatisfaction [4, 7, 8].

Measurable effects include a 10-15% increase in NPS, a 20-30% acceleration in product launches, and a 25% reduction in complaints.

Table 2 – Examples of implementation of HR methods in Russian banks

Bank	Initiative	The essence	Results
SberBank	«Digital Footprint», AI «Pulse»	System Activity Analysis, Burnout Forecasting	18% reduction in customer churn; 12% increase in customer NPS
VTB	«Flexible cells»	Temporary cross-functional teams for digitalization	Reduce product launch time by 30%
Alpha-Bank	«Voice of the customer»	Monthly complaint analysis + "quick fix" teams	Increased customer NPS by 12%; decreased repeat requests by 22%.
T-Bank	VR-simulators	Simulations for cashiers and call centers	20% reduction in errors; increased service speed

Implementing modern HR methods requires a well-thought-out sequence of actions. We propose a step-by-step decomposition of the HR management system in banking and suggest possible solutions for each stage.

Step 1: ***Talent acquisition***. This involves finding and attracting people with the necessary skills to meet the organization's needs.

1. HR branding: Positioning the bank as an innovative, high-tech, and stable employer through digital channels (e.g., "Setka" – a social platform for networking and professional development, launched by hh.ru).

2. Digital recruiting:

- Using AI for initial resume analysis
- Video interviews and asynchronous interview platforms
- Actively working with referral programs.

3. Onboarding:

- Mentoring system.
- A clear onboarding plan for the first 90 days with measurable KPI [5].

Step 2: ***Learning & Development***: a strategic approach to employee development aimed at enhancing their professional competencies, productivity, and engagement.

1. Flexible Learning System:

- Digital-first: LMS (Learning Management System) offering on-demand courses, additional training, and webinars
- Targeted programs: Talent Pool, Management School, Technical Expertise (for IT and analysts).

2. Talent Management:

- Regular potential assessment (9-box grid – a potential and performance matrix) – an employee assessment tool that combines two key indicators: current performance and projected development potential) [3]
- Individual Development Plans (IDPs).

Step 3: *Employee Motivation, Assessment, and Retention* (*Performance & Retention*)

1. Modern Performance Management:

- Replacement of annual performance reviews with continuous feedback
- Using the OKR (Objectives and Key Results) methodology to set goals flexibly linked to strategy [5]

2. Flexible motivation system:

- Financial: competitive salary, variable component (KPIs, project bonuses)
- Non-financial: development opportunities, recognition (gratitude).
- Benefits: corporate programs with a partner bank, gym memberships, psychological support (Employee Assistance Program, EAP), remote work options, etc.

3. Engagement and retention management:

- Corporate culture development programs (values, inclusivity)
- Analysis of reasons for dismissals
- Burnout prevention programs [5].

This system is dynamic and cyclical. It allows not only for the effective management of current staff but also for the active development of a talent pool necessary for the bank's future in the digital economy. Its successful implementation depends on top management support, investments in HR technologies, and a corporate culture ready for change.

Therefore, modern HR methods are not just a passing fad, but a strategic tool for a bank's sustainable development. Their proper implementation allows for:

- increasing the organization's adaptability in unstable conditions;
- reducing costs by automating routine processes;
- strengthening the employer's reputation by attracting the best specialists;
- improving customer experience through developing staff competencies;
- creating a culture of innovation where every employee feels valued.

In the face of a shortage of qualified personnel, human-centric HR is becoming a key factor in competitiveness. Banks that successfully implement modern HR methods will gain a long-term advantage in the competition for talent and customer loyalty.

REFERENCES

1. Asryan A. S. *Tsifrovaya transformatsiya tekhnologiy upravleniya bankovskim personalom* [Digital transformation of banking personnel management technologies] // Gumanitarnye, sotsial'no-ekonomicheskie i obshchestvennye nauki. 2024. No. 5. URL: \https:// cyberleninka.ru/article/n/tsifrovaya-transformatsiya-tehnologiy-upravleniya-bankovskim-personalom

2. Bystrov A. N., Shumilina V. E. *Sovremennye metody upravleniya personalom organizatsii* [Modern methods of personnel management in an organization] [Electronic resource] // Nauka i mir: elektron. nauch. zhurn. – No. 3. – 2022. – URL: https://www.elibrary. ru/download/elibrary_49416543_47022225.pdf

3. Davlatov I. Kh., Tursunova T. *Razvitie bankovskogo menedzhmenta* [Development of banking management] [Electronic resource] // Natsional'naya akademiya nauk Tadzhikistana: elektron. nauch. zhurn.. - № 1 – 2020. – URL: https://www. elibrary.ru/ download/elibrary_44422151_13365609.pdf

4. *II ot «Sbera» nauchilsya otslezhivat' vygoranie sotrudnikov* [AI from Sber has learned to track employee burnout] - https://gaichtranslations.ru/?p=26730.

5. *Kak upravlyat' personalom v banke*: *ot motivatsii do obucheniya* [How to manage personnel in a bank: from motivation to training] [Electronic resource] – URL: https://potok.io/ blog/hr-overview/upravlenie-personalom-v-banke/

6. Kozhevnikova G. V., Grosheva N. B. *Metody proektnogo upravleniya*: *ispol'zovanie gibkikh metodologiy* (*AGILE*, *SCRUM*) *v realizatsii proektov tsifrovoy transformatsii v bankovskoy sfere* [Project management methods: the use of flexible methodologies (AGILE, SCRUM) in the implementation of digital transformation projects in the banking sector] // Mezhdunarodnyy nauchno-issledovatel'skiy zhurnal. — 2025. — №4 (154). — URL: https://research-journal.org/archive/4-154-2025-april/10.60797/IRJ.2025.154.29

7. Salin D. S., Vittenbek N. V. *Upravlenie chelovecheskimi resursami v usloviyakh tsifrovoy transformatsii bankov* [Human resource management in the context of digital transformation of banks] // Liderstvo i menedzhment – 2025. – Том 12. – № 5. – С. 1247–1262 — URL: https://cyberleninka.ru/article/n/upravlenie-chelovecheskimi-resursami-v-usloviyah-tsifrovoy-transformatsii-bankov

8. Smirnov N. *Al'fa-Bank*: *«golos klienta» kak osnova dlya uluchsheniya* [Alfa-Bank: "Voice of the Customer" as a Basis for Improvement] – https://www.osp.ru/articles/2024/0227/ 13058105

9. Tikhonov R. *Bitva za finansy budushchego*: *kak BigTekhi menyayut pravila igry na bankovskom pole* [Battle for the Finance of the Future: How BigTechs are Changing the Rules of the Game in the Banking Field] https://www.novostiitkanala.ru/news/detail. php?ID=184100

APPLICATION OF BI SYSTEMS AND AI ANALYTICS IN SUPPORTING STRATEGIC DECISIONS OF A GOLD MINING COMPANY

A. R. Kharisova

Research advisor: I. L. Klavsuts, Cand. Sc. (Engineering)

Novosibirsk, *Novosibirsk State Technical University*,
xarisova.2025@stud.nstu.ru

Abstract: The article examines the application of BI systems and AI analytics in the strategic management of gold mining companies. Key directions of data analytics utilization are outlined, alongside Russian industry cases and organizational prerequisites for successful digital transformation in the area of asset and risk management.

Keywords: digital business transformation; strategic management; gold mining company; business intelligence; BI systems; artificial intelligence.

ПРИМЕНЕНИЕ BI-СИСТЕМ И AI-АНАЛИТИКИ В ПОДДЕРЖКЕ СТРАТЕГИЧЕСКИХ РЕШЕНИЙ ЗОЛОТОДОБЫВАЮЩЕЙ КОМПАНИИ

А. Р. Харисова

Аннотация: Статья посвящена применению BI-систем и AI-аналитики в стратегическом управлении золотодобывающими компаниями. Показаны ключевые направления использования аналитики данных, отраслевые российские кейсы и организационные условия успешной цифровой трансформации в области управления активами и рисками.

Ключевые слова: цифровая трансформация бизнеса; стратегическое управление; золотодобывающая компания; бизнес-аналитика; BI-системы; искусственный интеллект.

Gold mining companies operate under conditions of high price volatility, substantial capital expenditures, and stringent industrial safety and environmental requirements. In such an environment, the cost of a strategic error runs into billions of rubles. At the same time, digitalization and the data economy have radically expanded the volume of available information on deposits, logistics, and markets. This makes Business Intelligence (BI) systems and artificial intelligence tools a critical factor in improving the quality of strategic management across the industry.

BI systems represent an integrated suite of technologies for data collection, integration, and visualization, supporting decision-making at all levels of

management. A key driver of BI development has been the application of data mining technologies, which enable the identification of hidden patterns within large information datasets. This transforms BI from a simple reporting tool into a fully capable platform for complex decision-making [1, 2, 3].

The next step involves integrating artificial intelligence methods: machine learning, neural networks, and advanced optimization. As noted in the Global Mining Guidelines Group (GMG) framework document "Foundations of AI: A Framework for AI in Mining", the industry distinguishes a "decision supported" level, at which AI is embedded within the management system and generates recommendations for both strategic and tactical decision-making [6, 7].

For a gold mining company, BI systems and AI analytics can support a broad range of strategic objectives. The principal ones are outlined below.

1. Formulation, development, and implementation of corporate strategy, encompassing four functional strategies: marketing, human resource management, financial, and operational. Strategic planning of extraction and mineral resource base development. The integration of geological models, processing data, and price forecasts into a unified platform enables scenario modelling of orebody extraction. Research indicates that novel machine learning-based methodologies can optimize entire mining complexes, increasing project net present value (NPV) by up to 40% [8].

2. Formulation, development, and implementation of financial strategy, including an investment program portfolio. BI integrated with accounting systems provides end-to-end cost control and constructs long-term scenarios incorporating sensitivity to gold prices and currency exchange rates.

3. Formulation, development, and implementation of tactical and operational plans aimed at achieving operational efficiency. In gold mining, a significant proportion of production costs is attributable to the mining and haulage complex, energy consumption, and equipment maintenance. Analytics derived from telemetry (IoT sensors on mining equipment), production systems, and accounting data within the BI platform enables the identification of systemic losses: excavator and haul truck downtime, inefficient haulage routes, fuel overconsumption, and maintenance budget overruns. AI-driven predictive maintenance models and mine scheduling optimization provide quantitatively substantiated recommendations for revising fleet management strategies and maintenance planning [4, 5].

4. Risk management, safety, and sustainable development, as a consequent outcome of the above. Contemporary approaches to digital transformation in the mining sector emphasize that AI analytics can be applied to accident prediction, workforce behavioral pattern analysis, and environmental impact scenario

modelling. For a gold mining company, this means the ability to ground strategic decisions – technology selection, tailings storage facility configuration, and ESG policy – in big data-driven quantitative risk assessment.

The experience of Russian gold mining companies demonstrates that the transition from fragmented reporting to a unified analytics environment significantly improves the quality of management decisions. Highland Gold Group is currently implementing a unified Mine Geological Information System (MGIS), integrating Micromine, Deswik, the R-Mine platform, the K2 Five electronic document management system, and Microsoft Power BI visualization tools [9]. The project aims to standardize business processes, establish a shared data warehouse and regulatory reference database, and reduce labor intensity and errors in mine planning and operations accounting. In parallel, SCADA-class systems and energy efficiency analytics platforms – notably based on the SEDMAX platform – are being deployed across the Group's operations, providing automated energy resource metering, equipment monitoring, and the preparation of analytical reports for management [10, 11].

The integration of telemetry, process, and energy performance data into the BI environment provides management and dispatch services with a single version of truth for key indicators, including production volumes, ore grade, equipment utilization, and downtime, reduces manual data entry through a unified data warehouse and standardized reference data, enables the identification of hidden loss sources, and supports the use of regular end-to-end analytics in the formulation and adjustment of strategic KPIs for productivity and cost management [11].

A comparable approach is demonstrated by Russia's largest non-ferrous metallurgy companies, whose experience is directly relevant to gold mining. «Норникель» (OJSC MMC Norilsk Nickel) is developing the MAGMA suite of industry-specific digital solutions — encompassing a mine geological information system and underground mine planning and dispatch systems — as well as the Axioma AI- and digital twin-based predictive emissions monitoring system, deployed to optimize production processes and enhance environmental safety. «Полюс» (PJSC Polyus), as part of its digital transformation program, places emphasis on the adoption of artificial intelligence, digital twins, and advanced analytics, aligning IT projects and product teams with the company's long-term strategy [12, 13]. These cases demonstrate that BI systems and AI analytics are becoming the strategic management infrastructure of mining companies, directly influencing technology selection, capacity configuration, and project portfolio development [14, 15].

The experience of implementing BI systems and AI solutions demonstrates that technology alone is insufficient. Research on the digital transformation of industrial

enterprises underscores the importance of a comprehensive approach: a mature data architecture, source data quality, management engagement, and organizational change readiness [16].

For a gold mining company, the following conditions are critical:

- unified data architecture. Integration of geological systems, automated process control systems (APCS, rus. «АСУТП»), telemetry, and ERP into a single data warehouse.
- data quality. Without standardized reference data and data governance standards, any analytics will produce distorted results – a finding consistently supported by academic research in this field [17].
- strategic alignment. BI and AI must be embedded within planning and budgeting processes.
- organizational transformation. The formation of cross-functional teams as comprising geologists, IT specialists, and financial analysts, is required, alongside the development of a data-driven management culture.

BI systems and AI analytics are becoming indispensable elements of development strategies for gold mining companies. They enable the transformation of heterogeneous data – from geological models to telemetry and financial reporting – into evidence-based strategic decisions. International and industry research demonstrates that the adoption of BI and AI accelerates decision-making processes, enhances their quality, and helps companies transition from reactive management to a proactive approach grounded in forecasts and scenario analysis. For gold mining, as a capital-intensive and high-risk industry, this represents not merely an efficiency gain, but a fundamental improvement in long-term business resilience.

REFERENCES

1. Business analytics / B. A. Shakhmanova, N. A. Shcherbakova, A. A. Astra, I. L. Klavsuts, A. A. Balabin. Novosibirsk : NSTU Publishing House, 2022. 110 p.

2. Klavsuts I., Digital management of electricity consumption as a factor of transport company value / I. Klavsuts, N. Shcherbakova. - DOI 10.1051/e3sconf/202337604022. - Text : electronic // E3S Web of Conferences. - 2023. – Vol. 376 : Environmental Risks and Safety in Mechanical Engineering (ERSME–2023) : inter. scien. and practical conf., Rostov-on-Don, 1–3 March 2023.

3. Klavsuts I. L. A new method and device of voltage normalization in electric grids / I. L. Klavsuts, D. A. Klavsuts. – DOI 10.1109/MPS58874.2023.10187502. – Text : electronic // 10 International Conference on Modern Power Systems (MPS–2023) : proc., Romania, Cluj-Napoca, 21–23 June 2023. – IEEE, 2023. – 5 p.

4. Improving operating modes of automation control of technological processes of pump equipment based on devices of demand side management [Electronic resource] /

A. I. Dvortsevoi, I. L. Klavsuts, D. A. Klavsuts, M. V. Khayrullina // 55 International universities power engineering conference (UPEC) : proc., virtual conf., Italy, Torino, 1–4 Sept. 2020. – Torino : IEEE, 2020. – 6 p.

5. Klavsuts I. L. Simulation Models for Management Solutions when Implementing Innovative Technologies / I. L. Klavsuts // SHS Web of Conferences. - 2020. - Vol. 80 : Prospects of Fundamental Sciences Development : 17 intern. conf. of students and young scientists (PFSD-2020). - Art. 01020 (8p.).

6. Tracking the trends 2024 Deloitte – URL: https://cisp.cachefly.net/assets/articles/attachments/92383_tracking_the_trends_2024.pdf (accessed: 25.02.2026).

7. Foundations of AI: A Framework for AI in Mining published – URL: https://gmggroup.org/foundations-of-ai-a-framework-for-ai-in-mining-published/ (accessed: 25.02.2026).

8. Yassine Yaakoubi, Roussos Dimitrakopoulos Decision-focused neural adaptive search and diving for optimizing mining complexes // European Journal of Operational Research - 2025 – P. 699-719.

9. The connecting link of the GGIS Highland Gold – URL: https://www.vnedra.ru/tehnologii/informacionnye-tekhnologii/svyazuyushhee-zveno-ggis-highland-gold-10169/ (accessed: 25.02.2026).

10. Highland Gold increases the level of automation – URL: https://www.vnedra.ru/novosti/highland-gold-povyshaet-uroven-avtomatizaczii-20051/ (accessed: 25.02.2026).

11. Highland gold: digitalization is gaining momentum – URL: https://sedmax.ru/about/publications/highland-gold-tsifrovizatsiya-nabiraet-oboroty/ (accessed: 25.02.2026).

12. «Nordnickel» demonstrated the latest achievements in the field of information technology, digitalization and artificial intelligence – URL: https://www.cnews.ru/news/line/2025-06-04_nornikel_prodemonstriroval (accessed: 25.02.2026).

13. «Axioma "Nordnickel": a unique emission forecasting system» – URL: https://nornickel.digital.djiggo.ru/pulse/axioma_nornikelya__unikalnaya_sistema_po_prognozirovaniyu_vybrosov_aktivno_razvivaetsya_na_rynke (accessed: 25.02.2026).

14. Artificial intelligence helps to mine gold – URL: https://www.ogirk.ru/2025/12/17/iskusstvennyj-intellekt-pomogaet-dobyvat-zoloto/?erid=2VtzqvMjvin (accessed: 25.02.2026).

15. «IT Reboot: the mission of the future» – URL: https://sustainability.polyus.com/ru/blog/it-perezagruzka-missiya-budushchego/ (accessed: 25.02.2026).

16. Digital transformation of mining enterprises - URL: https://www.fbacs.com/images/pdf?ysclid=mm366vyg46286996727 (accessed: 25.02.2026).

17. Elsa Pansilvania Andre MANJATE, Yoko OHTOMO, Takahiko ARIMA, Tsuyoshi ADACHI, Bernardo Miguel BENE, Youhei KAWAMURA Applying Nonnegative Matrix Factorization for Underground Mining Method Selection Based on Mining Projects' Historical Data // International Journal of the Society of Materials Engineering for Resources – 2023 – P. 1-13.

UNIVERSITY DORMITORY MANAGEMENT: CURRENT ISSUES AND CHALLENGES

A. S. Khruchsheva

Research advisor: A. A. Borisova, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
Krushchevaanastasia2003@gmail.com

Abstract. The article is devoted to the crisis of the "Soviet model" of student dormitory management, characterized by outdated infrastructure and administrative supervision. The discrepancy of management methods to the demands of modern students is analyzed. It is proved that the quality of the living environment is becoming a factor in the competitiveness of the university. Ways of modernization are proposed: renovation of spaces, digitalization of services and development of student self-government.

Key words. Student dormitory, university, management, competitiveness, quality of life of students, crisis of the Soviet model, student satisfaction.

УПРАВЛЕНИЕ СТУДЕНЧЕСКИМ ОБЩЕЖИТИЕМ: СОВРЕМЕННЫЕ ПРОБЛЕМЫ И ВЫЗОВЫ

А. С. Хрущева

Аннотация. Статья посвящена кризису «советской модели» управления студенческими общежитиями, характеризующейся устаревшей инфраструктурой и административным надзором. Анализируется несоответствие методов управления запросам современных студентов. Обосновывается, что качество жилой среды становится фактором конкурентоспособности вуза. Предлагаются пути модернизации: реновация пространств, цифровизация сервисов и развитие студенческого самоуправления.

Ключевые слова: Студенческое общежитие, университет, управление, конкурентоспособность, качество жизни студентов, кризис советской модели, удовлетворенность студентов.

In the current environment of rapid change and intense competition, education and student housing management play a key role in creating a comfortable, productive, and favorable environment for students. Research in this area is becoming increasingly important because the organization of training, motivation, and human development are directly linked to the educational process. Today, the

quality of higher education programs in Russia enables the training of highly skilled specialists across a wide range of fields. Educational outcomes are influenced not only by the educational process and the environment within the university's teams and in academic buildings, but also by the residential environment in which non-local students spend most of their time. It is here that students seek to meet their basic needs for rest, study, nutrition, and communication [1]. At the moment, for every university, dormitory quality is an important aspect of the educational process, because an important factor for applicants when choosing a university is the quality of dormitories. Comfort, safety and infrastructure affect overall student satisfaction, their academic motivation, psychological state, and social adaptation. Therefore, recognizing this, universities are actively developing and improving their dormitory management systems, introducing modern standards and providing a favorable social environment. Universities today vary in the conditions and quality of their student housing, so universities seek to enhance the factors that make them attractive to applicants. This will help them remain competitive in the higher education landscape, create a positive image for the educational institution and attract talented students.[2]

Thus, the choice of the topic is prompted by the need for an integrated approach to developing the educational environment and student housing, and the improvement of management models in response to contemporary challenges. This will help universities remain competitive and become more attractive to applicants and maintain high levels of student satisfaction with educational quality.

Nowadays universities face unequal conditions regarding the provision of student housing, some dormitories are in good condition, while others, conversely, require significant improvements. This creates unequal initial opportunities for students from different universities and affects their choice of educational institution. In order to understand this problem, we need to examine it from several perspectives.

The main problem addressed in this article is that the lack of comfortable living conditions in dormitories limits the university's competitiveness in attracting applicants and negatively affects student satisfaction with the quality of education.

The main reason for this is the crisis of the "Soviet model" of administration, when the infrastructure cannot handle the burden, and administrative methods of regulating student behavior are outdated and ineffective in the context of a new student culture.

For example, the dormitories of NSTU illustrate this. The campus has nine dormitories, eight of which were built during the Soviet era, the most recent dormitory being built and opened in 2022 [3]. The standard of living, accommodation, and management in these dormitories vary significantly, and this

is not merely a matter of renovation. Dormitories built in the 50s and 80s were designed according to the principle of minimal provision and are characterized by the following types of problems:

1. Housing problems: In small rooms accommodating two, three, or four students, residents have to share not only the room but also toilets, showers, and kitchens; overpopulation, overpopulation (e.g., three or four people living in rooms designed for two); lack of basic dormitory amenities (furniture not provided; no kitchen utensils, laundry room, or rest area).

2. Hygiene and sanitation: unsanitary conditions, which lead to infestations of insects (cockroaches, bedbugs) and rodents, queues for shared facilities (toilets, showers, kitchens), cluttering of premises with personal belongings that students bring with them: clothes, shoes, textbooks, musical instruments.

3. Social: conflicts due to everyday problems (for example, cleaning the kitchen and floor), interpersonal hostility, student behavior, noise; conflicts with roommates over minor household issues.

4. Administrative problems: violation of the rules of accommodation, for example, using the room for other purposes (e.g., subletting or using it as storage), causing damage to the property of the dormitory (furniture, walls, appliances); prohibition of some household electrical appliances in the room (e.g., electric kettles, slow cookers, electric stoves, heaters); the problem of "dead souls" – rooms that are paid for but remain unoccupied. Under the law, such a tenant can only be evicted after the lease agreement expires.

5. Economic problems: notable hostel management problems include arbitrary rent increases, lack of billing transparency, non-functional sub-meters, and non-refund of security deposits by hostel managers, as well as violation of hostel rules, damage to hostel facilities and 'selling of rooms' by hostel tenants.[4]

The lack of comfortable dormitory conditions creates a chain reaction of negative effects, such as a decrease in the competitiveness and attractiveness of the university to applicants, a deterioration in academic performance, a decrease in student satisfaction with the learning process, psychological distress, and in the long run it can lead to reputational losses, financial losses and social risks.

To solve the crisis of the "Soviet model," it is not enough simply to make repairs or "be nicer" to the dormitory superintendent. To do this, we must fundamentally change the entire management paradigm, shift from the model of "supervision and maintenance" to the model of "service and community development". To do this, it is necessary:

1. To transform the physical infrastructure: to design the space based not on the corridor layout, but on the block layout. Create blocks of 2-4 rooms with one bathroom and a kitchenette per block. This reduces conflict and increases privacy.

It is also necessary to create additional spaces, such as coworking spaces, kitchens, and recreation areas. For example, in NSTU one dormitory has a free sports hall for students in its basement.

2. Technological changes: the availability of free WI-FI in every dormitory, the installation of electronic locks and passes. Many dormitories restrict entry and exit at night. Also, creating a mobile application for the dormitory, through which students can conveniently request repairs, pay dormitory fees, and reserve the kitchen or washing machine.

3. Addressing the staffing crisis: instead of a dormitory superintendent, rebrand the position as dormitory manager, who will be responsible for overseeing contractors' service work, and interact with the student council. Improve the skills of a dormitory head through training in various skills such as mediation or event management. It is also possible to conduct trainings for old staff on the topic of customer orientation and conflict management.

4. Addressing the social challenges: to do this, it is necessary to create a student council with genuine authority that will actively participate in organizing and managing the dormitory.

5. Addressing the economic challenges: introducing financial transparency by providing detailed cost estimates, so that students understand what constitutes their dormitory fees.

In summary, this article has identified a problem area related to the living conditions of students in dormitories. The findings indicate that the lack of comfortable conditions negatively not only affects student satisfaction, but also challenges the university's overall competitiveness. An unfavorable living environment undermines student motivation and the quality of the educational process, which ultimately harms the institution's reputation. To improve university performance and enhance the educational experience, it is necessary to prioritize the creation of comfortable living conditions in dormitories by reforming their management systems.

REFERENCES

1. Borovkova A. A., Metla V. F., Khaletskaya Yu. A. Basic Principles of Forming a Comfortable Environment in Student Dormitions // Bulletin of Polotsk State University. Series F. Construction. Applied Sciences. 2019. No. 8. URL: https://cyberleninka.ru/article/n/osnovnye-printsipy-formirovaniya-komfortnoy-sredy-studencheskih-obschezhitiy (in Russian)

2. Pan S., Franklin M. (2017). Student Housing and University Competitiveness: The Role of Residential Facilities in Attracting and Retaining Students // Journal of Higher Education Policy and Management, Vol. 39, Issue 4, pp. 417-431.

3. NSTU. Hostel information. Retrieved April 27, 2024, URL: https://www.nstu.ru/campus/hostel

4. Clarkson M., Wanie E. E., Oben E. E., Molombe, J. M., & Tassah, I. T. (2017). Youth advocacy for efficient hostel management and affordable university students' housing in Buea, Cameroon. International Journal of Housing Markets and Analysis // Vol. 10, Issue 1, Pages 81–111.

EXHIBITION PROMOTION MANAGEMENT: THE EXPERIENCE OF «RUSSIAN HOUSE. CREATIVE REGIONS 2025»

N. V. Kulichkov, Ya. Yu. Anufrieva

Research advisor: T. Y. Kaloshina, Cand. Sc. (Sociology)

Novosibirsk, *Novosibirsk State Technical University*,
anufrieva.work@mail.ru

Abstract. The paper examines exhibition promotion management through the case of «Russian House. Creative Regions 2025». It analyzes the integrated communication strategy combining PR, media relations, partnership programs, and ambassador engagement. The results demonstrate the effectiveness of coordinated promotional tools reflected in increased attendance and exhibitor growth.

Keywords: exhibition promotion, integrated marketing communications, public relations, exhibition management, creative industries, design exhibition, Russian House, communication campaign, event marketing, brand promotion.

УПРАВЛЕНИЕ ПРОДВИЖЕНИЕМ ВЫСТАВКИ: ОПЫТ «РУССКОГО ДОМА. КРЕАТИВНЫЕ РЕГИОНЫ 2025»

Н. В. Куличков, Я. Ю. Ануфриева

Аннотация. В статье рассматривается управление продвижением выставки на примере проекта «Русский дом. Креативные регионы 2025». Анализируется интегрированная коммуникационная стратегия, объединяющая PR, связи со СМИ, партнерские программы и привлечение амбассадоров. Результаты демонстрируют эффективность скоординированных промоинструментов, что выражается в росте посещаемости и увеличении числа участников.

Ключевые слова: продвижение выставок, интегрированные маркетинговые коммуникации, связи с общественностью, выставочный менеджмент, креативные индустрии, дизайн-выставка, Русский дом, коммуникационная кампания, ивент-маркетинг, продвижение бренда.

In the contemporary environment, exhibitions remain a key instrument of marketing communications, integrating the capabilities of direct contact, advertising, public relations, and promotion into a unified complex[1]. An exhibition event is characterized by a synergistic effect: it combines advertising (through mass media, the internet, and outdoor media), public relations (shaping the event's image and attracting public attention), direct marketing (personalized invitations to target groups), as well as sales promotion and personal selling at exhibition stands[1]. Exhibition promotion requires a distinctive approach that accounts for the unique properties of such events: a high intensity of interpersonal contacts, the opportunity to demonstrate products in action, information exchange between manufacturers and consumers, among others[1]. Owing to these characteristics, a well-designed exhibition promotion campaign is capable not only of attracting the maximum number of visitors and exhibitors, but also of strengthening trust in the brands represented at the exposition[4].

It should be noted that integrated marketing communications form the foundation of exhibition promotion[1]. This implies the simultaneous use of multiple channels: advertising in mass media and on the internet, PR activities (press releases, press conferences, information partnerships), direct communication with the target audience (email campaigns, personalized invitations, social media), and so forth.

The promotion of the «Russian House 2025» exhibition was carried out through a pre-planned comprehensive communication campaign encompassing PR, advertising, and digital activities. The key directions of this campaign and the specific decisions made by the organizers to attract a broad audience and participants are examined below.

One of the central promotional instruments was a large-scale PR campaign aimed at enhancing the exhibition's visibility within the professional community and among the general public. The organizers actively engaged with the media: well in advance of the event, press releases announcing the exhibition, its objectives, and its unique features were prepared and disseminated. The culmination of the PR effort was a press conference held at the TASS (Telegraph Agency of News) venue, where the exhibition's founder, Andrey Radaev, personally presented the project to journalists[5]. This media event ensured extensive coverage of the exhibition in federal news feeds and set the tone for the information campaign.

Partnership support from the state and major organizations significantly strengthened the promotional campaign. The exhibition was officially held under the auspices of the Ministry of Industry and Trade of the Russian Federation and was included in the ministry's consolidated event plan[5]. This entailed government-backed information support: announcements on the ministry's specialized platforms,

participation of government officials at the opening ceremony—all of which attracted the attention of the business community.

An important decision was the engagement of a project ambassador—a well-known public figure. In 2025, the face of the exhibition became Honoured Artist of the Russian Federation Natalia Koroleva[2]. Her involvement intensified interest not only from the professional audience but also from mass media outlets: news coverage of the opening was accompanied by her commentaries on a new interpretation of Russian style in design[1]. The presence of a celebrity at the opening (alongside other public figures, such as singer Lolita Milyavskaya[2]) lent the event additional prestige and ensured supplementary mentions of the exhibition in social columns and social media. Furthermore, specialized publications became information partners of the exhibition. For instance, WA (World Architecture) Journal served as the general information partner of the event[2], organizing its own exhibition stand and publishing reports on the exhibition's progress. This partnership not only expanded the reach to the target audience through the journal's readership but also enabled coverage of organizational aspects «from the inside» thereby reinforcing the transparency of the event's image.

To maintain sustained interest, PR activities continued throughout the duration of the exhibition. Within the framework of the business program, public discussions and special events were organized, and journalists were invited for their coverage.

The success of the exhibition's promotion is reflected not only in attendance figures (40,000 visitors compared to 13,000 the previous year) and the number of exhibitors (over 500, up from approximately 250), but also in qualitative indicators—high audience engagement, broad media coverage, and the strengthening of the event's image in the professional community.

By leveraging a combination of PR, advertising, digital tools, and partnership programs, the organizers succeeded in attracting a record number of participants and visitors, establishing new benchmarks for interior design exhibitions in Russia.

REFERENCES

1. Internet-Advance.ru (n.d.) Vystavka kak sredstvo reklamnogo prodvizheniya [Exhibition as a Means of Advertising Promotion]. Available at: http://internet-advance.ru/vystavochno-yarmarochnaya-deyatelnost/vystavka-kak-sredstvo-reklamnogo-prod-vizheniya/ (accessed 13.11.2025) (in Russian).

2. Korkina D. (2025) Russkiy dom. Kreativnye regiony 2025: Regiony zadali novyy trend v dizayne [Russian House. Creative Regions 2025: Regions Set a New Trend in Design]. MV Magazine, 17 September. Available at: https://mv-magazine.ru/kuda-shodit/russkij-dom-kreativnye-regiony-2025-regiony-zadali-novyj-trend-v-dizajne/ (accessed 13.11.2025) (in Russian).

3. Kostyrin V., Sobolev Ya., Shteiner A. (2025) Vyrastaya nad soboy: reportazh s vystavki "Russkiy dom 2025" [Outgrowing Ourselves: A Report from the Russian House 2025 Exhibition]. WA Journal, 15 September. Available at: https://wajournal.ru/events/reportazh- russkij-dom-2025/ (accessed 13.11.2025) (in Russian).

4. Marketing-Tech.ru (2024) PR vystavki: kak privlech' SMI i obshchestvennost' k meropriyatiyu (opyt MITT 2024) [Exhibition PR Campaign: How to Attract Media and Public Attention to an Event (MITT 2024 Experience)]. Available at: https://marketing-tech.ru/cases/bbagency/pr_vystavki_kak_privlech_smi_i_obschestvennost_k_meropriyatiyu/ (accessed 13.11.2025) (in Russian).

5. TASS (2025) Vystavka dizayna «Russkiy dom. Kreativnye region» ob'edinit bole 500 kompaniy [The Russian House. Creative Regions Design Exhibition to Unite Over 500 Companies]. 8 September. Available at: https://tass.ru/kultura/24995375 (accessed 13.11.2025) (in Russian).

PUBLIC-PRIVATE PARTNERSHIP AS A DRIVER OF COMMERCIAL POTENTIAL IN REGIONAL SPORTS: A CASE STUDY OF NOVOSIBIRSK OBLAST

V. A. Petrenko

Research advisor: S. A. Mamontov, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
wrestlerviktor@yandex.ru

Abstract. The development of regional sports infrastructure requires substantial investment, which public budgets alone cannot always sustain. This paper explores the role of public-private partnerships (PPPs) in unlocking the commercial potential of sports facilities in Novosibirsk Oblast. By analyzing regional projects and legislative frameworks, the study identifies key success factors and barriers to PPP implementation in the sports sector. The findings suggest that PPPs not only alleviate budgetary pressures but also enhance the quality and accessibility of sports services, fostering long-term economic and social benefits.

Keywords: public-private partnership, regional sports, commercial potential, infrastructure development, Novosibirsk Oblast, investment, sports management.

ГОСУДАРСТВЕННО-ЧАСТНОЕ ПАРТНЁРСТВО КАК ДРАЙВЕР КОММЕРЧЕСКОГО ПОТЕНЦИАЛА В РЕГИОНАЛЬНОМ СПОРТЕ: НА ПРИМЕРЕ НОВОСИБИРСКОЙ ОБЛАСТИ

В. А. Петренко

Аннотация. Развитие региональной спортивной инфраструктуры требует значительных инвестиций, которые государственные бюджеты не всегда могут обеспечить самостоятельно. В данной статье исследуется роль государственно-частного партнёрства (ГЧП) в раскрытии коммерческого потенциала спортивных объектов Новосибирской области. На основе анализа региональных проектов и законодательной базы в исследовании выявлены ключевые факторы успеха и барьеры для реализации ГЧП в спортивной сфере. Полученные результаты показывают, что ГЧП не только снижает бюджетную нагрузку, но и повышает качество и доступность спортивных услуг, способствуя долгосрочным экономическим и социальным выгодам.

Ключевые слова: государственно-частное партнёрство, региональный спорт, коммерческий потенциал, развитие инфраструктуры, Новосибирская область, инвестиции, спортивный менеджмент.

Introduction

The sports industry in Russia is increasingly viewed not only as a social service but also as a promising field for commercial development. In regions such as Novosibirsk Oblast, the demand for modern sports facilities and services continues to grow. For the 2026 fiscal year alone, the regional government has planned an overall sports budget of approximately 9 billion rubles, which allocates significant funding for ten professional teams and various infrastructure projects [3]. However, even with this level of public investment, budget constraints often limit the scale and quality of publicly funded projects. Public-private partnerships (PPPs) have emerged as an effective mechanism to bridge this gap, combining public oversight with private sector efficiency and capital [1].

This paper aims to analyze the current state and potential of PPPs in the sports sector of Novosibirsk Oblast. It examines specific infrastructure projects planned for 2026, identifies challenges, and proposes recommendations for enhancing the commercial viability of sports facilities through collaboration between the state and private investors.

Theoretical Framework

Public-private partnerships are contractual agreements between governmental bodies and private enterprises to deliver public services or infrastructure. In the context of sports, PPPs can take various forms, including construction and operation

of stadiums, sports complexes, and recreational centers. The private partner typically finances the project in exchange for the right to generate revenue through operations, while the public partner ensures regulatory support and long-term stability [4].

The commercial potential of sports infrastructure lies in its ability to generate income through ticket sales, memberships, advertising, hosting events, and ancillary services such as cafés or sporting goods stores. PPPs can unlock this potential by introducing professional management, marketing strategies, and innovative service delivery models.

Case Study: Novosibirsk Oblast

Novosibirsk Oblast, as one of Russia's largest industrial and cultural hubs, has a growing demand for diverse sports and recreational facilities. The regional government has recognized the importance of sports for public health, social cohesion, and economic development. According to the regional Minister of Physical Culture and Sports, Sergei Akhapov, 2026 will see the active use of federal co-financing instruments under the national sports development program.

Specific infrastructure initiatives planned for 2026 include:

- Construction of 12 'GTO' ('Ready for Labor and Defense') training and testing grounds, eight of which will be built under the federal mass sports development project [3].
- Development of three "smart" sports complexes in the Moskovsky, Kochenevsky, and Bolotninsky districts under the federal "Business Sprint" project, funded entirely from the federal budget [3].
- Completion of a modular sports hall in Krasnoobsk and the region's first 'phygital center'in Novosibirsk's Kalininsky district, which combines digital and physical competition formats [4]. The phygital center, a modular building covering over 1,000 square meters, received more than 82 million rubles in federal funding [4].
- Regional capital construction projects include a new sports complex in Severnoye, a universal sports hall in Dovolnoye, initiation of a swimming pool construction project in Kochenevo, and completion of a ski base in Novosibirsk's Pervomaisky district [3].

These projects demonstrate a multi-layered approach combining federal programs, regional initiatives, and, implicitly, opportunities for private sector involvement in operation and management. For instance, facilities such as the phygital center or modular sports halls, once constructed, require ongoing management and commercial activity to remain operational, which creates natural entry points for private partners.

Results and Discussion

The analysis of planned and existing sports infrastructure projects in Novosibirsk Oblast reveals several critical factors for success and persistent challenges:

1. **Clear legal framework**: Transparent and stable legislation reduces investment risks and encourages private participation. The variety of funding mechanisms (federal programs, regional budgets) requires clear contractual structures for any private involvement.

2. **Professional management**: Involving experienced operators ensures efficient use of facilities and maximizes revenue streams. Facilities like the modular sports hall in Krasnoobsk or the new phygital center could benefit significantly from private sector expertise in programming and commercial operations.

3. **Community engagement**: Facilities that offer programs tailored to local needs attract more users and generate steady income. The geographic distribution of new facilities across both urban and rural districts (Kochenevsky, Bolotninsky, Dovolnoye) suggests attention to regional accessibility, but commercial viability will depend on local programming.

4. **Diversified revenue sources**: Successful projects rely not only on direct user fees but also on event hosting, sponsorship, and partnerships with schools and clubs. The phygital center format, combining esports and traditional athletics, offers particularly diverse revenue potential through tournaments, memberships, and digital content [4].

Barriers to PPP implementation include inconsistent regional policies, limited access to long-term financing, and insufficient dialogue between public and private stakeholders. While major federal programs fund construction, the operational phase often lacks structured private partnership models. Overcoming these obstacles requires capacity building within regional administrations and the development of standardized PPP models adapted to the sports sector [1].

Conclusion

Public-private partnerships hold significant promise for enhancing the commercial potential of regional sports infrastructure in Novosibirsk Oblast. The extensive construction program planned for 2026 provides a unique window of opportunity to embed PPP principles not only in facility operation but also potentially in future project planning. By leveraging private investment and expertise, the region can expand access to quality sports services while reducing the long-term burden on public budgets. However, realizing this potential requires a supportive legal environment, institutional readiness, and a focus on long-term sustainability. Future research should track the operational phase of newly constructed facilities and develop best practices for PPP implementation across Russian regions [2].

REFERENCES

1. Goryachko M. A. Gosudarstvenno-chastnoe partnerstvo v sportivnoy industrii: rossiyskiy i mezhdunarodnyy opyt [Public-Private Partnership in the Sports Industry: Russian and International Experience]. Zhurnal regional'noy ekonomiki, 2021, vol. 15, no. 3, pp. 45–59. (in Russian)
2. Ministerstvo fizicheskoy kul'tury s porta Novosibirskoy oblasti. Plan razvitiya regional'noy sportivnoy infrastruktury na 2026 god [Regional Sports Infrastructure Development Plan 2026]. Ofitsial'nyy press-reliz, fevral' 2026 g. (in Russian)
3. Smith J., & Brown L. Financing Sports Infrastructure through PPPs: Opportunities and Risks. International Journal of Sports Finance, 2019, vol. 14, no. 2, pp. 112–128.
4. TASS. Pervyy figital'nyy tsentr otkroetsya v Novosibirske [First Phygital Center to Open in Novosibirsk]. 7 maya 2025 g. Available at: https://tass.ru/ (Accessed: 12 March 2026). (in Russian)

COMBINING LEAN MANUFACTURING AND DIGITALIZATION IN SMES: CHALLENGES AND SUCCESS FACTORS

A. B. Petrov

Research advisor: T. I. Kaloshina, Cand. Sc. (Sociology)

Novosibirsk, *Novosibirsk State Technical University*,
petrov03@mail.ru

Abstract. This paper examines the synergy between lean manufacturing and digitalization in SMEs. It analyzes the transition to business intelligence systems, identifying financial and cultural barriers. Findings reveal that a phased, modular approach to digital adoption, bolstered by government initiatives, enables SMEs to achieve substantial operational efficiency gains without prohibitive costs.

Keywords: lean manufacturing, digitalization, SMEs, business intelligence, Lean 4.0, operational efficiency, digital transformation.

ИНТЕГРАЦИЯ БЕРЕЖЛИВОГО ПРОИЗВОДСТВА И ЦИФРОВИЗАЦИИ В МСП: ВЫЗОВЫ И ФАКТОРЫ УСПЕХА

А. В. Петров

Аннотация. В данной работе исследуется бережливое производства и цифровизация в секторе малых и средних предприятий (МСП). Анализируется переход к системе бизнес-аналитики, выявляются финансовые и культурные

барьеры. Результаты показывают, что поэтапный модульный подход к внедрению цифровых технологий, поддерживаемый государственными инициативами, позволяет МСП достигать значительного роста операционной эффективности без непомерных затрат.

Ключевые слова: Бережливое производство, Цифровизация, МСП, Бизнес-аналитика, Lean 4.0, Операционная эффективность, Цифровая трансформация.

1. Introduction

Rapid technological advancements make the synergy between lean manufacturing and digitalization essential. For small and medium enterprises (SMEs), this combination plays a critical role in sustaining growth and securing a competitive market position. In Russia, the national project "Productivity" was launched at the government level and ran from 2019 to 2024, accelerating the introduction of digital tools and lean practices [1].

Many SMEs, however, continue to rely on basic software. Research by analytical agencies shows that 52% of Russian companies manage their core business processes using basic digital tools such as Microsoft Excel [2]. Excel is often the first tool companies use to digitalize their business processes, but its functionality is limited. As data volumes grow, basic spreadsheets become prone to performance lags and manual errors. This bottleneck highlights the stalled transition toward integrated ERP and BI systems among domestic SMEs. Since both lean and digitalization share the core goal of eliminating waste, it is critical to understand the real-world challenges and benefits companies face when combining these approaches for production planning [3].

The goal of this paper is to analyze the synergy between lean manufacturing and digitalization within SMEs. Based on publicly available data, the study aims to identify key implementation barriers and success factors that allow SMEs to optimize processes effectively without excessive costs.

2. Theoretical framework

This research builds on the concept of "Lean 4.0" or "Smart Lean." Rather than simply adding software to an old framework, this paradigm requires deep integration of digital tools and lean practices to create mutual reinforcement [4]. Lean 4.0 adapts classical principles like Kaizen, Muda, and Heijunka to the connected Industry 4.0 environment. Unlike manual methods, Lean 4.0 automates data collection, enabling faster analysis and real-time decision-making.

The lean manufacturing approach is based on standardizing each action, minimizing losses during task execution, reducing costs, and increasing transparency throughout the optimization process. The main goal is to eliminate all

actions that do not add value to the business process. Digitalization is also a tool within lean manufacturing. By implementing product control, counting sensors, or data analysis tools, companies automate routine management tasks, freeing up more time for strategic tasks, such as refining the current business model and identifying problems.

3. Methods

This study is based on data collected over the past six months. Articles were selected through aggregator sites using keywords such as "lean manufacturing," "digitalization," and "SMEs". An important selection criterion was that the articles were freely accessible. The selected sources include analytical reports, scientific articles, industry journals, and official reports.

4. Results and Discussion

4.1 Current level of digital development

Small and medium-sized enterprises often use diverse digital technologies. Their main challenge is to integrate disparate data into a single information system. In practice, however, little effort is made toward unification. Data becomes duplicated, stored in disparate places, and sometimes lost. These blind spots prevent managers from seeing the entire business process and obtaining a complete picture of production.

This is why the transition from basic information tools such as Access to BI systems is a critical task for companies. Another important consideration during the transition is the possibility of transferring legacy data to the new ICS. If complete data transfer is not possible, additional time must be devoted to processing legacy data. However, after implementation, company management will find it much easier to track operational information about the company's status.

4.2 Economic effects of digitalization in real business conditions

Research indicates that integrating BI tools with lean manufacturing is a cost-effective strategy for SMEs. Lean methodology directly lowers expenses by targeting waste, while BI software provides the real-time data to identify that waste with precision. Companies that fully adopt this approach can expect to see their long-term operating costs drop by 15-20% [5].

Regional data from the national project "Productivity" reveal strong economic benefits. As a leading participant, Rostov Oblast reduced average process lead time by 31% and work in progress by 36%, while increasing total output by 51% through supported lean tools [6].

A peer-reviewed technical case study complements these aggregated figures with a concrete example of digital optimization. An article in the journal *Energies* describes

a hybrid online diagnostic and analytics system for power-transformer equipment that integrates real-time measurements, a historical database, and predictive analytics. The study reports that moving from periodic manual inspection to continuous digital monitoring enabled earlier fault detection and more effective predictive maintenance. This shift yielded measurable reductions in unplanned downtime and improved asset utilization efficiency [7].

4.3 Barriers to implementation

The main barrier is financial constraints. The total cost of software, hardware, and staff training often seems too high. As a result, businesses face a difficult choice. They must decide between spending money to maintain current operations and investing in digitalization that might pay off in the future.

Beyond financial constraints, other obstacles exist. Equally important are challenges related to human resources. SMEs struggle to hire reasonably priced IT specialists familiar with lean manufacturing. At the same time, frontline employees often lack digital skills and resist the introduction of new BI systems. Accustomed to simple Excel tracking, they frequently view digitalization as an unnecessary complication or a threat to their jobs.

Technological and organizational barriers also slow progress. Upgrading legacy equipment that lacks digital interfaces is technically complex and expensive. Without a clear transformation strategy, management often purchases incompatible software. As a result, companies end up with fragmented data and isolated systems. This is the very opposite of operational synergy [8].

4.4 Success factors and strategies

Successful integration works best with practical, step-by-step strategies rather than large-scale overhauls. The key is a phased approach. Building a "smart factory" all at once is too expensive for small businesses. Instead, management should identify one critical bottleneck and address it with a simple digital tool. Achieving a quick win builds momentum and demonstrates the value of the investment to the team.

Second, focus on internal training. Instead of hiring expensive consultants, SMEs should train their own employees. Partnering with local universities also helps identify graduates who are already familiar with lean methods and digital tools.

Third, use state support. In Russia, national projects offer resources, expert advice, and sometimes grants to SMEs. Actively using these programs helps reduce the costs of digitalization.

A final critical step is to build a culture of data transparency. Leaders must support these changes and ensure that data are clear to everyone. When employees use data to drive improvements, digitalization becomes part of the company culture rather than just a top-down mandate.

5. Conclusions

This study yielded the following findings For SMEs, automation and lean practices should not be introduced in all areas simultaneously. Instead, it is worth analyzing the most critical bottlenecks and using them to introduce changes gradually. Moreover, employees will be more willing to accept gradual updates than a large bundle of new tasks all at once. The most significant barrier to introducing new digital technologies is the lack of financial resources, which can be addressed by participating in grants offered through state programs.

REFERENCES

1. Pravitel'stvo Rossiiskoi Federatsii (2018) Postanovlenie Pravitel'stva Rossiiskoi Federatsii ot 29.12.2018 № 1642 «Ob utverzhdenii pasporta natsional'nogo proekta «Proizvoditel'nost' truda i podderzhka zaniatosti» [Decree of the Government of the Russian Federation No. 1642 dated 29.12.2018 "On Approval of the Passport of the National Project 'Labor Productivity and Employment Support'"]. URL: http://government.ru (accessed 20.02.2026) (in Russian).

2. Lanit (n.d.) Issledovanie tsifrovizatsii: glavnyi tormoz – den'gi, draiver – proizvoditel'nost' truda [Digitalization research: The main brake is money, the driver is labor productivity]. URL: https://lanit.ru/press/archive/issledovanie-tsifrovizatsii-glavnyy-tormoz-dengi-drayver-proizvoditelnost-truda/ (accessed 20.02.2026) (in Russian).

3. Buer S. V., Semini M., Strandhagen J. O., Sgarbossa, F. (2021) The complementary effect of lean manufacturing and digitalisation on operational performance. International Journal of Production Research, 59 (7), 1976-1992.

4. Okpala C. C., Udu C. E., Chukwumuanya E. O. (2025) Lean 4.0: The enhancement of lean practices with smart technologies. International Journal of Engineering and Modern Technology, 11 (6), 160-173.

5. Forbes Russia (2025) Ne roskosh', a neobkhodimost': pochemu tsifrovizatsiia - glavnyi instrument vyzhivaniia i rosta dlia liubogo biznesa [Not a luxury, but a necessity: Why digitalization is the key tool for survival and growth for any business]. URL: https://blogs.forbes.ru/2025/11/18/ne-roskosh-a-neobhodimost-pochemu-cifrovizacija-glavnyj-instrument-vyzhivanija-i-rosta-dlja-ljubogo-biznesa/ (accessed 20.02.2026) (in Russian).

6. Regional'nyi tsentr kompetentsii (2024) Rezul'taty raboty 2024 [Results of work 2024]. Proizvoditel'nost' na Donu [Productivity on Don]. URL: https://производительность-на-дону.рф/результаты-работы-2024/ (accessed 20.02.2026) (in Russian).

7. Beloev I., Alpatov M. E., Garifullin M. S., Galiev I. F., Rakhmankulov S. F., Iliev I., Valeeva Y. S. (2025) Development of a hybrid expert diagnostic system for power transformers based on the integration of computational and measurement complexes. Energies, 18 (20), 5360.

8. Mick M. M. A. P., Kovaleski J. L., Chiroli, D. M. d. G. (2024) Sustainable digital transformation roadmaps for SMEs: A systematic literature review. Sustainability, 16 (19), 8551.

BARRIERS AND DRIVERS OF AI ADOPTION IN RUSSIAN COMPANIES: A JOBS-TO-BE-DONE APPROACH

I. A. Samoilov

Research advisor: V. Yu. Popov, Doctor of Sciences (Phys.-Math)

Moscow, Graduate School of Business,
National Research University Higher School of Economics,
Samoylov.I.A@hse.ru

Abstract. The adoption of AI in Russian companies occurs under unique institutional constraints: withdrawal of Western vendors, sanctions pressure, and import substitution policy. Based on 49 in-depth JTBD interviews with top managers, this study identifies key barriers and drivers using the Four Forces Model (Push–Pull–Anxiety–Habit). Four executive segments are identified: Experimenters (35%), Critical Pragmatists (29%), Integrators (24%), and Conservatives (12%). Specific institutional barriers are revealed: distrust of AI output quality (69%), competency deficit at the AI–business interface (63%), cybersecurity regime constraints (53%), and 1C ecosystem integration dependency (57%). The study extends technology adoption theory and provides a basis for differentiated AI implementation strategies.

Keywords: artificial intelligence; AI adoption; institutional barriers; Jobs-to-be-Done; Four Forces Model; top management; Russian context; organizational readiness; import substitution; qualitative research.

БАРЬЕРЫ И ДРАЙВЕРЫ ВНЕДРЕНИЯ ИИ В РОССИЙСКИХ КОМПАНИЯХ: ПОДХОД «JOBS-TO-BE-DONE»

И. А. Самойлов

Аннотация. Внедрение ИИ в российских компаниях происходит в уникальных институциональных условиях: уход западных вендоров, санкционное давление и политика импортозамещения. На основе 49 глубинных интервью по методологии JTBD с топ-менеджерами в данном исследовании выявлены ключевые барьеры и драйверы с использованием модели четырёх сил (Push – Pull – Anxiety – Habit). Выделены четыре сегмента руководителей: экспериментаторы (35%), критичные прагматики (29%), интеграторы (24%) и консерваторы (12%). Выявлены специфические институциональные барьеры: недоверие к качеству результатов работы ИИ (69%), дефицит компетенций на стыке ИИ и бизнеса (63%), ограничения режима кибербезопасности (53%) и зависимость от интеграции с экосистемой «1С» (57%). Исследование расширяет теорию принятия технологий и создаёт основу для дифференцированных стратегий внедрения ИИ.

Ключевые слова: искусственный интеллект; внедрение ИИ; институциональные барьеры; Jobs-to-be-Done; модель четырёх сил; топ-менеджмент; российский контекст; организационная готовность; импортозамещение; качественное исследование.

1. Introduction

The adoption of artificial intelligence (AI) in business processes is becoming a critical competitive factor. Leading AI adopters demonstrate 20–30% higher operational efficiency compared to laggards (McKinsey & Company, 2025). The global AI market is valued at $150 billion with projections to reach $1.5 trillion by 2030 (IDC, 2024). However, only 10% of companies investing in AI achieve substantial commercial returns (Ransbotham et al., 2020). The remainder face technological, organizational, and institutional barriers that impede the transition from pilot experiments to systematic industrial AI application.

The Russian AI market is in a unique institutional situation following the withdrawal of key Western vendors in 2022–2023. Domestic solutions are actively developing: YandexGPT, GigaChat (Sber), and adaptations of open-source models. The market reached 650 billion rubles in 2024 with 25–30% annual growth (Analytical Center under the Government of the Russian Federation, 2024). Yet only 16% of Russian companies systematically apply AI in business processes, compared to 58% in China and 51% in the US (Abdrakhmanova et al., 2024).

Existing academic research on AI adoption barriers is predominantly quantitative and focused on developed markets (Davenport & Ronanki, 2018; Fountaine et al., 2019; Ransbotham et al., 2020). The Jobs-to-be-Done (JTBD) methodology (Christensen et al., 2016; Ulwick, 2005) enables uncovering latent motivations inaccessible to survey methods, making it particularly suitable for the Russian institutional context. The study aims to identify key barriers and drivers of AI adoption in Russian companies based on qualitative analysis of executive needs, with three research objectives: (1) systematize barriers within the Four Forces framework; (2) build an empirically-grounded executive typology; (3) compare Russian barriers with Western data.

2. Theoretical Background

Academic literature on AI adoption barriers forms three clusters: technological (data quality, integration complexity, the 'black box' problem), organizational (competency deficits, change resistance, absence of measurable KPIs), and institutional (regulatory uncertainty, ethical concerns, and for Russia specifically: sanctions, cybersecurity requirements, and import substitution policy). Classic TAM (Davis, 1989) and UTAUT (Venkatesh et al., 2003) models were designed for deterministic technologies and do not account for the probabilistic uncertainty inherent in AI systems.

The JTBD methodology proposes that executives 'hire' AI not for its features but to accomplish a specific 'job' arising in particular organizational circumstances. The Four Forces Model (Moesta & Spiek, 2016) identifies four competing forces: Push (pain making the status quo unacceptable), Pull (expected benefits from the new solution), Anxiety (fears about the transition), and Habit (loyalty to current solutions). Switching occurs only when Push + Pull exceeds Anxiety + Habit — explaining the paradox of 'perceived utility without adoption.' The hybrid intelligence framework (Dellermann et al., 2019) provides theoretical grounding for interpreting Anxiety and Habit forces by reframing AI adoption from 'automation' to 'augmentation.'

3. Research Methodology

The study employs a qualitative exploratory design based on semi-structured JTBD interviews. The interview protocol comprised four blocks: (1) temporal — the moment of first serious consideration of AI adoption; (2) contextual — circumstances and triggers; (3) Four Forces analysis — systematic exploration of Push, Pull, Anxiety, and Habit; (4) retrospective — practical experience with AI tools. Average interview duration was 52 minutes (range: 38–71 minutes).

The sample included 49 top managers from Russian companies responsible for AI adoption decisions. Interviews were conducted in January–February 2025 using purposive sampling with snowball elements. Selection criteria: (a) C-suite or direct report level (C-1); (b) relevant AI experience regardless of outcome; (c) industry diversity. Theoretical saturation was reached at interview 44; five additional interviews confirmed identified patterns. Sample characteristics are presented in Table 1.

Data analysis employed thematic coding (Braun & Clarke, 2006) in six stages, generating 316 primary codes aggregated into 28 thematic categories and 9 key barriers/drivers. Dual independent coding yielded Cohen's $\kappa = 0.84$. Executive typology was constructed via analytic induction. Opportunity Scoring (Ulwick, 2005) quantified barrier priorities: $OS = Importance + \max(Importance - Satisfaction, 0)$, where $OS > 15$ indicates critically underserved needs.

4. Results

4.1 Executive Segment Typology

Analysis of 49 interviews identified four stable executive segments (Table 2).

Experimenters (35%, n=17) are technologically proactive with minimal Habit inertia. They actively test AI tools and pilot projects, tolerating errors as part of innovation. Dominant forces: Pull↑↑ (technology leadership) + Push↑↑ (competitive pressure). Typical profile: CTO/CEO of a tech company, ages 27–40.

Table 1 – Sample Characteristics (n = 49)

Parameter	**Category**	**n**	**%**
Position	CTO / Technical Director	19	39
	IT Director / IT Manager	12	24
	Head of Automation	8	16
	CEO / SME Owner	6	12
	Head of Procurement	4	8
Company Size	Large (>500 employees)	14	29
	Medium (50–500)	18	37
	Small (<50)	17	35
Industry	IT / Software Development	18	37
	Retail / E-commerce	8	16
	Manufacturing	8	16
	Finance / Fintech	7	14
	Other	8	16

Table 2 – Executive Segments by Four Forces Model

Parameter	**Experimenters**	**Crit. Pragmatists**	**Integrators**	**Conservatives**
Share	35% (n=17)	29% (n=14)	24% (n=12)	12% (n=6)
Dom. Forces	Pull↑↑ Push↑↑	Anxiety↑↑ Habit↑	Pull↑↑ Push↑	Habit↑↑ Anxiety↑↑
Key Anxiety	Quality control loss	AI failures, SLA breach	1C/ERP risk	Regulatory & control loss
Strategy	API-first, freemium, TTv<2wk	Sandbox, A/B, SLA guarantees	Native 1C, ROI calc	On-premise, 152-FZ

Critical Pragmatists (29%, n=14) are cautious pragmatists demanding reproducible evidence before scaling. Their core concern is AI output unpredictability in edge cases. Dominant forces: Anxiety↑↑ (fear of AI failures in critical processes) + Habit↑ (trust in established SLAs). Typical profile: IT infrastructure or DevOps manager, ages 30–45.

Integrators (24%, n=12) are systemic strategists with 3–5-year planning horizons focused on ROI and infrastructure integrability. Dominant forces: Pull↑↑ (scalability, cost reduction) + Push↑ (process bottlenecks). Typical profile: CDTO or automation director in medium/large business.

Conservatives (12%, n=6) face highest institutional anxiety in the sample. They recognize AI transformation under external pressure but are psychologically unprepared. Dominant forces: Habit↑↑ (legacy systems) + Anxiety↑↑ (regulatory risk, loss of control). Typical profile: functional manager in large corporation or state enterprise, aged >40.

4.2 Barriers to AI Adoption

Thematic coding and Opportunity Scoring revealed nine key barriers (Table 3). Distrust of AI output quality (69%, OS=16.0) is the most universal barrier across all segments, though its nature varies: for Critical Pragmatists it is a technical question of edge-case unpredictability; for Conservatives, it concerns institutional accountability before regulators.

Table 3 – Barriers to AI Adoption in Russian Companies (n = 49)

Type	Barrier	n	%	OS
Technological	Distrust of AI output quality	34	69	16.0
	1C ecosystem integration complexity	28	57	17.0
	Insufficient training data quality	22	45	14.2
Organizational	AI–business competency deficit	31	63	16.1
	Employee resistance to change	24	49	14.3
	Time & resource deficit	16	33	14.8
Institutional	Cybersecurity regime constraints	26	53	16.2
	Unavailability of Western tech stacks	19	39	17.3
	Personal data legislation constraints	14	29	14.9

Note: *OS = Opportunity Score* (*Ulwick*, *2005*).

1C ecosystem integration (57%, OS=17.0) is the most Russia-specific barrier, nearly absent from Western literature. The typical workflow — '1C → Excel export → manual analytics → re-entry into 1C' — creates significant transaction costs. AI solutions with native 1C integration hold a structural competitive advantage on the Russian market.

Cybersecurity regime constraints (53%, OS=16.2) occur in the Russian sample 1.7 times more frequently than in Western studies (31%), driven by 'zero trust' cloud

policies and personal data localization requirements (Federal Law 152-FZ). Unavailability of Western technology stacks (39%, OS=17.3) has the highest Opportunity Score, indicating a critically underserved need absent in Western markets (<5%).

4.3 Drivers of AI Adoption

Among push factors, two patterns dominate: 'overload under resource constraints' (78% of respondents face task volumes exceeding team capacity) and 'routinization of skilled labor' (71% note excess repetitive low-complexity tasks consuming specialist time). Pull factors leaders: operational cost reduction (73%), analytics acceleration (65%), and scalability without proportional headcount growth (55%).

Notably, for three of four segments, switching to AI is blocked not by absent pull factors but by dominating Anxiety and Habit. 'Technology leadership' as a pull factor is mentioned by 94% of Experimenters but only 8% of Conservatives, confirming that universal single-factor AI positioning is ineffective.

5. Discussion

Comparative analysis against Western studies (Ransbotham et al., 2020) reveals a 'dual barrier gap.' Quantitatively, cybersecurity barriers are 1.7× more frequent in Russia (53% vs. 31%) and 1C integration barriers significantly higher (57% vs. 38%). Qualitatively, the 'unavailability of Western technology stacks' barrier (OS=17.3, 39% in Russia vs. <5% in the West) represents a structurally different barrier class arising not from internal company limitations but from external institutional conditions — the sanctions regime.

The theoretical contributions are threefold. First, an empirically-verified executive typology based on the Four Forces Model explains the paradox of 'perceived utility without adoption' — high TAM scores do not guarantee implementation when Anxiety and Habit dominate. Second, new variables for AI adoption theory are identified: 1C dependency and Western technology stack unavailability. Third, JTBD methodology is demonstrated applicable to corporate B2B technology decisions, revealing latent motivations inaccessible to standard surveys.

6. Conclusion

This study identified key barriers and drivers of AI adoption in Russian companies through qualitative analysis of 49 JTBD interviews. The application of the Four Forces Model revealed four executive segments with distinct motivational profiles. The Russian institutional context produces a specific barrier landscape

absent from Western literature: 1C integration dependency (57%, OS=17.0), cybersecurity constraints (53%, OS=16.2), and Western technology stack unavailability (39%, OS=17.3).

The gap between AI potential and adoption reality in Russian companies is driven not by AI's technological limitations or irrational conservatism, but by rational responses to objective institutional barriers. Further progress requires not only technological and educational efforts but also institutional changes: regulatory sandboxes, development of 1C-compatible AI solutions, and building a professional community of 'AI translators.'

Limitations: geographic specificity of the sample, IT-sector overrepresentation (37%), qualitative design precluding statistical causal inference, and data collection date (January–February 2025). Future research directions: (1) quantitative validation of the typology on a representative national sample; (2) longitudinal analysis of barrier dynamics; (3) comparative analysis with other economies under external technological constraints.

REFERENCES

1. Abdrakhmanova G. I., Vishnevskiy K. O., Gokhberg L. M. (2024). Digital Economy: 2024. Moscow: HSE Publ., 332 p.

2. Analytical Center under the Government of the Russian Federation (2024). Development of Artificial Intelligence in Russia: Results of 2024. Moscow: AC Publ.

3. Arrieta A. B., Díaz-Rodríguez N., Del Ser J. et al. (2020). Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI. Information Fusion, vol. 58, pp. 82–115.

4. Bordeleau F.-È. et al. (2019). Business intelligence and analytics value creation in Industry 4.0. Production Planning & Control, 31, pp. 173–185.

5. Braun V., Clarke V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, vol. 3, no. 2, pp. 77–101.

6. Brynjolfsson E., Li D., Raymond L. R. (2023). Generative AI at work. Quarterly Journal of Economics, vol. 138, no. 4, pp. 889–942.

7. Christensen C. M., Hall T., Dillon K., Duncan D. S. (2016). Competing against luck. New York: Harper Business, 288 p.

8. Creswell J. W., Creswell J. D. (2018). Research design. 5th ed. London: SAGE, 304 p.

9. Davenport T. H., Ronanki R. (2018). Artificial intelligence for the real world. Harvard Business Review, vol. 96, no. 1, pp. 108–116.

10. Davis F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, vol. 13, no. 3, pp. 319–340.

11. Dellermann D., Ebel P., Söllner M., Leimeister J. M. (2019). Hybrid intelligence. Business & Information Systems Engineering, vol. 61, no. 5, pp. 637–643.

12. Fountaine T., McCarthy B., Saleh T. (2019). Building the AI-powered organization. Harvard Business Review, vol. 97, no. 4, pp. 62–73.
13. Hickok M. (2020). Lessons learned from AI ethics principles for future actions. AI and Ethics, vol. 4, pp. 41–47.
14. IDC (2024). Worldwide Artificial Intelligence Spending Guide. IDC.
15. Landis J. R., Koch G. G. (1977). The measurement of observer agreement for categorical data. Biometrics, vol. 33, no. 1, pp. 159–174.
16. McKinsey & Company (2025). The state of AI in 2025: Generative AI's breakout year. McKinsey Global Survey.
17. Moesta B., Spiek C. (2016). Jobs to be Done: A roadmap for customer-centered innovation. New York: IDEO Press, 192 p.
18. Ransbotham S., Khodabandeh S., Kiron D. et al. (2020). Winning with AI. MIT Sloan Management Review, vol. 62, no. 1, pp. 1–17.
19. Ulwick A. W. (2005). What customers want. New York: McGraw-Hill, 242 p.
20. Venkatesh V., Morris M. G., Davis G. B., Davis F. D. (2003). User acceptance of information technology. MIS Quarterly, vol. 27, no. 3, pp. 425–478.

ENHANCING BUSINESS PROCESSES THROUGH INTERNAL COMMUNICATIONS

E. B. Shernyukova, B. A. Shakhmanova

Novosibirsk State Technical University,
shumilo.evgeniya@gmail.com

Abstract. This paper examines how intra-organizational communications drive business process improvement, particularly in small and medium-sized enterprises. Addressing the research gap on "soft" factors like trust and feedback, it proposes a Communication Audit toolkit to diagnose barriers and enable evidence-based operational enhancements.

Keywords: intra-organizational communications; business process improvement; small and medium-sized enterprises; communication audit; organizational efficiency; soft factors; operational performance; change management.

СОВЕРШЕНСТВОВАНИЕ БИЗНЕС-ПРОЦЕССОВ ПРИ ПОМОЩИ ВНУТРИОРГАНИЗАЦИОННЫХ КОММУНИКАЦИЙ

Е. Б. Шернюкова, Б. А. Шахманова

Аннотация. В данной статье рассматривается влияние внутриорганизационных коммуникаций на совершенствование бизнес-процессов, особенно в малых и средних предприятиях. Восполняя пробел в исследованиях «мягких»

факторов, таких как доверие и обратная связь, предлагается инструментарий «Коммуникационного аудита» для диагностики барьеров и обоснованного повышения операционной эффективности.

Ключевые слова: внутриорганизационные коммуникации; совершенствование бизнес-процессов; малые и средние предприятия; коммуникационный аудит; организационная эффективность; мягкие факторы; операционная деятельность; управление изменениями.

In today's competitive landscape, effective management drives sustainable organizational growth. Organizational growth and scaling inevitably demand transformation of management models and restructuring of delegation systems [2]. This necessity arises from the physical impossibility for a single leader to control an ever-expanding volume of operational tasks and a growing workforce. At a certain stage of development, top management recognizes the need to shift from operational micromanagement to strategic governance. However, a successful transition to strategic leadership is impossible without two critical enablers: first, a team of highly qualified professionals; and second, clearly designed, standardized, and streamlined business processes and intra-organizational communications, refined to the point of automatic execution [7].

Effective organizational performance depends on seamless cross-functional integration. The challenge of improving business processes through intra-organizational communications [3, 8] requires a holistic approach, as it functions as a cross-cutting process permeating all core management domains: strategic management, operations management, financial management, marketing management, HR management, crisis and change management, innovation management, and others. Consequently, communication effectiveness cannot be addressed in isolation; it must be integrated into the broader organizational improvement agenda.

This research area directly engages several pivotal questions: At what stage of maturity are intra-organizational communications within a given company? What is the company's current scale, and how do business processes influence communication patterns—and vice versa? Where, specifically, is the organization losing value due to communication breakdowns?

To establish a common conceptual foundation, we begin by defining two core constructs.

According to the Business Process Management Common Body of Knowledge (BPM CBOK 4.0) [5], *a business process* is a set of activities performed in a defined sequence to create customer value. A process begins with clearly identified external triggers and encompasses all actions and resources required to achieve a goal, produce a result, or deliver a product or service. Activities are viewed as a sequence

or flow and may be executed by people, systems, or both. The process concludes with one or more outcomes, which may include termination or transition to another process.

Intra-organizational communication (hereafter referred to as *internal communications*) is a business support function within companies designed to address strategic challenges of building an effective system of interaction between departments and employees. It is also one of the tools for achieving a company's strategic goals through an organized process of sharing internal corporate information among all employees.

Business processes are commonly categorized into: core processes (production of goods and services), support processes (ensuring organizational viability), management processes (planning, monitoring, control), and development processes.

Internal communications, in turn, are classified along multiple dimensions: direction (horizontal, vertical, diagonal) and formality (formal vs. informal channels).

The strategic significance of internal communications cannot be overstated: when properly designed and implemented, they enable leadership to maintain real-time awareness of business dynamics, consistently convey strategic direction to teams, gather actionable feedback from employees, and strengthen organizational loyalty. Conversely, when communications are left to evolve organically without intentional design, the organization effectively cedes control over a critical management lever—creating risks of misalignment, inefficiency, and cultural fragmentation.

Empirical evidence confirms this gap. Research [4,6] indicates that for the vast majority of Russian companies (80%), internal communications serve merely a basic informational function. Only 15% of organizations treat internal communications as a strategic function, prioritizing employee engagement and two-way dialogue. A mere 5% regard internal communications as a fully strategic capability—one that enables the deliberate transmission of organizational meaning and the purposeful orchestration of change initiatives. This distribution underscores a significant disparity between the potential strategic value of communication systems and their actual implementation in practice.

Large-scale studies conducted by the Russian portal Vnutricom and its partners in 2022 and 2023 reveal a notable evolution in communication practices among Russian companies [4,6]. Research indicates that 29% of companies have reoriented their corporate culture toward results and efficiency, while 21% have prioritized flexibility, adaptability, and human-centricity. At the same time, a key emerging trend has been heightened attention to employee feedback. Against the backdrop of talent shortages and declining workforce quality (as assessed by HR directors), companies have intensified their focus on employee care. Notably, 52% of respondents identified reinforcing corporate culture, operating principles, and core

values as a top priority in personnel management—alongside employee retention (51%)—with the development of internal communications following closely at 41%, underscoring its growing strategic relevance.

When employees see that their input genuinely influences operational processes, not only does loyalty increase, but so does their willingness to actively participate in improvement initiatives—directly enhancing business process efficiency. Approximately 30% of companies have shifted toward rapid, visual, and concise information delivery via messaging apps and corporate portals. This is not merely a trend—it is a necessity for effective coordination amid accelerating business cycles. Through short videos, infographics, and voice messages, leadership explains process changes, while employees gain the opportunity to ask questions and seek clarification within the same day. This approach reduces approval cycles and minimizes the frequency of errors.

Respondents also report the active development of trust-based relationships between leadership and teams. Furthermore, they observe that management has become more transparent in discussing risks and the current operational context. When leaders explain why a process is changing—not just what needs to change—resistance diminishes, and the pace of improvement implementation accelerates.

Thus, Russian companies are increasingly recognizing that internal communications are not merely a task for HR departments or PR units. In reality, internal dialogue constitutes a vital component of day-to-day business management. To improve workflows, organizations do not need to immediately implement complex Business Process Management (BPM) systems. A far more effective starting point is to engage directly with those who actually execute these processes—the employees themselves. When leadership not only communicates but also listens, and when employees feel empowered to voice their opinions and suggestions, resistance to change decreases, innovations are adopted more rapidly, and the tangible impact of these improvements becomes more visible and meaningful across the organization.

Internal communications are increasingly moving beyond the traditional model of one-way dissemination of decisions "from the top down." Instead, they are emerging as a central mechanism for managing organizational change. This shift enables companies to rapidly identify inefficient processes and propose operational-level improvements, fostering a culture of continuous feedback and adaptation.

Nevertheless, a critical barrier persists: the lack of practical, scalable tools to diagnose communication bottlenecks and quantify their impact on process outcomes. Without such instruments, even well-intentioned initiatives risk being perceived as speculative or non-essential. This measurement gap reinforces the tendency to deprioritize communication investments, particularly in resource-constrained environments such as small and medium-sized enterprises.

An analysis of contemporary scientific and applied literature reveals that the problem of improving business processes through intra-organizational communications remains insufficiently studied and systematized—particularly with regard to small and medium-sized enterprises. At the same time, it is precisely these companies that experience the greatest need for flexible, cost-effective, and human-centric tools to enhance operational performance.

Most research on business process improvement focuses either on technological solutions (BPM, RPA) or on large corporations with well-developed management infrastructure. At the same time, limited attention is paid to the role of "soft" factors—such as trust, feedback, employee engagement, and internal communications—in medium-sized companies. Yet it is precisely in such organizations that communication effectiveness directly influences the speed of adaptation and resilience to crises.

Addressing this challenge requires a dual-pronged approach: first, deepening the theoretical understanding of the interdependence between communication flows and process efficiency; and second, developing applied methodologies that empower managers to assess, monitor, and optimize communication practices in alignment with strategic business objectives.

Contemporary realities, shaped by technological progress and digitalization, have fundamentally accelerated the pace of business interaction and decision-making [1]. Under these conditions, even established corporations are compelled to continuously refine their internal communication practices in order to remain competitive.

Consequently, there is a pressing need for a simple, reliable, and scalable toolkit for the *Communication Audit of Business Processes*. Such an instrument would bridge the existing gap between theory and practice by providing a structured framework to: (1) identify communication barriers within operational workflows; (2) evaluate their tangible impact on process performance, resource utilization, and decision-making latency; and (3) generate actionable, context-specific recommendations for targeted interventions. By making the often-intangible effects of communication visible and measurable, this audit tool would enable organizations—particularly small and medium-sized enterprises with limited resources—to prioritize communication improvements based on evidence rather than intuition. Ultimately, integrating diagnostic rigor with practical applicability can transform internal communications from a peripheral support function into a lever for sustained operational excellence and strategic agility.

In summary, while the strategic importance of intra-organizational communications is increasingly acknowledged, their practical integration into business process improvement remains inconsistent. Overcoming this disconnect

demands not only a shift in managerial mindset—recognizing communication as a core operational variable rather than a soft, ancillary function—but also the development of accessible diagnostic tools that make the intangible impacts of communication visible, measurable, and actionable. Only then can organizations fully harness the potential of their internal communication systems to drive efficiency, agility, and sustainable growth.

REFERENCES

1. Abramov V.I., Churkin D.A. Rol' effektivnykh kommunikatsii i kollektivnogo razuma pri tsifrovoi transformatsii kompanii // Vestnik universiteta. 2024. № 4. Pp. 50-60. URL: https://vestnik.ru/article/abramov-churkin-2024 (accessed: 15.12.2025). [The Role of Effective Communications and Collective Intelligence in the Digital Transformation of Companies] (in Russian).

2. Coviello N., Autio E., Nambisan S., Patzelt H., Thomas L. D. W. Organizational scaling, scalability, and scale-up: Definitional harmonization and a research agenda // Journal of Business Venturing. 2024. Vol. 39, Iss. 5. P. 106419. DOI: 10.1016/j.jbusvent.2024.106419.

3. Demina I.N. Mesto i rol' kommunikatsii v biznes-protsessakh // Izvestiya BGU. 2012. №2. URL: https://cyberleninka.ru/article/n/mesto-i-rol-kommunikatsii-v-biznes-protsessah (accessed: 15.12.2025). [The Place and Role of Communication in Business Processes] (in Russian).

4. EKOPSI, Vnutricom. Zerkalo vnutrennikh kommunikatsii: issledovanie EKOPSI, Vnutricom [Electronic resource]. 2022. URL: https://vnutricom.ru/upload/iblock/2d7/94f3snqe3nsqc0lfqqh6076u2xq2yct2.pdf (accessed: 16.12.2025). [The Mirror of Internal Communications: A Study by EKOPSI, Vnutricom] (in Russian).

5. Hilti D., Morris D., Scharsig M., Kirchmer M., Franz P., Saxena R., & Benedict T. (2023). BPM CBOK 4.0. Alpina Publisher.

6. Jobby, Vnutricom. Kak transformiruyutsya korporativnye kul'tury i vnutrennie kommunikatsii: issledovanie Jobby, Vnutricom [Electronic resource]. 2023. URL: https://vnutricom.ru/base/issledovaniya/kak-transformiruyutsya-korporativnye-kultury-i-vnutrennie-kommunikatsii/ (accessed: 16.12.2025). [How Corporate Cultures and Internal Communications Are Transforming: A Study by Jobby, Vnutricom] (in Russian).

7. Vorob'ev A.I. Znachenie vnutriorganizatsionnykh kommunikatsii v kompanii // Zhurnal prikladnykh issledovanii. 2025. №9. URL: https://zhpi.ru/ru/storage/download/233596 (accessed: 15.12.2025). [The Role of Intra-organizational Communications in the Company] (in Russian).

8. Zaitseva A.A., Romanovich V.K. Kommunikatsii v sisteme strategicheskogo upravleniya organizatsiei // Ekonomika i biznes: teoriya i praktika. 2023. №12-1 (106). URL: https://cyberleninka.ru/article/n/kommunikatsii-v-sisteme-strategicheskogo-upravleniya-organizatsiey (accessed: 15.12.2025). [Communications in the System of Strategic Organizational Management] (in Russian).

APPLICATION OF FILLING LINE AUTOMATION SYSTEMS IN FOOD PRODUCTION: SECURITY AND ECONOMIC ASPECTS

A. V. Sogreshilin

Research advisor: D. M. Litmanovich, Cand. Sc. (Engineering)

Zelenograd, National Research University MIET,
andrey.sogreshilin@mail.ru

Abstract. Automation of technological processes increases the competitiveness of food industry enterprises. The article examines the effects of the introduction of automatic control systems on filling lines. Two key topics are considered: improving safety by reducing the risk of human factors and microbial contamination, and economic efficiency by optimizing production.

Keywords: Automation, food production, filling line, industrial safety, economic efficiency, PLC, MES-systems.

ПРИМЕНЕНИЕ СИСТЕМ АВТОМАТИЗАЦИИ РОЗЛИВНЫХ ЛИНИЙ В ПИЩЕВОМ ПРОИЗВОДСТВЕ: АСПЕКТЫ БЕЗОПАСНОСТИ И ЭКОНОМИКИ

А. В. Согрешилин

Аннотация. Автоматизация технологических процессов повышает конкурентоспособность предприятий пищевой промышленности. В статье рассматриваются эффекты от внедрения автоматизированных систем управления на розливных линиях. Анализируются две ключевые темы: повышение безопасности за счет снижения влияния человеческого фактора и риска микробного загрязнения, а также экономическая эффективность благодаря оптимизации производства.

Ключевые слова: автоматизация, пищевое производство, розливная линия, промышленная безопасность, экономическая эффективность, ПЛК, MES-системы.

Introduction

The food industry today faces the need to strictly adhere to high standards of quality and hygiene at all stages of production [3]. Of particular importance is the stage of filling beverages — it is this stage that largely determines the key consumer characteristics of finished products [6].

Correctly filled bottles guarantee:

- maintaining the declared expiration date [5];

- exact correspondence of the liquid volume to the packaging parameters [9];
- maintaining stable product quality [8];
- high level of trust and customer satisfaction [10].

The use of outdated manual process management methods carries a number of serious threats:

- errors in dosage-due to imperfect methods or human factors [7];
- the probability of microbiological contamination when personnel come into contact with products [5];
- errors caused by fatigue, lack of qualification or inattention of operators [4];
- instability of technological parameters from batch to batch [6].

Modern automated systems can dramatically minimize these risks. Implementation of solutions based on advanced technologies provides:

- maximum hygiene of the process by minimizing human intervention [5];
- high-precision dosing accuracy [9];
- stability of reproducible results [10];
- improving the overall efficiency of the production line [8].

The purpose of the article is to demonstrate clearly how automation of the filling process can strengthen quality control and safety of manufactured products, significantly reduce the level of operational risks, as well as achieve a significant economic effect due to the rational use of resources and reduction of possible losses.

Improving product safety and quality

Automation has a direct impact on compliance with the established standards of hygiene and quality of production, which comply with the international standards HACCP (Hazard Analysis and Critical Control Points) and ISO 22000: 2018 [3]. Further, we will consider specific methods that increase safety in food production.

Minimization of human factors and contamination risks

Traditional methods of filling liquids face a serious problem of the risk of spreading pathogenic bacteria due to the unavoidable contact of service personnel with the product itself. Maintaining the proper level of sanitary cleanliness becomes extremely difficult only by employees, because such a task requires absolute sterility and high discipline in order to avoid external contamination [4]. Modern equipment can radically change the situation, almost completely eliminating direct human access to materials that are being processed. This approach significantly strengthens the protection of the finished product against possible exposure to adverse biological agents [5].

The main advantage of the latest automation solutions is considered to be the fact that they are able to completely avoid any contact of workers ' hands with the product, thereby repeatedly increasing the overall level of hygiene measures and drastically reducing the chances of accidental introduction of pathogens into products [8]. Eliminating the influence of the human factor makes it possible to effectively control the risk of external contamination by properly designing automatic mechanisms that minimize the penetration of foreign elements into the production chain [9].

Another important positive effect of automation is the perfect implementation of the requirements prescribed in the instructions for regular maintenance of equipment and compliance with cleaning rules [4]. For example, special automated CIP (Clean in Place) flushing stations, controlled by complex programmable logic controllers (PLCs), guarantee perfect cleanliness of the machines involved in handling beverages. Regular cleaning and disinfection of such equipment contributes to achieving the highest standards of hygiene and quality.

It is also important to note the progress in minimizing errors made by operators [7]. Fully automated processes for regulating dosage volumes, container filling speeds, and ensuring reliable packaging sealing eliminate the risk of incorrect actions by employees caused by insufficient experience or fatigue. All this together creates a stable environment for accurate execution of technological operations, increasing the overall production efficiency and reducing the percentage of damaged products associated with the influence of the human factor [8].

Improved dosage accuracy and product composition

In traditional technology, the accuracy of dose measurement is determined by the time the container is filled or by fixed volumes of liquid supply. However, modern solutions involve the use of highly sensitive sensors and electronic devices for precise control of the mass or volume of the filled product.

Advantages of automated dosing:

- High dosage accuracy of fractions of a percent [9],
- reducing the likelihood of products with a violation of the declared characteristics (under-watering or overfilling of the product) [6].

Special attention should be paid to the implementation of an effective automatic deviation control system. Deep integration of management solutions ensures continuous monitoring of critical parameters of the production chain, such as temperature conditions, material consistency, internal pressure indicators and raw material loading intensity. In the event of detection of non-compliance with established technological standards, the intelligent platform immediately blocks the

operation of the production line, preventing the formation of defective products and ensuring prompt informing of personnel about detected violations [10].

In addition to this key aspect, the undoubted advantage of innovative filling equipment lines is the ability to comprehensively take into account and analyze each stage of the production cycle [9]. The use of integrated systems such as the Manufacturing Execution System (MES) makes it possible to record and archive the entire manufacturing history of products in detail. Any released product unit is provided with a unique identification label that contains accurate information about the release date, serial number of the batch, the recipe formula used, and the specifics of the technical process conditions. Economic aspects of

Although the initial investment in the installation of automated systems is quite large, the cost of implementing an automatic filling line depends on many factors, such as:

- performance;
- type of liquid being spilled.
- container format.
- quality of components;
- degree of automation.
- further integration with the production line.

Based on the requirements listed above, the price may vary from hundreds of thousands of rubles to tens of millions, but subsequent operation demonstrates a significant reduction in costs and an increase in the profitability of the enterprise [7].

Increased productivity and throughput

The introduction of automation allows you to maintain the operation of equipment at the maximum load level without compromising product quality. Key performance improvement factors:

- Reduced working cycle time. This point applies, the absence of interruptions due to the need to change the packaging forms manually or conduct quality control manually, allows you to reduce the total processing cycle of one unit of production [6].
- Possibility of round-the-clock operation. The equipment can function around the clock with virtually no operator involvement, allowing you to achieve high levels of productivity even with limited labor resources [8].

Efficient use of raw materials

Reasonable and effective management of available materials is one of the central areas that allow you to increase the profitability of your business. Effective ways to achieve significant savings include a rational and responsible approach to controlling

the volume of raw materials used. It should be noted that the traditional calculation methods used earlier often have a number of limitations, such as small deviations that are invisible at first glance, but lead to a serious cost overrun of the basic components.

State-of-the-art equipment and automated systems provide a fundamentally new approach, characterized by extremely high accuracy in element dosing procedures, which significantly reduces the risks of excessive inventory formation and significantly improves overall productivity and production efficiency. To illustrate the differences, we can conduct a comparative analysis of the traditional method and new technologies: the classical scheme allows for a certain number of defective units within 1% of the total number of products produced, while switching to high — end automated systems can reduce such losses to extremely low figures-literally up to 0.1% [7].

These changes become particularly important and significant when applied to large companies focused on food production, because here the scale of consumption of raw materials is so extensive that even a minimal reduction in the cost rate can achieve serious budget savings equivalent to millions of rubles during each calendar year.

Save operating costs

The formation of a stable financial and economic position of the enterprise is directly due to the skill of allocating budget funds allocated to ensure the stable operation of production units. The transition to automated technologies creates a unique opportunity to go beyond simply reducing the cost of materials, offering a wide range of promising achievements. Let's take a closer look at the key advantages that reveal the true potential of automation implementation:

The primary advantage is a sharp reduction in dependence on the human factor. Previously, typical work duties that required the involvement of experienced specialists are now performed by automated systems, which saves the company from having to maintain a large staff of professionals, accompanied by high salary costs. This solution not only reduces the amount of employee benefits, but also creates free cash reserves available to finance ambitious projects and progressive business development.

An additional positive effect is to improve the accuracy of prevention planning and timely repair of equipment. Specialized sensors connected to SCADA and HMI class control systems regularly record the current state of the units and instantly respond to the slightest signs of disruption to normal operation. This allows you to prevent major breakdowns and minimize periods of forced downtime, maintaining a constant rhythm of production and guaranteeing a regular flow of revenue, creating a reliable basis for the long-term success of the company.

Conclusion

Automation of filling processes in the food industry is necessary today to meet stringent quality standards and strengthen market positions. Modern automation tools, including PLC controllers and user-friendly HMI panels, successfully cope with key tasks of ensuring safety and improving product quality. The efficiency of production itself increases, improving the financial performance of companies and strengthening business stability. Further steps include the integration of computer vision technologies to control the tightness of packaging and the correct labeling, which will increase the transparency and quality of the final product. The interconnection of new equipment with ERP systems that combine information about all stages of production is also important. This will allow us to switch to a strategy of integrated enterprise management of a new generation based on digital transformation and the creation of smart factories of the future, adaptive to changes in demand and ensuring maximum production efficiency.

REFERENCES

1. GOSTR ISO 22000-2019. Food safety Management Systems. Requirements for organizations involved in the food production chain.

2. Materials of the forum " The Future of the food industry "(Moscow, October 2024).

3. Official website of the International Organization for Standardization (ISO.org).

4. HACCP Implementation Guide: Practical guide for food industry enterprises /Edited by A. V. Kulikov. Moscow: Pishchevaya promyshlennost Publ., 2023.

5. Technical Regulation of the Customs UnionTRCU 021/2011 "On food safety".

6. Food of the XXI Century Magazine: "Improving production efficiency in the food industry through automation", 2024.

7. Industry and Economics Magazine: "Optimization of industrialproduction with automation facilities", 2023.

8. Research reports Institute of Food Industry Economics, Moscow State University, 2023-2024

9. Practical guide to the introduction of MES-systems at food industry enterprises/Ed. by I. S. Petrov. - St. Petersburg.: Polytechnic, 2022.

10. Modern automation technologies in the food industry: monograph / Collective of authors. Moscow: Infra-M Publ., 2023.

STANDARDIZATION IN THE HOSPITALITY INNDUSTRY: MANAGERIAL CHALLENGES AND SOLUTIONS

T. V. Sokolova

Research advisor: A. A. Borisova, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
tais1337sokolova@gmail.com

Abstract. The article discusses the role of standardization in the hotel industry and management problems that arise during its implementation. The main directions of standardization in the hotel sector are analyzed; key organizational cultural and technological barriers are identified. A number of practical management solutions aimed at improving the efficiency of hotels and improving the quality of guest service are proposed.

Keywords: hospitality industry, standardization, service quality, management challenges, operational efficiency, customer experience, global hospitality standards.

СТАНДАРТИЗАЦИЯ ГОСТИНИЧНОЙ ДЕЯТЕЛЬНОСТИ: УПРАВЛЕНЧЕСКИЕ ПРОБЛЕМЫ И РЕШЕНИЯ

Т. В. Соколова

Аннотация. В статье рассматривается роль стандартизации в гостиничной индустрии и управленческие проблемы, возникающие при ее внедрении. Проанализированы основные направления стандартизации в гостиничной сфере, выявлены ключевые организационные культурные и технологические барьеры. Предложен ряд практических управленческих решений, направленных на повышение эффективности работы отелей и улучшения качества обслуживания гостей.

Ключевые слова: индустрия гостеприимства, стандартизация, качество обслуживания, управленческие вызовы, операционная эффективность, клиентский опыт, мировые стандарты гостеприимства.

Introduction

The hotel industry is one of the most dynamic sectors of the global economy and has significant social importance. Standardization plays an important role in the hotel industry; it is the dominant factor that ensures the stability of service quality in hotel operations. It sets the rules for the functioning of hotels, helps to streamline operational procedures and guest service. Thanks to standardization, guests can be sure of a uniform level of quality regardless of the hotel's location.

The purpose of this study is to analyze the management problems that arise during the implementation of internal standardization in the hospitality industry and develop recommendations for overcoming them.

Management problems of standardization

Standardization in the hospitality industry is a set of regulatory documents, procedures and regulations that determine the procedure for performing operations and requirements for the quality of services. Standards can be either external (national or international) or internal (corporate). This study focuses on internal standards and focuses on the implementation of new regulations.

After the departure of a number of international hotel chains, Russian enterprises faced the need to independently develop and update the already familiar service standards. Under these conditions, standardization becomes an important tool for ensuring the stable quality of service and competitiveness of the enterprise. In the scientific literature, standardization is considered a tool for managing quality and operational efficiency. Standardization reduces the variability of the service and ensures consistent outcomes, which is especially important for chain hotel and restaurant companies [1]. On the other hand, excessive regulation can limit the flexibility of service and reduce the level of personalization, which negatively affects customer satisfaction [2]. That is why the modern approach involves combining standardized procedures with elements of adaptive management.

One of the key problems that arise when implementing standards is staff resistance. Employees in the enterprise may perceive standards as limiting professional freedom and increasing control. The staff reacts particularly negatively to the introduction of new standards or the updating of existing ones, which most often affect the usual workflow and require changes and additional training efforts. Employees may resist implementing standards for a number of reasons, including fear of increased workload, uncertainty about requirements, and fear of possible negative consequences if regulations are not followed. Very often, new standards are perceived by staff as an additional administrative burden, rather than as a tool for improving the quality of guest service.

Research shows that resistance to change is one of the main reasons for inefficient implementation of standards in service organizations [3]. To reduce resistance, it is necessary to create a more sustainable organizational culture focused on quality and continuous improvement.

International hotel chains are often located in different parts of the world and operate in different cultural and institutional settings. Common standards developed at the corporate level do not always meet local customer expectations. For example, in countries with a high level of individualism, customers expect personalized

service, whereas in collectivist cultures, formalized service is valued. Thus, it is necessary to adapt the standards taking into account regional specifics [4].

In the modern hotel industry, much attention has been paid to personalized service in recent years, and tourists are increasingly expecting an individual approach based on their preferences or previous experience with the company. At the same time, standardization is aimed at unifying processes and reducing differences in the services provided. This allows hotels to maintain a single level of service regardless of the country or region chosen by the guest, as well as regardless of which branch or which staff member is involved, which is extremely important for maintaining the brand's reputation and building customer trust.

However, this may limit service flexibility and reduce the ability to accommodate each guest's unique requests. This contradiction creates a management challenge: to develop standards that guarantee a uniform and basic sequence of service delivery and quality, while maintaining autonomy in interacting with guests. The optimal approach is to create adaptive standards, where key processes remain unified, and minor elements can be adjusted to a specific guest, which contributes both to stability and to an individual approach [5].

Implementation of standards requires timely and systematic training of personnel. High staff turnover and the dynamics of the hospitality industry increase training costs and make traditional training methods less effective. In addition, it is necessary to regularly update the standards in accordance with changes in guest requirements, regulatory framework and technologies. That is why it is so important to prioritize the introduction of knowledge management systems and digital platforms for storing and distributing information. Thus, digital technologies also play an important role in standardizing processes. The use of CRM systems and automated services contributes to the formalization and control of processes. However, the implementation of technologies requires significant investment and it is important to take into account the likelihood of technical failures that can negatively affect the customer experience and disrupt the standardized processes [6].

Management decisions and development of recommendations

To minimize the conflict between personalization and standardization, managers should develop adaptive standards that define mandatory key guest service processes, but allow flexibility in secondary elements of the service provided. The mandatory part of the standards should provide a basic level of quality, safety and compliance with regulatory requirements, and variable elements allow flexibility in interaction with guests, while allowing hotels to combine an individual approach to the guest and take into account their unique requests. This model allows you to simultaneously maintain the stability of processes in the enterprise and provide

personalized service. Adaptability is particularly relevant in the context of changing consumer expectations and the transformation of the hotel services market.

One of the most effective solutions is staff participation in the development of standards, which allows you to take into account the practical experience of employees and increases adoption of regulations. Staff participation in the standards development process promotes a collective sense of responsibility and increases employees' willingness to implement and comply with them, so that they can better understand why certain procedures are needed and identify operational problems. In addition, managers need to explain to staff the benefits of standardizing processes and clearly articulate their responsibilities. Regular feedback between administrative and operational staff reduces uncertainty and increases confidence in management decisions. The involvement of staff in the development of standards, combined with motivational tools (financial incentives, recognition system, etc.), contributes to the formation of a stable corporate culture and trusting relationships within the organization, which are focused on continuous improvement of the quality of service and improvement of processes.

The effectiveness of standards directly depends on the level of training of employees, as they are the primary representatives of any hotel company. Developing regulations without properly communicating them to employees and training staff significantly reduces the effectiveness of implementation. We recommend the introduction of regular trainings aimed at learning not only new and updated procedures, but also at developing an understanding of the management rationale behind them. Training should be continuous and include introductory programs for new employees and regular programs for existing employees. Business simulations, scenario modeling, and case analysis can be used as training, which helps to consolidate standards both at the skill level and at the theoretical level. Therefore, it is important for hotels to rely on online training platforms and performance evaluation systems, as digitalization helps simplify the process of tracking service quality indicators and quickly adjust regulations. Electronic systems reduce the chance of information loss between departments, and as a result, standards become a flexible tool within the company. Well-thought-out standardization directly affects the operation of the hotel enterprise and its efficiency. When the rules are clear to all employees, all operational processes run more smoothly and quickly, but a well-developed corporate culture and management support are also necessary.

Conclusion

In the hotel industry, standardization remains one of the most important ways to maintain the quality of the service provided. This is especially important in the context of the departure of international hotel chains, when companies have to

rebuild the internal system of standards. The standardization process is not without its difficulties; employees may resist new requirements, the desire for personalization may contradict the uniform rules, and there are differences in approaches to guest service. Improving efficiency requires a comprehensive approach, which includes involving the team in the development of standards, adapting standards to real-world working conditions, and using digital tools to control the quality of service.

REFERENCES

1. Yang X., Balasubramanian K., Joaquim D. S. The effects of service quality on customer satisfaction and recommendation intention: Domestic versus international customer. International Journal of Hospitality Management. 2025

2. Ali Bayad & Gardi, Bayar & Othman, Baban & Ahmed, Shahla & Ismael, Nechirwan & A.hamza, Pshdar & Aziz, Hassan & Sabir, Bawan & Sorguli, Sarhang & Anwar, Kofand. Hotel Service Quality: The Impact of Service Quality on Customer Satisfaction in Hospitality. International Journal of Engineering, Business and Management. 2021.5.

3. Goh Dr. Edmund & Okumus Fevzi. Avoiding the hospitality workforce bubble: Strategies to attract and retain generation Z talent in the hospitality workforce. Tourism Management Perspectives. 2020.33.

4. Asgeirsson M., Gudlaugsson T., & Jóhannesson. The relationships between service quality, reputation, and performance in hospitality. Tourism and Hospitality, 2024 5, 736–752.

5. Levkulych Viktoriia & Momot Alexander. The use of ISO standards in the hospitality industry: a comparative analysis of European clusters. E3S Web of Conferences. 2021. 277.

6. Khamirzova S. K., Kumpilova A. R., Kalashnikova S. V., and Khacemizova E. A. “Napravleniya tsifrovoy transformatsii industrii gostepriimstva i turizma v sovremennykh usloviyakh” [Directions of digital transformation of the hospitality and tourism industry in modern conditions]. Voprosy innovatsionnoy ekonomiki, vol. 13, no. 4, 2023. (in Russian)

THE ROLE OF ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS IN ENHANCING THE EFFICIENCY OF A HIGH-TECH ENTERPRISE'S COMMUNICATION STRATEGY

V. Y. Solovov

Research advisor: I. L. Klavsuts, Cand. Sc. (Engineering)

Novosibirsk, *Novosibirsk State Technical University*,
solovov2017@mail.ru

Abstract. This article examines the role of artificial intelligence and data analytics in enhancing the effectiveness of partner communication strategies for export-oriented high-tech enterprises. The study analyzes AI-driven tools designed to support interorganizational interaction in the B2B segment, with an emphasis on their capacity to automate information processing, reduce transaction costs, and support managerial decision-making. The findings confirm that artificial intelligence and data analytics function as systemic components of communication management, improving efficiency through increased transparency, proactive risk management, and enhanced interorganizational coordination.

Keywords: artificial intelligence; B2B communication; data analytics; digital transformation; export-oriented manufacturing; high-tech production.

РОЛЬ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА И АНАЛИТИКИ ДАННЫХ В ПОВЫШЕНИИ ЭФФЕКТИВНОСТИ КОММУНИКАЦИОННОЙ СТРАТЕГИИ ВЫСОКОТЕХНОЛОГИЧНОГО ПРЕДПРИЯТИЯ

В. Ю. Соловов

Аннотация. В данной статье рассматривается роль искусственного интеллекта и анализа данных в повышении эффективности коммуникационной стратегии взаимодействия с партнерами для экспортноориентированных высокотехнологичных предприятий. В исследовании анализируются ИИ-инструменты, направленные на межорганизационное взаимодействие в B2B сегменте, с акцентом на их способность автоматизировать обработку информации, снижать транзакционные издержки и поддерживать принятие управленческих решений. Результаты подтверждают, что ИИ и анализ данных функционируют как системные элементы управления коммуникациями, повышая эффективность за счет повышения прозрачности, проактивного управления рисками и улучшения межорганизационной координации.

Ключевые слова: **партнеры**, искусственный интеллект; B2B коммуникации; аналитика данных; цифровая трансформация; экспортноориентированное производство; высокотехнологичная продукция.

Introduction

In the context of digital transformation and economic globalization, communication strategy occupies a central position within the management system of high-tech export-oriented enterprises. The term *partnership* is defined as purposive strategic relationships between independent firms who share compatible goals, strive for mutual benefit, and acknowledge a high level of mutual interdependence. They combine efforts to achieve goals that each firm, acting alone, could not attain easily [11]. For enterprises pursuing international market expansion, communication with partners — dealers, distributors, agents, franchisees, and resellers — becomes not only a factor in shaping corporate reputation but also a critical managerial instrument determining the speed of decision-making and the efficiency of business process coordination amid external uncertainty. Traditional approaches to managing interorganizational communications, such as periodic reporting, face-to-face negotiations, and document exchange via email or conventional electronic document management systems, are becoming less effective in highly dynamic B2B interactions. This creates a need to apply artificial intelligence and data analytics tools that enable the automation of information processing, enhance transparency in partner interactions, and accelerate managerial decision-making.

Issues related to the integration of these technologies into the communication strategy of interorganizational interaction remain insufficiently developed in the academic literature, particularly with regard to high-tech enterprises operating in international markets, which underscores the relevance of the present study. The purpose of this article is to analyze the role of artificial intelligence and data analytics in improving the effectiveness of partner communication at a high-tech enterprise in the context of B2B interactions.

1. Communication Strategy as an Element of Enterprise Management

Interorganizational communication is defined as the structures, forms, and processes created by the exchange of messages and the co-creation of meaning among organizations and their stakeholders [18].

In the contemporary digital economy, an enterprise's communication strategy is regarded as an element integrated into the management system, determining the alignment of actions among business process participants and the sustainability of organizational interactions. It represents a system of principles, instruments, and procedures aimed at organizing and coordinating information exchange between the enterprise and its stakeholders [9].

A communication strategy is designed to reduce uncertainty, align expectations, and foster long-term partnerships [21].

In B2B interactions, decisions are made based on a comprehensive assessment of technological, economic, and institutional factors, while the quality of communication determines the effectiveness of joint project coordination. Information exchange with foreign partners requires consideration of differences in business culture, regulatory environments, and institutional practices, which complicates the communication process. In this context, reputational risk management must also be taken into account, as the reliability and transparency of interactions are no less important than product quality [14].

The communication strategy performs an adaptive function in response to the requirements of international business activity [7]. For enterprises manufacturing high-tech export products, the effectiveness of such a strategy becomes increasingly significant, as it influences the quality of managerial decision-making and the results of operational activities within the framework of international operations [12].

Thus, the communication strategy ensures the linkage between the enterprise's strategic objectives and its operational activities and, under conditions of digital transformation, requires the application of artificial intelligence and data analytics tools.

2. AI and Data Analytics Tools in Interorganizational Communications: Role and Impact on Operational Efficiency

The development and implementation of a communication strategy are impossible without the use of artificial intelligence and data analytics technologies. Contemporary studies indicate that AI integrated into Partner Relationship Management (PRM) systems enables the automation of data collection, processing, and interpretation regarding partner interactions, thereby reducing transaction costs and improving coordination. In this context, AI is used to analyze interaction history, predict potential conflicts and disruptions, and support managerial decision-making within partner networks [17]. Data analytics tools make it possible to structure large volumes of data generated by the partner network, detect anomalies, and support decision-making processes [6].

The author classifies AI and data analytics tools for managing inter-partner communications:

1. Salesforce Einstein enables analysis of interaction history, KPI tracking, and planning in B2B channels [15];

2. IBM Watsonx is designed to process unstructured data, including contracts, correspondence, and negotiation records [8];

3. SAP Business AI (in conjunction with Oracle CX Sales AI) automates supply chain and contract management [16];

4. Tableau and Power BI provide KPI visualization and real-time partner monitoring [22];

5. ClickHouse supports the storage and processing of large volumes of data on partner interactions [3].

These tools cover two complementary domains: automation tools and data analytics tools. Their integration into a unified communication management framework enables a transition from reactive to proactive management of partner interactions.

Reviews of AI applications in supply chain management demonstrate that AI tools facilitate the integration of information flows between partners, enhancing process transparency, decision alignment, and responsiveness to change [5]. Thus, the impact of artificial intelligence and data analytics on operational efficiency is demonstrated through improvements in interorganizational information exchange.

Accordingly, the integration of AI and data analytics tools into PRM systems enables the transition from reactive to proactive management of partner communications, reducing transaction costs and improving the enterprise's operational efficiency.

3. Practical Aspects of AI Application in Communication Strategy

Artificial intelligence becomes practically significant as a means of enhancing the manageability and adaptability of communication processes. The application of analytical models and machine learning makes it possible to analyze the history of interactions with partners, identify bottlenecks and risks, and model scenarios for the development of partner relationships, thereby enabling a transition from static communication models to dynamic ones. AI-supported platforms facilitate effective knowledge exchange, increase transparency, and strengthen trust [4]. Data analytics, in turn, identifies signals of potential disruptions in partner interactions, reducing uncertainty.

For illustrative purposes, Table 1 presents examples of export-oriented enterprises that apply AI and data analytics tools in their interactions with partners. The examples are organized according to the following criteria: "company," "AI-tools," "communication transformation" and "type of transformation".

In each case, artificial intelligence served as the foundation for the systemic transformation of the communication strategy, contributing to enhanced analytical grounding for decisions, improved coordination of partner interactions, reduced communication and operational risks, and increased adaptability and interorganizational connectivity.

Thus, artificial intelligence and data analytics function not as auxiliary tools but as system core elements of the modern enterprise communication strategy.

Table 1 – Examples of AI tools used in partner communication by export-oriented enterprises

Company	Rolls-Royce	Siemens AG	Samsung Electronics
AI-tools	IntelligentEngine; Blue Data Thread; IFS Maintenix; QOCO Aviadex	Siemens Xcelerator; Industrial Copilot; NVIDIA Omniverse	AI Supply Chain Coordination Platform
Communication transformation	From manual Excel reporting to continuous two-way AI-based monitoring of engine telemetry	From fragmented channels to a unified AI-driven ecosystem for 3,100+ partners	From scheduled meetings to real-time ML-based supplier monitoring
Type of transformation	From static periodic communication to dynamic analytical interaction	From bilateral transactional communication to a multi-stakeholder ecosystem model	From periodic planning to continuous predictive coordination

Compiled by the author based on sources [1, 2, 10, 13, 19, 20, 23].

4. Conclusion

This analysis demonstrates that, in the context of digital transformation, communication strategy becomes a foundational element in the management of high-tech export-oriented enterprises. AI tools enable the integration of information flows, enhance transparency in partner interactions, support risk forecasting and managerial decision-making, and facilitate the transition to proactive management while reducing transaction costs. In international partnerships, these capabilities are essential for overcoming institutional and informational barriers.

Further research should focus on developing methodological approaches to integrating AI solutions into interorganizational and interaction systems, taking into account organizational and cross-cultural factors.

REFERENCES

1. ARC Advisory Group. (2023). Siemens Xcelerator: A business platform for industrial users [Industry analysis report]. ARC Advisory Group. https://www.arcweb.com/industry-best-practices/siemens-xcelerator-business-platform-industrial-users

2. Broekhuizen T., Dekker H., de Faria P., Firk S., Nguyen D. K., & Sofka W. (2023). AI for managing open innovation: Opportunities, challenges, and a research agenda. Journal of Business Research, 167, Article 114196. https://doi.org/10.1016/j.jbusres.2023.114196

3. ClickHouse Inc. ClickHouse: OLAP Database Management System for Real-Time Analytics. Official Technical Documentation. 2024. URL: https://clickhouse.com/docs (accessed: 27.02.2026).

4. Fehrenbach, David & Herrando, Carolina & Martín-De Hoyos, Mª José. (2024). Co-Creation with AI in B2B Markets: A Systematic Literature Review. Sustainability. 16. 8009. 10.3390/su16188009. https://www.researchgate.net/publication/384022746_Co-Creation_with_AI_ in_B2B_Markets_A_Systematic_Literature_Review

5. Giovanna Culot, Matteo Podrecca, Guido Nassimbeni, Artificial intelligence in supply chain management: A systematic literature review of empirical studies and research directions, Computers in Industry, Volume 162, 2024, 104132, ISSN 0166-3615, https://doi.org/10.1016/j.compind.2024.104132.

6. Goswami, S.S. et al. 2025. Artificial Intelligence-Enabled Supply Chain Management: Unlocking New Opportunities and Challenges. Artificial Intelligence and Applications. 3, 1 (Jan. 2025), 110–121.

7. Henry F.L. Chung, Herbert Sima, Mia Hsiao-Wen Ho, Dmytro Pichugin, Towards export success: The role of inter-cultural B2B relationships, immigrant managers and cultural distance, Industrial Marketing Management, Volume 120, 2024, Pages 29-48, ISSN 0019-8501, https://doi.org/10.1016/j.indmarman.2024.05.002.

8. IBM Corporation. IBM Watsonx: Enterprise AI and Data Platform. Official Product Documentation. 2024. URL: https://www.ibm.com/watsonx (accessed: 27.02.2026).

9. Liu L.; Zhang H. How Does Inter-Organizational Relational Governance Propel Firms' Open Innovation? A Conditional Process Analysis. Sustainability 2021,13, 10209. https://doi.org/10.3390/su131810209

10. Microsoft Corporation. Microsoft 365 Copilot: AI-Powered Automation in Business Communication. Official Product Documentation. 2024. URL: https://www.microsoft.com/en-us/microsoft-365/copilot (accessed: 27.02.2026).

11. Mohr Jakki & Spekman Robert. (1994). Characteristics of Partnership Success: Partnership Attributes, Communication Behavior, and Conflict Resolution Techniques. Strategic Management Journal. 15. 135 - 152. 10.1002/smj.4250150205.

12. Neale O' Connor, Paul Benjamin Lowry, Horst Treiblmaier, Interorganizational cooperation and supplier performance in high-technology supply chains, Heliyon, Volume 6, Issue 3, 2020, e03434, ISSN 2405-8440

13. QOCO Systems. (2020). Rolls-Royce uses engine performance data to improve service [Case study]. https://www.qoco.aero/case-studies/case-study-rolls-royce-uses-engine-performance-data-to-improve-service

14. Rudakova O. Yu., Bashmakova N. Yu., Rudakova T. A. Upravlenie kommunikatsiyami v sovremennykh organizatsiyakh: problemy i resheniya // Upravlenie sovremennoy organizatsiey: opyt, problemy i perspektivy.

15. Salesforce Inc. Salesforce Einstein: AI for CRM and B2B Partner Relationship Management. Official Product Documentation. 2024. URL: https://www.salesforce.com/products/einstein (accessed: 27.02.2026).

16. SAP SE. SAP Business AI: Integrating Artificial Intelligence into Enterprise Resource Planning. Official Product Documentation. 2024. URL: https://www.sap.com/ products/ artificial-intelligence.html (accessed: 27.02.2026).

17. Sheshadri Chatterjee, Ranjan Chaudhuri, Demetris Vrontis, Selma Kadić-Maglajić, Adoption of AI integrated partner relationship management (AI-PRM) in B2B sales channels: Exploratory study, Industrial Marketing Management, Volume 109, 2023, Pages 164-173, ISSN 0019-8501

18. Shumate, Michelle & Atouba, Yannick & Cooper, Katherine & Pilny, Andrew. (2016). Interorganizational Communication. 10.1002/9781118955567.wbieoc117.

19. Siemens AG. (2022, June 29). Siemens launches Siemens Xcelerator — an open digital business platform to accelerate digital transformation [Press release]. https://press.siemens.com/global/en/pressrelease/siemens-launches-siemens-xcelerator

20. Siemens AG. (2024). Siemens Xcelerator partner ecosystem boosted with AI-driven field service and asset management solution from IFS [Press release]. https://press.siemens.com/global/en/pressrelease/siemens-xcelerator-partner-ecosystem-boosted-ai-driven-field-service-and-asset

21. Solovov V.Yu., Sprynga S.E. Kommunikatsionnye Strategii Prodvizheniya Brendov Na Zarubezhnyy Rynok: Opyt Otechestvennykh I Zarubezhnykh Predpriyatiy/ V.Yu. Solovov, S.E. Sprynga; [Communication strategies for promoting brands into foreign markets: experience of domestic and foreign enterprises] // Zakharova, E. V. (Ed.). (2026). Nauka. Tekhnologii. Innovatsii [Science. Technologies. Innovations]: Collected scientific papers in 9 parts (Part 5). NSTU Publishing House. ISBN 978-5-7782-5569-2

22. Tableau Software (Salesforce). Tableau: Business Intelligence and Data Visualization Platform. Official Product Documentation. 2024. URL: https://www.tableau.com (accessed: 27.02.2026).

23. Ward, N. (2020). Meet the IntelligentEngine: Taking predictive engine maintenance to the next level. AircraftIT MRO, 9(3). https://www.aircraftit.com/articles/meet-the-intelligentengine-taking-predictive-engine-maintenance-to-the-next-level/

PLACEMENT OF A LAUNDRY BUSINESS: A LOGISTICS AND MARKETING PERSPECTIVE

S. E. Sprynga

Research advisor: I. L. Klavsuts, Cand. Sc. (Engineering)

Novosibirsk, *Novosibirsk State Technical University*,
thesveto4ka@gmail.com

Abstract. This paper examines the choice of a laundry location in the city as part of the strategic development of the company in the consumer services market. Using the example of an on-demand B2B laundry location, the author shows that proximity to customers and transport hubs reduce last-mile delivery costs and increases service speed, thereby enhancing the competitiveness of a consumer services company.

Keywords: urban laundry business, strategic location, logistics, marketing strategy, on-demand services, B2B services, competitive advantage.

РАСПОЛОЖЕНИЕ ПРАЧЕЧНОГО БИЗНЕСА В ГОРОДЕ С ТОЧКИ ЗРЕНИЯ ЛОГИСТИКИ И МАРКЕТИНГА

С. Е. Спрынга

Аннотация. В статье рассматривается выбор расположения прачечной в городе как часть стратегического развития предприятия на рынке бытовых услуг. На примере расположения on-demand B2B прачечной автор показывает, что близость к клиентам и транспортным узлам снижает затраты на доставку последней мили и повышает скорость обслуживания, повышая конкурентоспособность предприятия, оказывающего бытовые услуги.

Ключевые слова: прачечный бизнес в городе, стратегическое расположение бизнеса, логистика, маркетинговая стратегия, сервис on-demand, сервис B2B, конкурентоспособность.

In any business, it is important to increase the likelihood of business success. Effective management involves the formulation and timely updating of an enterprise's development strategy, as well as following this strategy [6]. The physical location of a business can be a vital component of its strategy. This paper examines the location considerations for an urban laundry business.

The laundry business is related to consumer services. When providing services, customer orientation is key in business, i.e. the target strategic priority of the enterprise is the full satisfaction of customer requests [5, 7]. For a consumer service enterprise such as a laundry, logistics play an important role. Properly organized logistics also facilitates the production and marketing activities of the laundry [8]. Logistics as a scientific discipline studies the organization of the rational movement of material flows. These include optimizing the processes of movement of goods, inventory management, and the creation of an effective infrastructure for the circulation of products and services. Logistics is divided into types: procurement, distribution, sales, transport, customs, warehousing, information and inventory logistics [13]. This article discusses transport logistics, i.e. the organization of delivery.

One of the most popular marketing models is the "4P" model. In it, each "P" refers to certain elements of this strategy (product, price, place, promotion). However, for household service enterprises, these elements proved insufficient. Due to the limitations of using this model, it had to be adapted. To do this, other "P" elements are added to the model, such as process, people, physical evidence, and productivity [11]. This indicates that paying attention only to the quality of the services provided can be a strategic mistake.

Components such as place and process play an important role in the development of the laundry business. The effectiveness of customer service is directly related to the choice of location and operating hours. Accessibility of the consumer is crucial. The way household services are provided should be considered. In accordance with OKVED No. 96.01 (All-Russian Classifier of Economic Activities), there are self-service laundries, as well as full-cycle laundries, including delivery of items to the customer's home or to the enterprise in the case of B2B. Depending on this, different business development strategies may be applied. The location of the enterprise and its structure are influenced by functional, organizational, size and spatial criteria, as well as the necessary investment needs. The actual layout is often influenced by logistical processes [1]. Thus, the logistical concept of a consumer service company significantly affects the choice of its location.

Laundries are in direct contact with their customers: therefore, they may be limited in their choice of working methods, but they can become more competitive and mitigate possible risks by providing a full range of services [12]. Also, for the consumer, the speed and convenience of place and time become very important factors when using services [11]. So, on-demand laundries are more competitive. This on-demand model provides services immediately after receiving a client request. This provides flexibility, convenience and accessibility, as it allows the client to receive the necessary services at any time convenient for them.

Another way to increase the competitiveness of the laundry is to accept orders at the client's workplace. With this model, the laundry organizes the reception of orders, and then brings the completed orders back to the customer [1]. In addition to fast delivery times, logistical problems can create additional pressure on production processes [2]. Therefore, it is important to pay attention to this when choosing the location of a laundry business.

Laundry pricing includes not only the cost of the service itself but also other costs. This is reflected in last-mile delivery. There are many definitions of this concept, but many define it as the supply chain from the last distribution center to the destination (the customer) [10]. In order to reduce costs, it is advisable to use lean production tools such as job standardization, workspace organization, value stream mapping, and others [3, 4]. In this case, the goal of reducing waste from waiting, transportation, and unnecessary movement is important.

The location of a laundry on the outskirts of the city may initially seem like a good location option due to the cheaper cost of the building/rental space. However, as mentioned earlier, there are other factors. Consider an example of the placement of a highly competitive on-demand laundry working with medical institutions in a city.

Since the clients are medical companies, they serve the population, and therefore are located closer to the city center, rather than on the outskirts. They open at 8-10 a.m. To efficiently deliver orders by the beginning of the working day, the driver needs to move quickly. Given that all orders cannot be placed in one car at a time, the driver may need to return to production several times.

Although it is more expensive to rent space in the city center, it is possible to quickly return to the laundry for completed orders; it is more convenient for laundry staff to get to work and home; there is no need to arrange a taxi or official transport for employees. From a marketing perspective, there is an advantage for customers – the speed of order fulfillment (a day instead of 2-3 days). Otherwise, more cars and drivers may be needed to maintain the level of service. It is noted that between a low price and fast and efficient delivery, consumers often choose the latter [9].

Also, fast delivery allows you to keep the packaging and items that were sent to the laundry in good condition. Speed also plays a role in rechecking items and resolving possible conflicts with customers. Table 1 contains the factors considered.

Table 1 – Comparative analysis of B2B laundry placement strategies

Comparison criterion	**Location on the outskirts of the city**	**Location in the city center**
Premises/rental cost	Low	High
Transportation needs	High (more vehicles are needed or more returns trips to laundry are required)	Low (orders can be completed with fewer vehicles)
Order fulfillment speed	Low (delivery may take several days)	High (delivery within 24 hours is possible)
Accessibility for Personnel	Low (remoteness, possible problems with public transport or the need to arrange a taxi/company transport)	High (proximity to metro/bus stops)
The impact on the quality of the service	Risk of package damage during long transportation, the difficulty of quickly resolving conflicts	Preservation of items, the possibility of prompt rechecks and communication with customers
Last-mile logistics	High mileage of transport, loss of time in traffic jams	Fast turnover of items

Compiled by the author based on empirical research

Local geographical features should also be taken into account. Most large cities are located on rivers and are separated by bridges. Bridges are critical infrastructure hubs, so you need to be located near one of them.

So, taking into account all the logistical factors, it is best to place the laundry closer to the city center, near a transport interchange that ensures maximum accessibility for delivery services.

Thus, by comprehensively addressing industry-specific challenges, the company can gain a competitive advantage, successfully develop and strengthen its market position. The location of the laundry business should be chosen in accordance with the developed strategies. Despite the higher cost of location, such a choice can significantly minimize other costs and make services more attractive to consumers.

REFERENCES

1. Dorokhin Yu. S., Sergeyev, A. N., Sergeyev, N. N., et al. (2016) Proyektirovaniye protsessa okazaniya uslug: Uchebnoye posobiye [Designing the Service Delivery Process: A Textbook] – Tula: Tula State University. – EDN VUIAUP (in Russian).

2. Gordeeva S. V. (2025) Analiz rynka prachechnykh uslug: trendy i perspektivy [Analysis of the Laundry Services Market: Trends and Prospects]. Vestnik nauki [Bulletin of Science], 12(93). (in Russian) Available at: https://cyberleninka.ru/article/n/analiz-rynka-prachechnyh-uslug-trendy-i-perspektivy (accessed 13.02.2026).

3. GOST R 56407-2023 Osnovnyye instrumenty i metody ikh primeneniya. [Lean production. Basic tools and methods of their application] (in Russian).

4. GOST R 56020-2020 Osnovnyye polozheniya i slovar' [Lean production. Fundamentals and vocabulary] (in Russian).

5. Klavsuts I. L. (2021) Novyye metody tsifrovogo upravleniya potrebleniyem resursov kak tekhnicheskiy drayver ekonomicheskogo rosta stran-chlenov SHOS [New Methods of Digital Management Used in Resources Consumption as a Technical Driver for Economic Growth of the SCO Member States] Voprosy novoy ekonomiki [Issues of the New Economy] – № 1 (57) – C. 58–65. – DOI: 10.52170/1994-0556-2021-57-58 (in Russian).

6. Klavsuts I. L. (2022) Strategicheskiy menedzhment: uchebnoye posobiye / I. L. Klavsuts, D. A. Klavsuts. [Strategic Management: A Textbook. I. L. Klavsuts, D. A. Klavsuts]. Novosibirsk: NSTU Publishing House – ISBN 978-5-7782-4675-1 (in Russian).

7. Klavsuts I. L. (2022) Zelenyye kompetentsii personala kak osnova soblyudeniya kompaniyami printsipov ESG-otvetstvennosti [Green competences of personnel as a basis for companies' compliance with ESG-responsibility principles / T. YU. Kaloshina, I. L. Klavsuts, D. A. Klavsuts] – DOI 10.52170/1994-0556_2022_61_37. – Text: direct. Voprosy novoy ekonomiki [Issues of the New Economy] – № 1 (61). – C. 37–46 (in Russian).

8. Klyusova Yu. Yu. (2017) Rol′ organizatsii logisticheskogo protsessa na predpriyatii [The Role of Logistics Process Organization in an Enterprise]. Aktual′nyye roblem aviatsii i kosmonavtiki [Current Problems of Aviation and Cosmonautics], 3(13), p. 630-632. – EDN YQWBBL (in Russian).

9. Kurochkina A.A., Shevchuk E.V., and Bikezina T.V. (2023) Transformatsiya dostavki posledney mili kak metod uluchsheniya kliyentskogo opyta v rossiyskoy federatsii [Transformation of Last Mile Delivery as a Method of Improving Customer Experience in the Russian Federation] Ekonomika i upravleniye [Economics and Management], vol. 29, no. 2, pp. 159-168 (in Russian).

10. Olsson, J., Hellström, D., & Pålsson, H. (2019). Framework of Last Mile Logistics Research: A Systematic Review of the Literature. Sustainability, 11(24), 7131. https:// doi.org/10.3390/su11247131

11. Otvagina I. E. (2014) Sovremennyye napravleniya rynochnoy politiki predpriyatiy bytovogo obsluzhivaniya na osnove marketinga otnosheniy: Monografiya [Modern Directions of Market Policy for Consumer Service Enterprises Based on Relationship Marketing: A Monograph] Kyzyl: Izdatel′stvo Sibprint [Kyzyl: Sibprint Publishing House] – 234 p. – ISBN 978-5-94301-552-6. – EDN TUOSOJ (in Russian).

12. Rutsik Yu. O. (2011) Innovatsionnyye protsessy v sfere uslug [Innovative Processes in the Service Sector] Uchenyye zapiski Sankt-Peterburgskogo universiteta upravleniya i ekonomiki [Scientific Notes of St. Petersburg University of Management and Economics], 1(31), p. 172-177 – EDN NTMPQT (in Russian).

13. Vladimirova A. S. (2016) Logistika, vidy logistiki i global′nyye sistemy [Logistics, Types of Logistics and Global Systems / A. S. Vladimirova, Yu. I. Vasilyuk] Aktual′nyye voprosy ekonomicheskikh nauk [Current Issues of Economic Sciences] – No. 51. – Pp. 108–112. – EDN WGEJIP (in Russian).

BALANCING ROSTER STRATEGIES: BUSINESS MODELS AND OPERATIONAL EFFICIENCY IN RUSSIAN VOLLEYBALL CLUBS

P. I. Topornina

Research advisor: E.S. Gorevaya, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
p.topornina@yandex.ru

Abstract. Professional sports clubs face a dual challenge: achieving sporting success while maintaining financial sustainability. This paper analyzes roster construction strategies as a core element of volleyball clubs' business models. Using proxy indicators – share of foreign players, academy graduates, and a proprietary "Status Index" – we identify four distinct business models among Russian Super

League clubs. The findings reveal a direct correlation between the chosen model, operational costs, and sporting performance, offering valuable insights for sports management.

Keywords: business model, operational efficiency, roster strategy, internal goods, external goods, volleyball.

БАЛАНС СТРАТЕГИЙ ФОРМИРОВАНИЯ СОСТАВА: БИЗНЕС-МОДЕЛИ И ОПЕРАЦИОННАЯ ЭФФЕКТИВНОСТЬ В РОССИЙСКИХ ВОЛЕЙБОЛЬНЫХ КЛУБАХ

П. И. Топорнина

Аннотация. Профессиональные спортивные клубы сталкиваются с двойным вызовом: достижение спортивного успеха при сохранении финансовой устойчивости. В статье анализируются стратегии формирования состава как ключевой элемент бизнес-модели волейбольных клубов. Используя прокси-показатели – долю легионеров, воспитанников и авторский «Индекс статуса» – мы выделяем четыре бизнес-модели среди клубов российской Суперлиги. Результаты выявляют прямую корреляцию между выбранной моделью, операционными затратами и спортивным результатом, что даёт ценные инструменты для спортивного менеджмента.

Ключевые слова: бизнес-модель, операционная эффективность, стратегия формирования состава, внутренние блага, внешние блага, волейбол.

Professional sports clubs are no longer just athletic organizations – they are complex business entities [1]. They operate in a highly competitive environment, balancing sporting success against financial sustainability [4]. For volleyball clubs in the Russian Super League, the central strategic decision is how to build a competitive roster. This involves a fundamental trade-off: investing in expensive foreign stars (external source) or developing homegrown talent through academies (internal source) [5]. This choice reflects the club's priorities: immediate success versus long-term sustainability [3]. Recent scholarship critiques sport management for reducing sport to a product and athletes to assets, distinguishing between internal goods (excellence, mastery, meaningful athletic experience) and external goods (profit, fame, social outcomes) [2]. This paper applies their framework to analyze roster strategies in Russian volleyball.

A business model describes how an organization creates, delivers, and captures value [5]. For sports clubs, this value is twofold: sporting (victories) and financial

(revenue) [4]. Unlike traditional businesses, sports clubs often prioritize winning over profit, reinvesting revenues into player acquisitions and accepting losses to maximize competitive potential [2]. This "win-maximizing" behavior distinguishes sports from other industries. The core of a sports club's business model lies in its roster strategy – how it acquires, develops, and retains players. Evaluating the effectiveness of these strategies requires measuring operational efficiency, defined as the relationship between resources invested and results achieved [3]. While sporting output is easily measured through league standings, input costs are difficult to access without salary data, leading researchers to employ proxy indicators. Building on this tradition, we introduce a "Status Index" as a proxy for player market value.

However, financial metrics alone miss what makes sport different. Gammelsæter and Anagnostopoulos [2] show that sport produces two kinds of value. One is internal: the skills, mastery, and meaningful experience that athletes gain from the game itself. The other is external: money, fame, and social recognition – things that matter more to sponsors, media, and officials. Clubs need organizations to survive, but chasing external success often undermines the internal goods that give sport its purpose. This tension is at the heart of every club's strategic choices. To conceptualize this tension, the authors propose four quadrants of sport outcomes:

– Quadrant I (Excellence) combines high internal and high external goods;

– Quadrant II (Exploitation) achieves external success at the cost of internal goods;

– Quadrant III (Attrition) sees both internal and external goods decline;

– Quadrant IV (Obsession) pursues internal excellence at any cost, often through unethical means.

This framework provides a lens for interpreting how different roster strategies balance athlete development against commercial success.

To test this framework empirically, we conducted a comparative case study of four Russian Super League clubs from the 2024/2025 season: Zenit-Kazan (1st place), Zenit St. Petersburg (2nd), Dinamo-LO (4th), and Kuzbass (8th). These clubs represent distinctly different approaches to roster construction. Data on team composition came from the All-Russian Volleyball Federation website, while player biographies and national team statistics were sourced from Volleybox.net. We focused on the core rotation – players with the highest playing time in key matches. To estimate operational costs without salary data, we developed a proprietary "Status Index". Each player received:

– 3 points: senior national team players from FIVB top-20 countries (Poland, Brazil, Italy, USA);

– 2 points: youth national team players from these countries, or foreign players in top leagues (Italy, Poland, Turkey);

– 1 point: all other players.

The club's total Status Index sums the scores for its core rotation.

Table 1 presents four distinct roster strategies identified through our analysis. Each represents a different approach to balancing the tension between internal and external goods, and each tells its own story.

Table 1 – Comparative analysis of roster strategies

Parameter	**Zenit-Kazan**	**Zenit (SPb)**	**Dinamo-LO**	**Kuzbass**
Foreign players, (%)	25	37.5	37.5	12.5
Academy graduates, (%)	50	0	12.5	25
Invited Russian players, (%)	25	62.5	50	62.5
Average age	29.5	28	33	30
Status Index	21	17	14	14
Final league position	1	2	4	8
Business model	Elite Hybrid	International Selection	Pragmatic Balance	Territorial Academy

Zenit-Kazan presents what we call the "Elite Hybrid" model. With the highest Status Index (21) and a remarkable 50% of academy graduates, this club demonstrates that investing in stars does not have to come at the expense of developing homegrown talent. Quite the opposite – here, they complement each other. Applying Gammelsæter and Anagnostopoulos's framework [2], Zenit-Kazan achieves both high external goods (the championship title) and high internal goods (genuine commitment to athlete development). Players are treated as subjects, not assets. This is Quadrant I (Excellence) – the ideal balance that every club strives for.

Zenit St. Petersburg offers a radically different picture. The "International Selection" model relies exclusively on ready-made players: zero academy graduates, 37.5% foreigners, and a high Status Index of 17. The result is second place – undeniably a strong external success. But there is a cost. With no homegrown players, athletes' risk being reduced to "income-earning assets." This model leans toward Quadrant II (Exploitation), where external achievements are built on shaky internal foundations. The practice community – the very source of long-term vitality – is simply absent.

Dinamo-LO takes yet another path. Their "Pragmatic Balance" model mixes veterans with carefully chosen foreign players. The average age is the highest in the league (33), and the Status Index is modest (14). Yet they finished fourth – a remarkable result for a club with limited resources. This is efficiency in the short term. But it also raises uncomfortable questions: What happens when the veterans retire? Where are the young players who will carry the club forward? The internal goods for the next generation remain an open question.

Finally, Kuzbass represents the "Territorial Academy" model. A quarter of the core rotation are club-grown players – a genuine commitment to internal goods. But with a Status Index of only 14 and an 8th-place finish, it becomes clear that academy work alone cannot compensate for the absence of star quality. This is Quadrant III (Attrition): internal goods are cultivated, but without external success, young talents risk discouragement and dropout. Strategic investment in star players could shift Kuzbass toward Quadrant I, following the logic of increasing returns: when a solid homegrown base is complemented by targeted star acquisitions, the result can be greater than the sum of its parts.

Our analysis shows no universal formula for success. Each strategy represents a different way of balancing internal and external goods. The "Elite Hybrid" demonstrates that academy investment and star acquisitions can be complementary, supporting Gammelsæter and Anagnostopoulos's call for research targeting both goods simultaneously.

For practitioners, we recommend:

− Implementing analytics that assess players' market value and psychological profiles – recognizing athletes as subjects, not assets.

− Developing "target graduate profiles" for academies aligned with first-team strategy.

− Conducting regular strategic audits using indicators like the Status Index to ensure external pursuits do not erode internal goods.

These tools will not replace managerial intuition, but they can support it – helping clubs make smarter, more balanced decisions. Because in the long run, the clubs that thrive will be those that remember: sport is not just about winning trophies. It is about building people.

REFERENCES

1. Demir, G. (2022) Management Process in Incorporated Football Clubs: Istanbul Başakşehir Football Clubs Example. Pakistan Journal of Medical and Health Sciences, 16(2), 834-837. URL: https://pjmhsonline.com/index.php/pjmhs/article/view/308/303 (accessed 04.02.2026).

2. Gammelsæter H., & Anagnostopoulos C. (2024) Enhancing the goods of sport: conceptualizing metatheory of sport management. European Sport Management Quarterly, 24(3), 581-598. URL: https://www.tandfonline.com/doi/full/10.1080/16184742.2024. 2409236 (accessed 15.10.2025).

3. Kızılgüneş M., & Koçak F. (2021) Investigation of corporate social responsibility in sports within the scope of corporate sustainability. The Journal of Eurasia Sport Sciences and Medicine, 3(2), 70-83. URL: https://dergipark.org.tr/en/download/article-file/1936569 (accessed 02.02.2026).

4. Manzari A., Savio R., & Marandola M. (2024) The Impact of Corporate Governance on Financial Performance in Professional Sports Clubs: The Case of Italian Serie A. International Journal of Business and Management, 19(1), 173-180. URL: https://ccsenet.org/journal/index.php/ijbm/article/download/0/0/49700/53830 (accessed 14.02.2026).

5. Wiśniewski A., & Siemiński, M. (2023) Business Models Trends in Sport. In Business Model Shift, 1-14. URL: https://www.taylorfrancis.com/reader/read-online/062ddb21-ab9d-4b35-9fec-576e31cddfa7/chapter/pdf?context=ubx (accessed 05.02.2026).

APPLYING INFORMATION AND ANALYTICS TO BUSINESS PROCESS, FINANCE, AND ECONOMIC SECURITY

AI-DRIVEN ESG INTEGRATION FOR RISK-ADJUSTED FINANCIAL PROJECT MANAGEMENT IN THE DIGITAL ECONOMY

R. T. Abutalipova

Research advisor: G. K. Mukhanova, PhD (Economics)

Astana, *Astana IT University*,
rosiettan23@gmail.com

Abstract. Traditional financial project appraisal methods increasingly fail to capture sustainability risks and long-term value drivers in the digital economy. This study proposes an artificial intelligence-driven framework that integrates Environmental, Social and Governance indicators into automated project evaluation. The approach translates ESG variables into risk metrics and improves risk-adjusted financial decision-making for housing projects and public finance programs.

Keywords: environmental, social and governance integration, artificial intelligence (AI), machine learning (ML), risk-adjusted valuation, sustainable finance, project finance, business-process automation, data analytics

ИНТЕГРАЦИЯ ESG НА ОСНОВЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА ДЛЯ УПРАВЛЕНИЯ ФИНАНСОВЫМИ ПРОЕКТАМИ С УЧЕТОМ РИСКОВ В ЦИФРОВОЙ ЭКОНОМИКЕ

Р. Т. Абуталипова

Аннотация. Традиционные методы оценки финансовых проектов всё чаще оказываются недостаточными для учёта рисков устойчивого развития и долгосрочных факторов создания стоимости в условиях цифровой экономики. В данном исследовании предлагается основанная на искусственном интеллекте модель, интегрирующая показатели Environmental, Social и Governance (ESG)

в автоматизированную систему оценки проектов. Предложенный подход переводит ESG-переменные в метрики риска и повышает качество принятия финансовых решений с учётом риск-корректированной оценки для жилищных проектов и программ государственного финансирования.

Ключевые слова: интеграция ESG, искусственный интеллект, машинное обучение, риск-корректированная оценка, устойчивые финансы, проектное финансирование, автоматизация бизнес-процессов, аналитика данных.

Introduction

Indicators like Net Present Value (NPV), Internal Rate of Return (IRR), and payback period are typically used in financial project appraisal. However, sustainability concerns, environmental effects, governance shortcomings, and social externalities that affect long-term project success are frequently overlooked by these measurements. Traditional evaluation techniques are becoming inadequate for handling complicated financial initiatives in the digital economy, where decision-making increasingly depends on data analytics and automated technologies [5].

Financial institutions are incorporating Environmental, Social, and Governance (ESG) considerations into financial decision-making due to the growing significance of sustainable development. The resilience and risk profile of investment projects are influenced by environmental performance, social impact, and governance quality, all of which are reflected in ESG indices [6]. ESG integration is still difficult, though, because data come from a variety of sources and employ various techniques, which results in inconsistent ESG scores and restricts its application in quantitative models [1].

AI and ML provide new opportunities to address these challenges by enabling automated processing of large datasets and identification of relationships between sustainability indicators and financial risks [7]. At the same time, international sustainability disclosure standards such as IFRS S1 and IFRS S2 aim to improve transparency and comparability of sustainability-related financial information [8].

In Kazakhstan, sustainable finance initiatives are gradually expanding as regulators introduce ESG disclosure guidelines and encourage financial institutions to integrate sustainability considerations into investment decisions [3]. In this context, the study proposes a conceptual framework for AI-driven ESG integration that automates the translation of sustainability indicators into financial risk variables and incorporates them into risk-adjusted project evaluation models. Table 1 presents the conceptual architecture of the proposed framework.

The proposed architecture demonstrates how ESG indicators can be systematically transformed into quantitative inputs for financial risk models. This approach enables financial institutions to move from narrative ESG reporting toward

automated, data-driven sustainability analytics integrated into financial project management workflows.

Table 1. Conceptual architecture of AI-driven ESG integration for financial project evaluation

Stage	Key elements
ESG data sources	Sustainability reports, regulatory disclosures, project data, climate scenarios
Data processing & validation	Data cleaning, missing value detection, governance controls
ESG indicator standardization	Normalization, feature engineering, ESG Integration Index
Machine learning risk modeling	Logistic regression, gradient boosting, risk prediction
Risk-adjusted financial evaluation	Expected cash flows, probability of default, risk-adjusted NPV
Decision support	Investment approval, risk monitoring, policy decisions

Methodology

The integration of Environmental, Social and Governance (ESG) indicators into financial project management requires a methodological framework capable of translating sustainability indicators into quantitative financial risk parameters. Traditional ESG reporting produces descriptive sustainability metrics, while financial decision-making requires measurable variables that can be incorporated into risk models and valuation frameworks. Therefore, the proposed methodology combines data standardization, econometric modeling, and machine learning methods to automate ESG integration in financial project evaluation.

The framework consists of four analytical stages: ESG data collection, indicator standardization, risk modeling, and risk-adjusted financial valuation. Together these stages form an automated analytical workflow that transforms heterogeneous ESG information into decision-relevant financial metrics.

The first stage involves collecting ESG indicators from multiple sources, including sustainability disclosures, regulatory reports, technical project documentation, and external ESG databases. Because ESG data are heterogeneous, indicators must be standardized before being used in quantitative models. Data standardization improves comparability across projects and reduces measurement bias [6].

To normalize ESG indicators, the study applies a standard score transformation. For an ESG indicator *k*observed for project *i*, the standardized value is calculated as:

$$z_{i,k} = \frac{x_{i,k} - \mu_k}{\sigma_k},$$

where $x_{(i,k)}$ – is the observed value of indicator *k* for project *i*; μ_k – represents the mean value of indicator *k* across all projects; σ_k – denotes the standard deviation of indicator k.

Standardized indicators are then aggregated into a composite Environmental, Social and Governance Integration Index (ESGI), which represents the sustainability performance of a project and serves as an input variable for financial risk models.

$$ESGI_i = \sum_{k=1}^{K} w_k \cdot z_{i,k} \text{ subject to } \sum_{k=1}^{K} w_k = 1 \; w_k \geq 0$$

where w_k represents the weight assigned to ESG indicator k; *K* denotes the total number of ESG indicators.

The ESG Integration Index is not intended to replicate external ESG ratings but to provide a consistent internal analytical indicator that allows financial institutions to integrate sustainability factors into automated risk evaluation processes [1].

The second stage translates ESG indicators into financial risk metrics. Logistic regression is widely used in financial risk modeling to estimate the probability of default based on explanatory variables. In the proposed framework, the ESG Integration Index is incorporated together with traditional financial indicators:

$$PD_i = \frac{1}{1 + \exp\left(-\left(\beta_0 + \beta_1 + \beta_2 X_i\right)\right)},$$

where PD_i – denotes the probability of default for project *i*; $ESGI_i$ – represents the ESG Integration Index; X_i denotes a vector of traditional financial variables such as leverage, liquidity, and project maturity.

Machine learning methods can further improve predictive accuracy by capturing nonlinear relationships between ESG indicators and financial risks. Gradient-boosted decision tree algorithms such as Extreme Gradient Boosting (XGBoost) are widely used in financial risk modeling due to their high predictive performance and ability to process structured financial data efficiently [7].

The final stage incorporates risk parameters into financial valuation models. In project finance, expected cash flows must be adjusted for default probability and potential losses:

$$E\left[CF_t\right] = \sum_s \pi(s) \cdot CF(t,s) \cdot \left(1 - PD(t,s) \cdot LGD(t,s)\right),$$

where $CF(t,s)$ – represents cash flow in period t under scenario s; $\pi(s)$ – denotes the probability of scenario s; $PD(t,s)$ – is the probability of default; $LGD(t,s)$ – denotes loss given default.

Based on expected cash flows, the risk-adjusted Net Present Value of a project can be calculated as:

$$NPV_{RA} = \sum_{t=1}^{T} \frac{E\left[CF_t\right]}{(1+)^t} - I_0,$$

where NPV_{RA} – represents risk-adjusted Net Present Value; r – is the discount rate; I_0 – denotes the initial project investment.

This framework enables ESG indicators to influence project valuation through their impact on risk parameters and expected cash flows. By integrating ESG data into automated analytical pipelines, financial institutions can improve project risk assessment and support more informed investment decisions in the digital economy.

Application to housing finance and policy implications

The relevance of AI-driven ESG integration is particularly evident in housing finance, where project performance depends not only on financial indicators but also on sustainability factors such as energy efficiency, housing affordability, and governance quality.

Environmental indicators influence operating costs and asset resilience. Energy-efficient buildings reduce default risk and improve property value stability, making variables such as energy consumption and emissions useful predictors in financial risk models [10].

Social factors, including housing affordability and infrastructure accessibility, affect demand stability and occupancy rates, while governance indicators such as transparency and contractor reliability influence project risks and implementation quality [2].

Artificial intelligence technologies enable financial institutions to process heterogeneous ESG datasets and identify relationships between sustainability indicators and financial risks, improving the accuracy of project evaluation [5].

For public investment programs, automated ESG evaluation supports more effective resource allocation by prioritizing projects with both financial and sustainability benefits. In Kazakhstan, the introduction of ESG disclosure guidelines

further increases the need for analytical tools capable of integrating sustainability indicators into financial decision-making [9].

Thus, AI-based ESG analytics can enhance risk assessment, improve investment transparency, and support sustainable housing development.

Conclusion

The digital economy is transforming financial project management and increasing the need for data-driven analytical tools. Traditional evaluation methods based on indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and payback period often fail to account for sustainability risks and non-financial factors that influence long-term project performance.

This study demonstrates that integrating Environmental, Social and Governance (ESG) indicators into financial evaluation improves risk assessment and provides a more comprehensive understanding of project sustainability. Environmental factors affect operational costs and asset resilience, social factors influence demand stability, and governance indicators reflect management quality and regulatory compliance.

Artificial intelligence technologies enable automated processing of ESG data and improve the accuracy of financial risk prediction. The proposed framework shows how ESG indicators can be standardized, aggregated into an Environmental, Social and Governance Integration Index, and incorporated into probabilistic risk models and risk-adjusted financial valuation.

The results highlight the practical relevance of AI-driven ESG integration for housing finance and public investment programs. Incorporating sustainability indicators into automated analytical systems can improve credit risk assessment, enhance transparency, and support more sustainable financial decision-making.

Overall, the integration of artificial intelligence and ESG analytics represents an important step toward modernizing financial project evaluation in the digital economy and strengthening sustainable financial systems.

REFERENCES

1. Agosto A., & Tanda A. (2025). Divergence and aggregation of ESG ratings: A survey. *Open Research Europe*, 5, 28.

2. Basel Committee on Banking Supervision. (2013). *Principles for effective risk data aggregation and risk reporting* (*BCBS 239*). Bank for International Settlements.

3. Basel Committee on Banking Supervision. (2022). *Principles for the effective management and supervision of climate-related financial risks*. Bank for International Settlements.

4. Berg F., Kölbel J. F., & Rigobon R. (2022). Aggregate confusion: The divergence of ESG ratings. *Review of Finance*, 26(6), 1315–1344.

5. Chen T., & Guestrin C. (2016). XGBoost: A scalable tree boosting system. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 785–794).
6. European Commission. (2025). *ESG rating activities*: *Regulation* (*EU*) *2024/3005 on the transparency and integrity of ESG rating activities*.
7. European Commission. (2025). *Artificial Intelligence Act*: *Shaping Europe's digital future*.
8. Network for Greening the Financial System. (2024). *NGFS climate scenarios for central banks and supervisors*.
9. Organisation for Economic Co-operation and Development. (2025). *Behind ESG ratings*: *Unpacking sustainability metrics*.
10. UNEP Finance Initiative. (2024). *Banking on green buildings*: *Financing energy efficiency in buildings*. United Nations Environment Programme.

STRATEGIC DESIGN MANAGEMENT IN DIGITAL ECONOMIES: BUSINESS MODELS, INTELLECTUAL PROPERTY, AND EDUCATIONAL IMPERATIVES FOR THE AI ERA

A. E. Efremova, I. Boboshozoda

Transbaikal State University, Chita, Russia-Tajikistan,
allapersona@mail.ru

Abstract. The convergence of artificial intelligence with digital economies has fundamentally altered the landscape in which design operates, demanding a reconceptualization of strategic design management. This article examines the intersection of business model innovation, intellectual property protection, and educational transformation as critical pillars for design leadership in the AI era, with particular attention to the Russian context.

Keywords: design management, digital economy, artificial intelligence, business models, Russian design education

СТРАТЕГИЧЕСКОЕ УПРАВЛЕНИЕ ДИЗАЙНОМ В ЦИФРОВОЙ ЭКОНОМИКЕ: БИЗНЕС-МОДЕЛИ, ИНТЕЛЛЕКТУАЛЬНАЯ СОБСТВЕННОСТЬ И ОБРАЗОВАТЕЛЬНЫЕ ИМПЕРАТИВЫ ЭПОХИ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

А. А. Ефремова, И. Бобошозода

Аннотация. Конвергенция искусственного интеллекта с цифровой экономикой коренным образом изменила ландшафт, в котором функционирует дизайн, требуя переосмысления стратегического управления дизайном. В данной

статье рассматривается пересечение инноваций в бизнес-моделях, защите интеллектуальной собственности и образовательной трансформации как важнейших столпов лидерства в дизайне в эпоху искусственного интеллекта с особым вниманием к российскому контексту.

Ключевые слова: управление дизайном, цифровая экономика, искусственный интеллект, бизнес-модели, российское дизайн-образование

Introduction

The birth of digital economies has fundamentally altered economic structures, positioning design at the centre of strategic business decisions that determine organisational success. In Russia, this transformation carries particular significance, with artificial intelligence development designated a state policy priority through the National Strategy for AI (Artificial Intelligence) Development until 2030 and federal projects under the National Digital Economy Programme [1, 8].

This article addresses three interconnected dimensions of strategic design management through the lens of Russian experience: the evolution of business models enabled by design-led innovation, the transformation of intellectual property frameworks necessitated by AI-generated design within the Russian legal context, and the educational imperatives for preparing future designers as strategic leaders. By examining these dimensions through Russian sources including legal analysis, university initiatives, and industry case studies, the article aims to provide design students with a comprehensive understanding of the strategic terrain they will navigate.

Methods

The article employs a multi-method qualitative approach. Document analysis examines Russian strategic policy documents including the National Strategy for AI Development. Case study methods examine Russian implementations of cases characteristic of strategic design. Legal analysis examines the Russian Civil Code, Supreme Court rulings, and legislative proposals related to AI-generated works. A review of educational programs examines initiatives at Russian universities and Sino-Russian cooperation programs.

Discussion

The transition from design as tactical function to design as strategic capability represents a fundamental shift. In Russia, this transition is shaped by both global technological trends and domestic priorities for digital sovereignty. Business models encompass multiple value layers: proposition, creation, delivery, and capture. Design contributes to each, from shaping compelling propositions through user

research to enabling efficient delivery through intuitive interfaces. The following examples of business model innovations in the Russian digital economy in the design sector illustrate its strategic reorientation.

Russia's largest bank "Sber" provides a compelling example of large-scale superiority in design. Its "Pulse" human resources platform, developed with a strictly mobile-first approach, received the Red Dot Design Award [7]. Pulse functions as a unified system for completing mandatory tasks such as goal setting and optional tasks like career planning. Created with human-centred design principles, the platform features a contemporary graphical user interface. The project team included specialists in product management, creative direction, art direction, graphic design, and project management – demonstrating the interdisciplinary collaboration characteristic of strategic design [6].

Other compelling case studies were presented at the All-Russian Forum on Interface Design and User Experience Improvement, "UX/UI 2025," organized by InterForum in November 2025 [13]. Representatives of leading Russian companies attended the forum, including a leading product designer at Yandex ECOM, the design director of the Center for Digital HR (Human Resources) Technologies at Greenatom, the design director of Skillbox production, the product art director at Wildberries&Russ, and the design director at Gazprom Neft. The presented case studies illustrate the infrastructural aspects of strategic design management. For example, in the case study "Harmonious Design as the Key to Balancing Business and Users," Daria Romanycheva, the lead product designer at Citydrive, demonstrated to the audience the complexities and contradictions designers face when, on the one hand, they must consider business requirements (increasing sales, clicks, and profits) while, on the other hand, creating a user-friendly and attractive user interface. Using a real-life case study from CityDrive and the SberSpasibo service, the speaker examined in detail the process of design adaptation, maintaining the corporate identity, and gradually implementing all necessary changes. The presentation also emphasized effective communication between designers, businesses, and users, as well as the ability to find compromise solutions. Other speakers demonstrated how design tools become strategic decisions that impact an organization's capabilities.

Creative industries can be drivers of cultural identity. Beyond individual companies, strategic design management functions within broader initiatives to develop creative industries. For example, the Moskino Film Factory and "I'm on Style" project represent an innovative model for integrating creative industries into cultural identity formation. The Moskino film cluster functions as an ecosystem where traditions of Russian cinema combine with advanced creative and IT (Information Technologies) technologies, encompassing full-cycle filmmaking,

fashion industry development, digital technology innovation including VR/AR (Virtual Reality/Augmented Reality), and educational programmes.

The "I'm on Style" fashion and design pavilion houses a laboratory and showroom that serves as an incubator for young design talents, a platform for cross-industry collaborations, a laboratory for developing new production technologies, and a centre for popularising Russian design [4].

The Agency for Creative Industries, in collaboration with the Union of Designers of Russia, is holding the "Design Factory 3.0" competition. Participants from across Russia are presenting innovative design solutions for clients. Clients include the Gus' Crystal Factory, the developer and manufacturer of educational robotics, ROBBO, the tech IT company producing new paradigm products for efficient power supply, VOLTS Battery Ltd., and other businesses. As part of the project, designers propose innovative business solutions. These include the creation of "smart" furniture and lighting, interactive educational toys, brand identities for domestic and international markets, and a mobile app interface for children with special needs [2].

In the era of AI-powered design, the issue of intellectual property is becoming increasingly pressing. In Russia, intellectual property protection is implemented within the framework of established legal doctrines, taking into account new technological realities [5].

Under current Russian legislation, the author of intellectual activity results and the initial holder of exclusive rights can only be an individual whose creative work created such results (Clauses 1 and 3 of Article 1228 of the Civil Code of the Russian Federation) [3]. The Civil Code and explanatory acts of the Supreme Court proceed from "aesthetic neutrality" – results are presumed created by creative work until proven otherwise [15]. The law specifies cases not recognized as creative contribution: technical, consulting, organizational, material assistance, and control over creation.

However, these clarifications prove insufficient for AI-generated content. Neural networks perform broader tasks that could be conditionally qualified as "co-authorship." From the definition of artificial intelligence, AI technology imitates human cognitive functions, and AI results are comparable to or superior to human intellectual activity.

A key question concerns whether human participation in AI-generated design by creating the "prompt" constitutes creative contribution warranting legal protection.

The minimal unit of human participation is the prompt – a pre-formulated request or instruction for a neural network describing a task. It is probably important to consider that the creation of a product is based on the free and creative choice of the person formulating the prompt – a specific task that technically translates the author's ideas into material form [15].

Another important issue of interest to be considered within the framework of the article is the educational imperatives in the field of design in the AI-era.

Central University, a Russian university embracing the STEM (Science, Technology, Engineering, and Mathematics) approach in higher education, was created in partnership with more than 50 of Russia's largest companies and organizations and is launching a design school with an experimental user experience design program.

The launch of Central University's design school with an experimental Human Experience Design (HX-design) programme represents a significant development. Rector Evgeny Ivashkevich emphasises that this area will become key for training specialists who can not only create innovations but make them truly human-centred [12].

The two-year programme is based on interdisciplinarity – students study design at the interface with technology, humanities, and management. Unlike traditional programmes, the HX approach involves working not only with visual solutions but also with designing meanings, scenarios of human interaction with technologies, and social systems. Students choose between product design and communication design profiles. Practising industry experts teach the programme, with special attention to leadership competencies. Graduates qualify for positions as lead designers, art directors, and design strategists [12].

Chinese-Russian educational cooperation is also noteworthy. The Second Sino-Russian Forum on Culture and Arts in Higher Education, held in Harbin in September 2025, showcased the international aspects of Russian design education [11]. Organized jointly by the Heilongjiang Sanjiang Professional College of Fine Arts and the Trans-Baikal State University (ZabGU, Chita), the forum built on achievements including exchange programs, cooperative education initiatives, and the joint creation of the Academy of Modern Digital Creative Industries, which offers an international bachelor's degree program. At the forum in China, students, future leaders of the creative industries, and ZabGU lecturers learned how to turn creativity into business and explored best practices in commercializing creative projects. The forum also featured master classes led by leaders of Chinese creative clusters, discussing real-life cases of bringing creative projects to market. Chinese colleagues shared effective methods for turning student work into commercial products – from registering intellectual property to finding investors for creative startups [14].

Particular attention was paid to creating sustainable connections between creative disciplines and the business community – it is this symbiosis that allows projects to survive and develop in the market.

Oksana Olegovna Martynenko, Rector of Transbaikal State University, emphasized that the key to success lies in training specialists with a deep understanding of both cultures, aesthetics, and the business environment [9].

Strengthening international ties is currently a key element of the university's transformation strategy. Furthermore, Chinese citizens account for 92% of international students at Transbaikal State University in Chita. Chinese Sanjiang Institute actively develops a practice-oriented approach to art education. Students closely collaborate with businesses and the provincial government, participating in the design of urban spaces. According to the Rector of Transbaikal State University, this experience should be implemented in the Transbaikal region: "We have seen how systematically commercialization work is structured in China, from simple student projects to complex digital products – every project can find its consumer and become a successful business". Oksana Martynenko notes that the goal of such projects is to train specialists with intercultural competencies who are capable of bringing creative products from Russia and China to the global market [9].

Furthermore, a Russian-Chinese Institute of Design and Neuroart is planned to be established at Transbaikal State University in Chita. The program is slated to launch in the new academic year of 2026. Neuroart is an innovative field at the intersection of design, art, artificial intelligence, and digital technologies. ZabGU is interested in the implementation and development of modern technologies. Graduates of this institute are expected to receive two diplomas upon completion – one Russian and one Chinese [10].

Thus, Russian educational initiatives highlight several key competencies for future designers: digital literacy, enabling the effective use of AI tools; technical understanding sufficient for meaningful collaboration; human-computer interaction skills that view AI as a creative partner; and systems and creative thinking, enabling an understanding of how design influences business development.

Conclusion

Strategic design management in Russian digital economies demands capabilities extending far beyond traditional design expertise. Business model innovation requires understanding how value is created, delivered, and captured in digital markets. Intellectual property strategy requires navigating transforming legal frameworks that struggle to accommodate AI-generated designs – frameworks currently under review by Russian legislators and courts. Educational transformation requires reimagining how designers are prepared for careers in which technological change is constant reimagining exemplified by Central University and Sino-Russian educational collaborations.

The AI-era will reward designers who can integrate technological capability with strategic vision, legal awareness with creative ambition, and professional expertise with humanistic wisdom. Strategic design management, understood in this

integrated way, offers a framework for meeting this challenge. The designers who embrace it will not only survive the transformations ahead but will lead them contributing to Russia's digital sovereignty, creative economy development, and cultural identity preservation while competing successfully in global markets.

REFERENCES

1. Averyanov A. O. Managing the Development of Artificial Intelligence in Russia through the Prism of Theory and Methodology of Strategizing // Administrative consulting. 2024. N 6. P. 240-254. (in English).

2. Fabrika dizayna 3.0: kak konkurs prevrashchaetsya v federal'nuyu ploshchadku i zadaet novye standarty dlya industrii // Zhurnal o dizayne inter'era i arkhitekture. [Design Factory 3.0: How a Competition Is Transforming into a Federal Platform and Setting New Standards for the Industry // Interior Design and Architecture Magazine]. – URL: https://decornews.ru/editors-choice/fabrika-dizajna-3-0-kak-konkurs-prevrashchaetsya-v-federalnuyu-ploshchadku-i-zadaet-novye-standarty-dlya-industrii/ (Access 10.02.2026). (in Russian).

3. Grazhdanskiy kodeks Rossiyskoy Federatsii. Stat'ya 1228. Avtor rezul'tata intellektual'noy deyatel'nosti. [Civil Code of the Russian Federation. Article 1228. Author of the result of intellectual activity]. – URL: https://base.garant.ru/10164072/ c9dba8812fc 7519f26a2f33227305022/ (Access 18.02.2026). (in Russian).

4. International Women's Union. Moscow's Creative Industries as Drivers of the Cultural Code // International Women's Union. – 29.04.2025. – URL: https://www.iwuorg. com/kreativnye-industrii-moskvy-kak-drajvery-kulturnogo-koda-moda-kino-animaciya-i-novye-media-v-formirovanii-rossijskoj-identichnosti/?lang=en (Access 15.02.2026). (in English).

5. Lukashova A. V. Avtorskoe pravo i proizvedeniya, sgenerirovannye neyroset'yu / A.V. Lukashova // Voprosy Rossiyskoy Yustitsii / Izd-vo: FGBOU VO «Ural'skiy gosudarstvennyy yuridicheskiy universitet», Ekaterinburg. 2024. – Vyp. 28. – S. 122-132. [Lukashova A. V. Copyright and works generated by a neural network / A. V. Lukashova // Issues of Russian Justice / Publisher: Ural State Law University, Yekaterinburg. 2024. - Issue 28. – Pp. 122-132]. – URL: https://cyberleninka.ru/article/n/avtorskoe-pravo-i-proizvedeniya-sgenerirovannye-neyrosetyu (Access 17.02.2026). (in Russian).

6. Red Dot Design Award. Pulse: Human Resources Platform. – URL: https://www.red-dot.org/project/hr-platform-pulse-55316 (Access 18.02.2026). (in English).

7. Sber pobedil v pyati nominatsiyakh prestizhnoy premii Red Dot Awards// Nezavisimaya Gazeta. [Sberbank won five nominations at the prestigious Red Dot Awards// Nezavisimaya Gazeta] – 28.08.2021. – URL: https://www.ng.ru/news/717822.html (Access 18.02.2026). (in Russian).

8. Ukaz Prezidenta Rossiyskoy Federatsii «O razvitii iskusstvennogo intellekta v Rossiyskoy Federatsii». – 10.10.2019. № 490. [Decree of the President of the Russian Federation "On the development of artificial intelligence in the Russian Federation"]

10.10.2019 г. № 490. – URL: \https://normativ.kontur.ru/document?moduleId=1&documentId=471786 (Access 22.02.2026). (in Russian).

9. Van-Fu-Li T., Shadrina A., Prodan A. Studenty ZabGU predstavili kitayskoy delegatsii svoi kartiny // Regional'nyy televizionnyy kanal «Zabaykal'e» (RTK «Zabaykal'e»). [Van-Fu-Li T., Shadrina A., Prodan A. Students of Zabaykal State University presented their films to the Chinese delegation // Regional television channel "Zabaykalye" (RTK "Zabaykalye")]. – 05.02.2026. – URL: https://zrtk.ru/posts/16008-studenty_zabgu_predstavili_ delegacii_knr_svoi_kartiny (Access 18.02.2026). (in Russian).

a. V Chite planiruyut sozdat' Rossiysko-kitayskiy institut dizayna v 2026 godu // Informatsionnoe agentstvo TASS [A Russian-Chinese Design Institute is planned to be established in Chita in 2026 // TASS News Agency]. – 05.02.2026. – URL: https://tass.ru/obschestvo/26352329 (Access 18.02.2026). (in Russian).

b. V Kharbine sostoyalsya 2-y Kitaysko-rossiyskiy forum po vysshemu obrazovaniyu v sfere kul'tury i iskusstva // Kitayskiy informatsionnyy internet-tsentr [The 2nd China-Russia Forum on Higher Education in Culture and Arts was held in Harbin // China Internet Information Center]. Russian. China. Org. CN. – 24.09.2025. – URL: \http://russian.china.org.cn/china/txt/2025-09/24/content_118095820.htm (Access 18.02.2026). (in Russian).

c. V Rossii nachnut gotovit' dizaynerov-strategov novogo pokoleniya // Izvestiya. [Russia will begin training a new generation of strategic designers // Izvestia] - 27.05.2025. – URL: https://iz.ru/1893336/2025-05-27/v-rossii-nachnut-gotovit-dizainerov-strategov-novogo-pokoleniia (Access 18.02.2026). (in Russian).

d. Vserossiyskiy forum po dizaynu interfeysa i uluchsheniyu pol'zovatel'skogo opyta «UX/UI 2025» [All-Russian Forum on Interface Design and User Experience Improvement "UX/UI 2025"] // OOO Inter forum. – 14.11.2025. – URL: https://interforums.ru/uxui25/home?utm_source (Access 15.02.2026). (in Russian).

e. Zhen'min' Zhibao Onlayn // Gazeta Kitayskoy Narodnoy Respubliki [Zhen'min' Zhibao Online // Newspaper of the People's Republic of China]. – 25.09.2025. – URL: https://russian.people.com.cn/n3/2025/0925/c31516-20370613.html (Access 18.02.2026). (in Russian).

f. Zuykov S. Neyroset' i avtorskoe pravo: granitsy tekhnicheskogo sodeystviya i tvorcheskogo vklada // Zuykov i partnery. [Zuikov S. Neural network and copyright: the boundaries of technical assistance and creative contribution // Zuikov and partners]. – 12.02.2026. – URL: https://zuykov.com/about/articles/neiroset-i-avtorskoe-pravo-granitsi-tekhnicheskogo-sodeistviya-i-tvorcheskogo-vklada/ (Access 17.02.2026). (in Russian).

ANALYSIS OF BUSINESS PROCESSES FOR FINANCING THE "GREEN" TRANSITION IN SINGLE-INDUSTRY TOWNS AS A TOOL FOR IDENTIFYING THREATS TO ECONOMIC SECURITY AND MONEY LAUNDERING SCHEMES

A. L. Gieeva, E. A. Prikhodko

Novosibirsk, Novosibirsk State Technical University,
baekmirs@yandex.ru

Abstract. This study examines the financing of the "green" transition in Russian single-industry towns, highlighting associated economic security risks. It analyzes the structure of financing business processes and proposes a system of risk indicators to identify money laundering schemes. The findings underscore the need for enhanced information and analytical tools to mitigate these threats and ensure the sustainable development of these vulnerable territories.

Keywords: single-industry towns, green transition, economic security, money laundering, business processes, risk indicators, decarbonization, sustainable development.

АНАЛИЗ БИЗНЕС-ПРОЦЕССОВ ФИНАНСИРОВАНИЯ «ЗЕЛЁНОГО» ПЕРЕХОДА В МОНОГОРОДАХ КАК ИНСТРУМЕНТ ВЫЯВЛЕНИЯ УГРОЗ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ И СХЕМ ОТМЫВАНИЯ ДЕНЕГ

А. Л. Гиёва, Е. А. Приходько

Аннотация. В данном исследовании рассматривается финансирование «зелёного» перехода в российских моногородах с акцентом на связанные с этим риски для экономической безопасности. Анализируется структура бизнес-процессов финансирования и предлагается система индикаторов риска для выявления схем отмывания денег. Результаты подчёркивают необходимость совершенствования информационно-аналитических инструментов для снижения этих угроз и обеспечения устойчивого развития этих уязвимых территорий.

Ключевые слова: моногорода, «зелёный» переход, экономическая безопасность, отмывание денег, бизнес-процессы, индикаторы риска, декарбонизация, устойчивое развитие.

The rapid development of technologies actualizes the problem of their impact on the environment, which requires a comprehensive assessment of the environmental risks associated with them. In modern business practice, the answer to this challenge

is to integrate the principles of sustainable development into corporate strategies. This approach is expressed in the ESG concept, which combines environmental, social and managerial aspects of business entities ' activities.

The Russian President has approved a new, more ambitious climate goal: to reduce greenhouse gas emissions to 65-67% of 1990 levels by 2035. This indicator formed the basis of the updated national plan of Russia, which was presented to the UN at the end of 2025 [4]. The summit marked the transition from promises to an "era of implementation", setting new financial goals and updating national climate plans. The final text of COP30 received the symbolic name Global Mutirão (translated from Portuguese - "collective effort"). The document calls for maintaining multilateralism and joining forces to achieve the Goals [2]

Implementing these collective efforts requires a huge financial injection aimed at modernizing the industry and reducing the carbon footprint. The key recipients of these funds are single-industry towns – territories with a high concentration of metallurgical, coal and chemical industries. They directly depend on the city - forming enterprises (hereinafter referred to as SOEs). The financial flows of decarbonization flowing into these closed economic systems form specific business processes, the analysis of which makes it possible not only to assess the effectiveness of the "green" transition, but also to identify potential threats to economic security, including attempts to legalize criminal proceeds.

In order to ensure that large-scale financing of the "green" transition in single-industry towns does not result in the loss of control over budget funds and the growth of the shadow sector, effective information and analytical support tools are needed. Analysis of business processes of financing allows not only to assess the effectiveness of investment development, but also to identify signs of preparation or implementation of questionable operations. The use of modern financial monitoring methods, including counterparty chain analysis and risk indicators, opens up opportunities for early detection of money laundering schemes.

The structure of business processes of financing is divided into three levels: state, institutional and corporate. These three levels do not function in isolation, but within a single time sequence of financial flows. Any decarbonization project in a single-industry city, regardless of the source of funds, goes through a number of mandatory procedural stages. Let's look at this process in stages, starting with the very first and critical step-legal recognition of the project as "green".

Stage 1: Identification and classification.

At this stage, the project is recognized as "green" or "adaptive". Decree of the Government of the Russian Federation No. 1587 of September 21, 2021 "On Approval of criteria for projects of sustainable (including Green) development in the Russian

Federation and requirements for the system of Verification of instruments for financing sustainable Development in the Russian Federation" developed criteria for implementing the goals and directions of sustainable development of the Russian Federation [3]. The main purpose of the resolution is to create a taxonomy of projects that are divided into priority and other projects.

Stage 2: Consolidation of funding sources.

This stage is a combination of all methods of financing single-industry towns. These include: concessional loans through projects of VEB. RF (fund for the development of single-industry towns) [5], green bonds, ESG lending, state subsidies.

Stage 3: Monitoring and reporting.

Stage of regular audit of environmental indicators and targeted use of funds. The instruments are non-financial reporting in accordance with GRI or IFRS standards. It is at this stage that the risks and vulnerabilities of companies that hinder sustainable development are developed [6].

The" green " transition of single-industry towns, coupled with large-scale modernization of production capacities and restructuring of existing socio-economic ties, generates non-trivial challenges to economic security.

These challenges are caused by the high concentration of financial flows, the closeness of local markets, and the close affiliation of investment process participants. At the same time, such threats are usually not adequately reflected in classical business models that focus mainly on financial and economic efficiency and technical parameters of projects, but do not take into account the criminogenic risks of the transformation period. The following risks can be identified:

1. The risk of a "carbon shock" and social destabilization.

If the city-forming enterprise, in an effort to meet high ESG ratings and meet the requirements for decarbonization, decides to abruptly close the "dirty" ones, the city faces an acute socio-economic crisis. The release of a significant part of the labor force in a single-industry city, where the labor market is not diversified and there are no alternative jobs, provokes a sharp surge in unemployment, population outflow and an increase in social tension.

Typical green transition financing models that focus exclusively on achieving environmental KPIs and improving non-financial reporting do not have a mandatory "Fair Transition" stage. This stage involves the integration of a set of measures aimed at mitigating social consequences into the investment project.

2. High dependency on a single borrower

For a bank, a single-industry city is a concentration of risk. If the SOE has financial difficulties, the default will hit all related projects that also tried to "turn green".

3. Lack of local competencies

Green finance business processes require complex reporting and verification. Single-industry towns often lack specialists capable of preparing international-level documentation, which cuts them off from cheap capital.

4. Long payback cycle

Environmental projects have a payback period of 10-15 years. In conditions of volatile markets and high interest rates, private investors are reluctant to enter such projects without 100% government guarantees.

Table 1 – Matrix of key actors and their roles

Participant's Role in the WEB development process	Role in the process	Vulnerability
Russian Federation	Providing "cheap" money and guarantees	Limited budget limits
City-forming enterprise	Initiator, main borrower	Risk of falling demand for basic products
City administration	Creating infrastructure, working with the population	Low budget security
Commercial banks	Working capital financing	Sensitivity to changes in the key rate

For the business process to be sustainable, it needs to be supplemented with a "looping" mechanism: revenues from reducing environmental charges (fines) and saving energy resources should be allocated to a special fund for urban environment development, and not just go to the SOE's profit.

The high concentration of budget and investment funds in single-industry towns creates a favorable environment for theft and money laundering in the implementation of environmental projects. The analysis of practice makes it possible to identify typical ML/CFT schemes that are characteristic of "green" initiatives [1].

The most common mechanism for overstating the estimated cost of work is based on the complexity of verifying the scope of environmental measures. The objects of manipulation are land reclamation (overestimation of the volume of soil removal and recycling rates), construction of sewage treatment plants (overestimation of the cost of equipment and installation), reforestation (overestimation of the cost of planting material and plant maintenance). The difference between the actual and inflated cost is cashed out through controlled structures and returned to the initiators as a "rollback".

Another common scheme is fictitious subcontracts using "one-day firms" to withdraw funds. A general contractor affiliated with a city-forming enterprise or administration attracts subcontractors without a material and technical base, and enters into contracts with them for obviously impossible amounts of work. After the transfer of funds, subcontractors cash out and liquidate them, and the work is either not performed, or is performed by the general contractor, but is registered as a subcontractor.

A more complicated version is "carousel" schemes with multiple transfers of funds to obfuscate their origin. They are characterized by multi-level counterparty chains (including offshore companies), transit operations with the assignment of payments that are not related to real activities (consulting services), and fast withdrawal of funds. The ultimate beneficiary is the persons controlled by the initiators of the scheme.

The most dangerous scheme is the development of budget funds under the guise of "green" initiatives without a real environmental effect. Forms of implementation: pseudo-modernization (installation of idle equipment), creation of non-operational waste management facilities, manipulation of carbon units (overestimation of reduced emissions). In addition to embezzling funds, such schemes damage environmental safety and discredit the idea of a "green" transition.

The closed environment of single-industry towns increases the vulnerability of business financing processes to illegal encroachments. First of all, it is the consolidation of participants in a single circle of affiliated persons: the administration, management of the city-forming enterprise and key contractors form a closely connected community, which makes it possible to coordinate illegal actions based on personal connections, making it difficult to identify them. The lack of real competition due to the limited number of contractors excludes market pricing and allows affiliated structures to dictate terms. Social pressure serves as a cover: the implementation of decarbonization projects is presented as a condition for preserving the enterprise, so any costs are perceived by the local community as a necessary necessity, reducing public control. The intersection of financial flows, when it is difficult to divide funds for modernization and social development, allows you to mask the withdrawal of assets.

To identify threats to money laundering in "green" projects, a system of risk indicators is needed. The first indicator is the participation of high-risk contractors using the Bank of Russia's Know Your Customer platform. The presence of organizations with signs of fictitiousness requires detailed verification, since funds are most often withdrawn through them.

The second significant signal is a sharp deviation of the estimated cost from the average market indicators. Overestimation of estimates, especially for land

reclamation, construction of sewage treatment plants or reforestation, where it is difficult to verify the volume, may indicate the preparation of withdrawal of funds through "kickbacks". A suspiciously low price, on the contrary, often indicates dumping with subsequent non-performance of work or the use of low-quality materials.

A critical indicator is the contractor's lack of real resource capabilities to perform the work: own equipment, qualified personnel, and experience in similar projects. If an organization that does not have the necessary assets wins a competition to carry out complex environmental measures, it is highly likely that the real contractor is another person, and the contractor acts only as a transit link for cashing out funds.

Serious attention should be paid to the practice of splitting large contracts into many small ones to avoid competitive procedures and conduct purchases from a single supplier. This technique allows affiliated structures to receive contracts without competition, which in the conditions of single-industry towns creates almost unlimited opportunities for inflating prices in favor of "their" companies.

A typical risk indicator is also the acceptance of work carried out shortly before the reporting dates without a real check of the volume and quality. Hasty signing of acts in the absence of photo recording of stages, technical supervision conclusions or independent measurements masks either non-fulfillment of obligations or overestimation of actual volumes.

The use of the described system of indicators in the framework of information and analytical support makes it possible to identify projects with increased risks of income legalization at an early stage and initiate additional control procedures in a timely manner, which is especially important in single-industry towns, where the consequences of illegal schemes directly affect the socio-economic stability of the territory.

REFERENCES

1. Chuzhmarova S.I., Chuzhmarov A.I. Nalogovoye stimulirovaniye investitsiy v zelenyye tekhnologii: opyt otdel'nykh stran [Tax incentives for investments in green technologies: experience of selected countries]. *Finansovyy zhurnal*, 2023, vol. 15, no. 2, pp. 74-89. Available at: https://cyberleninka.ru/article/n/nalogovoe-stimulirovanie-investitsiy-v-zelenye-tehnologii-opyt-otdelnyh-stran (accessed 20.02.2026). (In Russian)

2. Itogi 30-y sessii Konferentsii storon Ramochnoy konventsii ob izmenenii klimata [Results of the 30th session of the Conference of the Parties to the UN Framework Convention on Climate Change]. Russian International Affairs Council (RIAC), 2026. Available at: russiancouncil.ru (accessed 20.02.2026). (In Russian)

3. Ob utverzhdenii kriteriyev proyektov ustoychivogo (v tom chisle zelenogo) razvitiya v Rossiyskoy Federatsii i trebovaniy k sisteme verifikatsii proyektov ustoychivogo (v tom

chisle zelenogo) razvitiya v Rossiyskoy Federatsii: Postanovleniye Pravitel'stva RF ot 21.09.2021 № 1587 [On approval of criteria for sustainable (including green) development projects in the Russian Federation and requirements for the verification system of sustainable (including green) development projects in the Russian Federation: Decree of the Government of the Russian Federation of September 21, 2021 No. 1587]. GARANT: Legal Reference System. Available at: base.garant.ru (accessed 20.02.2026). (In Russian)

4. Prezident utverdil novuyu tsel' po snizheniyu vybrosov parnikovykh gazov [The President approved a new goal for reducing greenhouse gas emissions]. Ministry of Economic Development of the Russian Federation, 2020. Available at: www.economy.gov.ru (accessed 20.02.2026). (In Russian)

5. Proyekty razvitiya dlya gorodov i ekonomiki [Development projects for cities and the economy]. VEB.RF: State Development Corporation. Available at: https://вэб.рф/ (accessed 20.02.2026). (In Russian)

6. VEB.RF. Natsional'naya metodika zelenogo finansirovaniya. Taksonomiya zelenykh proyektov i trebovaniya k sisteme verifikatsii [National green finance methodology. Taxonomy of green projects and requirements for the verification system]. Moscow: State Development Corporation VEB.RF, 2021. Available at: https://veb.ru/ustojchivoe-razvitie/zelyonye-finansy/ (accessed 20.02.2026). (In Russian)

ASSESSMENT OF THE BUSINESS RISKS OF WHOOSH HOLDING PJSC AS A FACTOR OF GOING CONCERN

A.V. Gordt

Research advisor: T. V. Zhukova, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
alya.gordt@mail.ru

Abstract. The purpose of this study was to assess the going concern of PJSC "WHOOSH Holding", which depends not only on the company's current financial performance indicators but also on the specifics of its operations, including financial and non-financial risks. To this end, an analysis of the risks disclosed in the company's annual report for investors was conducted. Based on the information published by the company, the study determined that the operational and financial activities are in line with the company's development trend, and no significant risks regarding the organization's going concern were identified.

Keywords: going concern, operational risks, financial risks.

ОЦЕНКА РИСКОВ ДЕЯТЕЛЬНОСТИ ПАО «ВУШ ХОЛДИНГ» КАК ФАКТОР НЕПРЕРЫВНОСТИ ДЕЯТЕЛЬНОСТИ

А. В. Гордт

Аннотация. Целью данного исследования являлась оценка непрерывности деятельности ПАО «ВУШ Холдинг», которая зависит не только от показателей текущего финансового состояния компании, но и от особенностей ее деятельности, включая риски финансового и нефинансового характера. Для этого был проведен анализ рисков, раскрытых в годовом отчете для инвестора компании. В результате исследования на основе опубликованной компанией информации определено, что операционная и финансовая деятельность находится в тренде развития компании, и серьезных рисков в отношении непрерывности деятельности организации не выявлено.

Ключевые слова: непрерывность деятельности, операционные риски, финансовые риски.

Assessment of an organization's going concern is one of the most critical aspects of an enterprise's operations in the foreseeable future. Such an assessment must be conducted in a timely manner to identify risks and take measures to reduce them to an acceptable level or eliminate them to ensure continued operations.

In terms of financial conditions, positive indicators have been identified that point to the development and expansion of the activities of PJSC "WHOOSH Holding". In the long term, these could lead the organization to a stable level of qualitative financial performance. However, there is a liquidity risk, which is mentioned in the financial statements and is under the control of management.

Based on the results of the analysis of risks associated with operational activities, it can be concluded that there are no signs of an intention to liquidate or cease operations. The company demonstrates steady asset growth – from RUB 11.4 billion in 2022 to RUB 21.9 billion in 2024. Investment activity (procurement of personal mobility devices in 2024) confirms the company's long-term development plans. The company's profitability remains at a high level.

The operational activity of PJSC "WHOOSH Holding" according to the annual report for investors for 2024 is presented in Table 1.

The presented data characterize the rapid development of the operational activities of the company in question and a significant increase in its target audience, which is a positive factor in the context of a going concern analysis. Furthermore, the expansion of the scale of operational activities of PJSC "WHOOSH Holding" is evident in its expansion into new cities of the Russian Federation, CIS countries, and Latin America.

Table 1 – Operational Activity of PJSC "WHOOSH Holding" According to the Annual Report for Investors for 2024 [1]

Indicators	2024	Increase compared to the previous year, %
Fleet of Personal Mobility Devices (Fleet), thousand units	214,2	+42,9
Number of locations	61	+10,9
Number of registered accounts, million units	27,6	+35,3
Number of trips, million units	149,7	+44,0
Number of trips per active user, units	20	+39,0
Average revenue per active user, rubles	1910	+28,0

In addition, PJSC "WHOOSH Holding" has begun a partnership with the SberPrime ecosystem, which allows it to strengthen its position as the preferred kick-sharing service for SberPrime subscribers, whose audience exceeds 22 million people. The audience is attracted through offers of free starts, as well as discounts of 50% on the first trip and 10% on subsequent trips. At the same time, the company is actively digitizing its business processes, which has a positive impact on operational activities, as well as on data analytics, ensuring more efficient management of the existing fleet.

PJSC "WHOOSH Holding" cooperates with NinebotSegway, a leader in the market of micromobility vehicles. The key goal of this cooperation is to find the most efficient scooter model designed for sharing. This goal is expected to be achieved based on WHOOSH's engineering and operational experience. The anticipated results include an increase in the scooter's service life and operational characteristics, making investments in them more efficient.

The development of the technological base and operational processes of PJSC "WHOOSH Holding" has a comprehensive impact on the efficiency of its operational activities. The implementation of proprietary batteries with improved characteristics reduces charging time by half, which is especially important during peak demand hours. At the same time, doubling the range allows for expanding the geography of customer service without the need to create additional recharging infrastructure, thereby reducing operational costs for logistics and maintenance.

The modernization of the IoT platform addresses a critical issue for this business—the stability of the connection with devices. Increasing the speed and reliability of data transmission minimizes cases of scooter "loss" and false activations,

which reduces costs for maintenance personnel and increases customer satisfaction. The creation of a specialized repair center in Moscow optimizes the approach to managing the equipment life cycle. Refurbishment to an "as new" condition allows for a significant extension of the useful life of fixed assets, which, given a fleet of thousands of units, provides a substantial economic effect

In addition, the localization of the production of 30% of components also has a significant impact on the company's operational activities. As a result, currency risks are reduced due to decreased import dependence, logistics costs and delivery times are cut, and the resilience of the supply chain is increased in the context of foreign policy instability.

Collectively, these changes enable a transition to a new level of operational quality—a shift from an extensive growth model to an intensive one, within which increasing the efficiency of using existing assets becomes a key factor in profitability.

Regarding market risks and threats from competitors, the loss of key customers is unlikely, as the business is oriented towards the mass consumer. According to the annual report for investors, the organization has maintained a 50% share of the kick-sharing market in recent years.

It can be concluded that PJSC "WHOOSH Holding" complies with the going concern principle. The steady growth of assets, investment activity, and expansion of the target audience confirm the company's long-term plans. The partnership with SberPrime and cooperation with NinebotSegway strengthen its position in the kick-sharing market. The digitalization of processes and modernization of the technological base increase the efficiency of operational activities, while the localization of production reduces currency risks. All these factors contribute to the transition to an intensive growth model, which creates confidence in the future development of the company.

Based on the annual report for investors for 2024, no personnel risks, risks related to compliance with legislative requirements, or insurance risks were identified for PJSC "WHOOSH Holding".

Under the current operating conditions, litigation risks are significant for the company. According to the data from the "Electronic Justice" website, no such risks have been identified for PJSC "WHOOSH Holding". No current court cases in which PJSC "WHOOSH Holding" would act as a defendant were found. It can be assumed that there is a risk of changes in regulation regarding the tightening of rules for the use of personal mobility devices within the city, which would lead to restrictions on the use of the main product and, consequently, reduce demand. However, at the moment, the occurrence of significant restrictions is unlikely. Based on the data concerning other events related to lawsuits, there are no serious reasons to doubt the company's going concern.

Based on the analysis conducted, it can be stated that there are no significant risks at PJSC "WHOOSH Holding", and the company can continue its activities as a going concern in the foreseeable future.

REFERENCES

1. Otchetnost' [Reporting]. Available at: https://whoosh-bike.ru/ir/reporting (Accessed 01 March 2026). (In Russian)

THE CONCEPT OF FINANCIAL CONDITION IN THE CONTEXT OF ANALYSIS AND FORECASTING

K. I. Ikonnikov[1], O. V. Usacheva[2]

[1,2]*Novosibirsk State Technical University, Novosibirsk,*
klimikon1@yandex.ru

Abstract: This article examines methodological approaches to defining the concept of an organization's "financial condition." By systematizing existing scientific perspectives, the study identifies key methodological approaches to interpreting this term. A comparative analysis highlights differences in scholarly interpretations—ranging from understanding financial condition merely as the availability of financial resources to viewing it as an integrated characteristic that encompasses both current capabilities and strategic development prospects of an enterprise. Special attention is paid to the role of this category in the system of analysis and forecasting of business entities' activities. Based on the findings, the author proposes an original definition of the term. The results may be applied in developing methods for analyzing and forecasting the financial condition of business entities.

Keywords: financial condition, methodological approaches, analysis, forecasting, financial resources, solvency, financial stability, operational efficiency.

ПОНЯТИЕ ФИНАНСОВОГО СОСТОЯНИЯ В КОНТЕКСТЕ АНАЛИЗА И ПРОГНОЗИРОВАНИЯ

К. И. Иконников, О. В. Усачева

Аннотация: В данной статье рассматриваются методологические подходы к определению понятия «финансовое состояние» организации. Путем систематизации существующих научных взглядов в исследовании выделены ключевые методологические подходы к трактовке данного термина. Сравнительный

анализ выявляет различия в научных интерпретациях — от понимания финансового состояния просто как наличия финансовых ресурсов до рассмотрения его как интегральной характеристики, включающей как текущие возможности, так и стратегические перспективы развития предприятия. Особое внимание уделяется роли данной категории в системе анализа и прогнозирования деятельности хозяйствующих субъектов. Основываясь на полученных результатах, автор предлагает оригинальное определение термина. Результаты могут быть применены при разработке методик анализа и прогнозирования финансового состояния хозяйствующих субъектов.

Ключевые слова: финансовое состояние, методологические подходы, анализ, прогнозирование, финансовые ресурсы, платежеспособность, финансовая устойчивость, эффективность деятельности.

The relevance of studying the concept of "financial condition" stems from its central role in the management system of a modern organization. In a dynamic economic environment and amid intensifying competition, it is the financial condition that determines an enterprise's ability to develop sustainably and adapt to changing external conditions. Despite a long history of research on this category in economic science, there is still no universally accepted definition, which necessitates a systematic analysis of existing methodological approaches.

It is also worth noting that this concept can be examined at both the micro and meso levels. However, it cannot be applied at the macro level in its direct, microeconomic sense. To describe and assess the economic health of a country, a different conceptual framework is used, including terms such as "financial stability of the economy," "macroeconomic stability," and "balance of the budgetary system."

This study systematizes the main methodological approaches to defining the financial condition of an organization as presented in the works of Russian and foreign economists. An analysis of the academic literature revealed nine key approaches, each emphasizing different aspects of this economic category. To illustrate the results of the comparative analysis, Table 1 summarizes the various approaches to defining financial condition.

The presented diversity of approaches to defining financial condition is not merely a theoretical discussion. Which definition is taken as a basis directly determines the goals, objectives, and tools of analysis and forecasting of an enterprise's activities.

In modern economic science and practice, the analysis of financial condition is traditionally viewed as a process of studying, evaluating, and interpreting a set of indicators reflecting various aspects of an organization's activities. Its key task lies in diagnosing the current state of affairs, identifying "bottlenecks," and uncovering unused reserves. However, in conditions of high uncertainty and a dynamic external environment, forecasting the financial condition gains particular significance.

Table 1 – Comparative analysis of Interpretations of the Concept of "Financial Condition"

Level of Analysis	Approach Group	Authors	Definition
Micro level	Basic (Resource) Approach	Lyubushin N.P.	"Financial condition is the ability of an organization to finance its activities" [3]
	Structural-Balance Approach	Borisov A.B.	"Financial condition is the level of provision of an economic entity with monetary resources for carrying out its current work, maintaining an optimal operating mode, and timely fulfillment of necessary settlements" [2]
	Externally-Oriented Approach	Savitskaya G.V.	"Financial condition reflects the ability of an economic entity to finance its activities, continuously maintain its solvency and investment attractiveness" [4]
	Functional-Target Approach	Grishchenko O.V.	"Financial condition is the ability of an enterprise to provide capital for its own activities. Among the characteristics included in it are the availability of financial resources, the rationality and expediency of their allocation, and the efficiency of their use."
	Comprehensive (System) Approach	Abdukarimov I.T.	"The financial condition of an enterprise is a set of indicators characterizing the availability of financial resources by type, the level of competitiveness, financial stability, and the ability to fulfill obligations to the state and other economic entities" [1]
		Surina L.N.	"Financial condition is a fairly broad concept that includes various indicators directly demonstrating the current position of a given organization, all its prospects and corresponding opportunities, as well as the level of its financial stability" [5]

Micro level	Comprehensive (System) Approach	Zaitseva S.S.	"Financial condition is a comprehensive concept that determines the result of interaction of all elements of relations into which an enterprise enters in the course of its activities."
	Strategic Approach	James Van Horne	"Financial condition is a dynamic balance between liquidity, profitability, and risk, which determines the company's ability to adapt to changes in the external environment."
	Long-Term Sustainability Approach	Edward Altman	"A company's financial condition is a comprehensive assessment of its ability to generate cash flows, meet its obligations, and maintain stability in the long term."
Meso level	Systemic-Industry Approach	Batishcheva E.A.	"Financial condition at the meso level is an integral characteristic of the financial position of a group of economic entities united by industry or regional characteristics, taking into account the impact of specific meso-economic factors on them."
	Industry Risk Approach	Pasynkov A.F.	"The financial condition of the agricultural sector is characterized by the average values of key financial ratios for a group of enterprises, as well as the level of their dependence on systemic industry risks (seasonality, government regulation)."

Forecasting, unlike retrospective analysis, is oriented toward the future. Based on identified trends and patterns (the results of the analysis), it allows one to model the possible states of an enterprise depending on changes in internal and external factors. As the proponents of the comprehensive and strategic approaches rightly note (Surina L.N., James Van Horne, Edward Altman), financial condition is not a static characteristic. It is a dynamic category that should be assessed not only from the perspective of "what we have today," but also from the perspective of "what will happen if...".

Thus, analysis and forecasting of financial condition represent two inextricably linked stages of a single management process:

Analysis (diagnostics) answers the question "What is the current situation?" and identifying strengths and weaknesses, and the compliance of actual parameters with normative or planned values.

Forecasting answers the question "How might the situation change in the future?" allowing for a proactive response to potential threats and the exploitation of emerging opportunities.

The integration of analysis and forecasting tasks imposes special requirements on the conceptual framework. The definition of financial condition must be sufficiently comprehensive to serve as a basis for both retrospective assessment and the construction of forecast models (trend, factor, simulation).

Considering the foregoing, it seems reasonable to define the financial condition of an organization as a comprehensive economic category reflecting the real and potential ability of an enterprise to ensure financial stability and solvency, efficiently utilize resources to achieve strategic goals, and adapt to market fluctuations, macroeconomic changes, and industry transformations in the current and forecast periods.

This definition integrates several key aspects:

- Outomes aspect (current ability to ensure stability and solvency) – the basis for retrospective analysis.
- Resource and functional aspects (efficiency of resource use) – the basis for factor analysis.
- Predictive and adaptive aspects (potential ability and adaptation to changes) - the basis for forecasting and strategic planning.

This study has systematized the diversity of methodological approaches to defining the essence of an organization's financial condition. The identified evolution of the concept - from narrow resource-based interpretations to comprehensive systemic characteristics - confirms its dynamic nature and strategic significance in company management. The key role of the category of financial condition as an object of analysis and forecasting is substantiated, showing the relationship between the theoretical interpretation of the concept and the applied tasks of management. The proposed author's definition, integrating aspects of stability, efficiency, and adaptability, can serve as a theoretical foundation for developing applied methodologies for the analysis and forecasting of financial condition, with an emphasis on the challenges of an unstable external environment.

Thus, this study not only systematizes theoretical approaches to understanding financial condition but also creates a foundation for solving applied problems in the

field of financial management. The proposed definition guides practitioners towards the necessity of combining retrospective analysis with the development of forecast models that take into account both the internal patterns of enterprise development and the uncertainty of the external environment. Further research in this direction may be related to the development of a system of indicators for quantitatively assessing the adaptive potential of an organization, as well as to the creation of industry-specific methods for forecasting financial condition that consider the peculiarities of various economic sectors.

REFERENCES

1. Abdukarimov I. T., & Bespalov, M. V. (2023). Analiz finansovogo sostoyaniya i finansovykh rezul'tatov predprinimatel'skikh struktur [Analysis of the financial condition and financial results of entrepreneurial structures]. Moscow: INFRA-M. (in Russian)

2. Borisov A. B. (2013). Bol'shoy ekonomicheskiy slovar' [Comprehensive Dictionary of Economics] (3rd ed., rev. and enl.). Moscow: Knizhnyy Mir. (in Russian)

3. Lyubushin, N. P. (2019). Ekonomicheskiy analiz [Economic analysis]. Moscow: YUNITI-DANA. (in Russian).

4. Savitskaya G. V. (2025). Kompleksnyy analiz khozyaystvennoy deyatel'nosti predpriyatiya [Comprehensive analysis of the economic activity of an enterprise] (7th ed., rev. and enl.). Moscow: INFRA-M. (in Russian).

5. Surina L. N. (2024). Podkhody issledovateley k opredeleniyu i vzaimosvyazi ponyatiy «finansovoye sostoyaniye», «finansovaya ustoychivost'» i «finansovaya politika» [Researchers' approaches to the definition and interrelation of the concepts "financial condition", "financial stability" and "financial policy"]. Vestnik nauki – Bulletin of Science, (1(70)), 254-258. (in Russian).

SYSTEM OF EARLY WARNING INDICATORS ON HYBRID THREATS TO THE NATIONAL ECONOMY OF THE RUSSIAN FEDERATION: SELECTION METHODOLOGY AND MAIN PRINCIPLES

A. V. Kushnarenko

Research advisor: D. A. Andreyeva, Cand. Sc. (Econ.)

Saint Petersburg, Saint-Petersburg State University of Economics,
av_kushnarenko@mail.ru

Abstract. The article substantiates methodological approaches for constructing an early warning indicator system for hybrid threats to Russia's economic security. A conceptual gap is identified between recognizing hybrid threats and the absence of

a unified diagnostic framework. Based on threat classification, key indicator selection principles are formulated, flexible threshold approaches proposed, and a preventive system's conceptual scheme developed.

Keywords: hybrid threats, national security, economic security, early warning system, indicators, preventive monitoring.

СИСТЕМА ИНДИКАТОРОВ РАННЕГО ПРЕДУПРЕЖДЕНИЯ О ГИБРИДНЫХ УГРОЗАХ НАЦИОНАЛЬНОЙ ЭКОНОМИКЕ РОССИЙСКОЙ ФЕДЕРАЦИИ: МЕТОДОЛОГИЯ ОТБОРА И ОСНОВНЫЕ ПРИНЦИПЫ

А. В. Кушнаренко

Аннотация. В статье обоснованы методологические подходы к созданию системы индикаторов раннего предупреждения о гибридных угрозах российской экономической безопасности. Выявлен концептуальный разрыв между признанием гибридных угроз и отсутствием единой диагностической системы. На основе классификации угроз сформулированы принципы отбора ключевых индикаторов, предложены гибкие пороговые подходы и разработана концептуальная схема превентивной системы.

Ключевые слова: гибридные угрозы, национальная безопасность, экономическая безопасность, система раннего предупреждения, индикаторы, профилактический мониторинг.

Introduction

In the face of sanctioning pressure, targeted campaigns to discredit key industries, and the use of digital platforms to destabilize financial markets, the Russian Federation's traditional economic-security monitoring systems have shown limited effectiveness. They record consequences but do not identify coordinated multilevel impacts at the stage of their formation.

Russian strategic documents define economic security as the protection of the national economy and the preservation of its sovereignty. To counter both external and internal threats—including discriminatory measures and vulnerabilities within the financial system—these frameworks mandate the establishment of a comprehensive national risk management system. This system is designed to operate in conjunction with enhanced public administration, forecasting, and strategic planning mechanisms. Furthermore, the protection of citizens and traditional values remains an integral component of this security paradigm, reflecting the need to address both conventional and emerging threat vectors [3, 4]. Existing studies

examine hybrid threats and their impact on public institutions, focusing on extremism, color revolutions, and information-psychological operations. However, these analyses remain qualitative, addressing operational counteraction while leaving formalized preventive diagnostics undeveloped [1, 5].

A conceptual gap persists: hybrid threats are acknowledged, yet no common methodological basis exists for their early detection. Current monitoring, lacking principles tailored to hybrid threats' synergistic, multi-vector nature, identifies them only fragmentarily and fails to capture their nature in time.

The aim of the study is to develop a methodological framework for constructing a system of indicators for anticipating hybrid threats to Russia's economic security.

The scientific novelty of the research is as follows:

1. Hybrid threats have been systematized for the areas of economic security of the Russian Federation, which has allowed us to move from their qualitative description to a structural basis for diagnosis.

2. For the first time, the principles of selection of indicators (prevention, contextual sensitivity, synergy, asymmetric reflection, adaptability) specific to the nature of hybrid threats have been formulated and substantiated.

3. A combined approach to the determination of threshold values of indicators is proposed, combining dynamic analysis, pattern recognition and expert-analytical verification.

The objectives of the study are as follows: to classify hybrid threats by spheres of influence in order to structure the indicator system; to formulate and substantiate the principles for selecting early warning indicators that possess high sensitivity to hybrid influence; to propose methodological approaches for determining threshold values of the indicators; to develop a conceptual scheme for the functioning of the early warning system.

The study is based on the hypothesis that the fragmentary nature of existing monitoring could be overcome by implementing a preventive indicator system based on these principles and flexible thresholds. which will make it possible to identify threats at the stage of creating the conditions for their implementation.

Materials and methods

The theoretical and informational basis was:

1. Strategic documents: National Security Strategy of the Russian Federation, Economic Security Strategy of the Russian Federation until 2030, other doctrinal documents setting the framework for analysis.

2. Scientific publications: The analysis of works of domestic and foreign authors ([1, 2, 5]) made it possible to identify the existing conceptual gap between the

recognition of hybrid threats and the absence of a formalized instrument of their preventive diagnosis. The literature is dominated by qualitative descriptions of operational counteraction, while issues of building early-warning systems remain underdeveloped.

The study, which was theoretical and methodological in nature, applied a set of general scientific methods:

1. Systemic analysis – to consider economic security as an object of hybrid impact.
2. Theoretical generalization and synthesis - to formulate principles for the selection of indicators based on classification of threats.
3. Abstract-logical method and structural-functional analysis - when developing a conceptual scheme of the system.
4. Graphical modeling – for visualization of threat classification and system architecture (Fig. 1, 2).

Results and discussion

Analysis of scientific literature [1, 2, 5] and policy documents [3, 4] confirms that hybrid threats are recognized as a key challenge, but their systematization for diagnostic purposes remains fragmentary. Existing classifications often focus on instruments (informational, economic) or subjects of influence, which is not sufficient to construct a system of indicators linked to objects of protection in the economic sphere. This work offers a different structuring logic. Based on the nature of the hybrid threat as a set of targeted actions to weaken the state, the author's classification is built on the spheres of state and public relations that are targets (see Fig. 1). Such an approach allows potential indicators to be "pegged" to specific vulnerabilities in financial, technological, socio-economic and other areas, providing a targeting for the monitoring system.

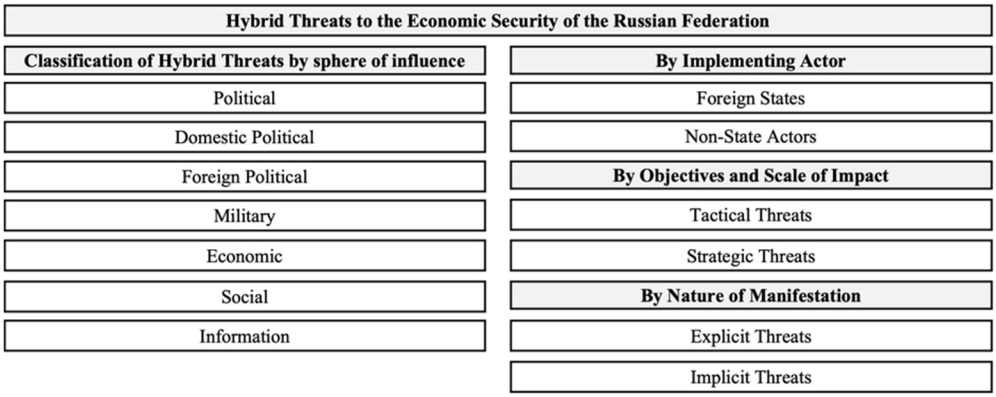


Figure 1. Classification of Hybrid Threats to Russia's Economic Security

Traditional monitoring, which focuses on tracking deviations of macroeconomic indicators from target values, is ineffective in identifying hybrid threats because of their complexity and asymmetry. Their manifestation is often not the result of deviations, but rather of disruptions to correlations between indicators or the occurrence of events that are beyond the reach of natural economic processes. Therefore, a new set of principles that the set of indicators must meet is required. Contextual sensitivity principle – indicators gain meaning only within geopolitical, political, and informational context. A statistical anomaly becomes a threat when coinciding with hostile actor actions or coordinated anti-Russian narratives. Synergy of threats principle – hybrid measures combine instruments that amplify each other. The system must identify correlations across different sectors rather than monitoring fragmented indicators. Asymmetric reflection principle – focus shifts from average values to low-resilience segments (vulnerable industries, mono-towns, socially tense regions). Deviations there may signal preparation for larger-scale destabilization. Adaptability principle – the indicator system requires regular review based on retrospective analysis of identified and neutralized threats to remain effective against evolving hybrid tactics

The rigid, permanently fixed thresholds that characterize strategic planning are not applicable for diagnosing hybrid threats because of their dynamic and synergistic nature. The author proposes a combined methodological approach with three complementary levels. Dynamic approach – moves from fixed values to deviation analysis. Threshold is crossed when an indicator leaves its "acceptable fluctuation corridor" derived from retrospective data over a defined period. Pattern recognition method – focuses on identifying typical scenarios for the implementation of destructive measures of a hybrid nature. The threat threshold is determined by the coincidence of a sequence of events. Expert-analytical method – engages experts for rapid verification of triggered indicators. Automated systems cannot always distinguish planned actions from random circumstances, requiring situational expertise for accurate assessment.

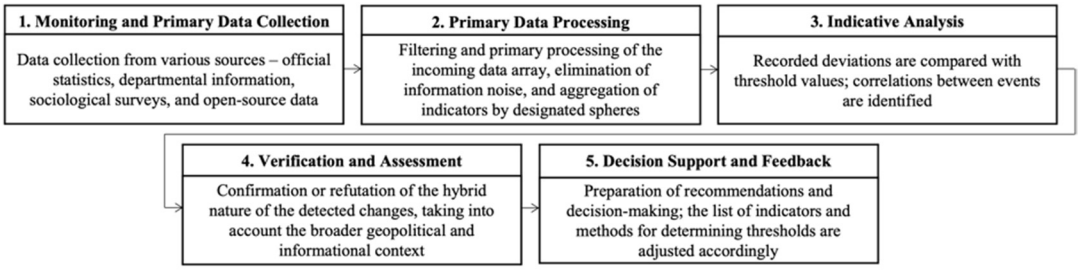


Figure 2. Conceptual scheme of the Hybrid Threat early warning system functioning

Implementation of the proposed classifications, principles and methods requires their integration into a common functional framework. The developed conceptual framework (Fig. 2) is a continuous cycle architecture where the steps of data collection, processing on the basis of defined principles and thresholds, expert verification and system update form a closed loop for preventive monitoring.

Conclusion

The research confirms the hypothesis: a proactive, principle-based indicator system overcomes the fragmented nature of current monitoring. The proposed framework – comprising threat classification, five selection principles, and flexible threshold approaches – provides a conceptual basis for early detection. The integrated scheme enables identification of hybrid threats at the formation stage rather than after consequences materialize.

Practical significance: the findings of this study can be utilized by federal executive authorities of Russia when formulating strategic and conceptual documents in the sphere of national and economic security.

Prospective directions for further research: development of a system of indicator criteria for identifying hybrid threats; elaboration of a strategy for ensuring Russia's economic security in the context of hybrid warfare.

REFERENCES

1. Kodaneva S. I. (2020) Gibridnye ugrozy bezopasnosti rossii: vyyavlenie i protivodeistvie [hybrid threats to russia's security: identification and counteraction]. *Kontury global'nykh transformatsii*: *politika*, *ekonomika*, *pravo*, 13 (2), 44-71.

2. Kushnarenko, A. V. (2025) Zakonodatel'nye mekhanizmy protivodeistviya gibridnym ugrozam natsional'noi bezopasnosti Rossiiskoi Federatsii [Legislative mechanisms for countering hybrid threats to the national security of the Russian Federation]. In: Sluzhenie Otechestvu: traditsii, tsennosti, innovatsii: Materialy mezhdunarodnoi nauchno-prakticheskoi konferentsii, Sankt-Peterburg, 24 aprelya 2025 goda. Saint Petersburg: OOO "Skifiya-print", pp. 14-34.

3. Strategii natsional'noi bezopasnosti Rossiiskoi Federatsii [On the National Security Strategy of the Russian Federation]: Decree of the President of the Russian Federation No. 400 of 02.07.2021. Available at: http://www.kremlin.ru/acts/bank/47046 (accessed 26.02.2026).

4. Strategii ekonomicheskoi bezopasnosti Rossiiskoi Federatsii na period do 2030 goda [On the Economic Security Strategy of the Russian Federation for the period up to 2030]: Decree of the President of the Russian Federation No. 208 of 13.05.2017. Available at: http://www.kremlin.ru/acts/bank/41921 (accessed 26.02.2026).

5. Zelenova D. A. and Romanov S. A. (2025) 'Gibridnye ugrozy' i natsional'naya bezopasnost' rossiiskoi federatsii ['hybrid threats' and national security of the russian federation]. *Pravo i gosudarstvo*: *teoriya i praktika*, (6), 207-209. doi: 10.47643/1815-1337_2025_6_207.

DIGITAL TRANSFORMATION REGARDING STATE REGULATION OF ORGANIZATIONS ACTIVITIES IN THE CUSTOMS SERVICES FIELD

A. S. Lemak

Research advisor: Yu. E. Gupanova, Doctor of Sciences (Economics)

Lyubertsy, Moscow region, Russian Customs Academy,
a.lemak@customs-academy.ru

Abstract. The article reveals the transformation of traditional approaches towards the organization's activities in the customs services field under the conditions of the digital economy. The article deals with the main directions and trends of digital transformation of the above-mentioned regulation in the customs services field. The key outcomes of digital and innovative technologies implementation into the regulatory process of organizations activities in the customs services field are highlighted.

Keywords: the field of customs services, state regulation, business, customs authorities, customs bodies, digital technologies, participants in the foreign trade activity.

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ ГОСУДАРСТВЕННОГО РЕГУЛИРОВАНИЯ ДЕЯТЕЛЬНОСТИ ОРГАНИЗАЦИЙ В СФЕРЕ ТАМОЖЕННЫХ УСЛУГ

А. С. Лемак

Аннотация. Статья посвящена исследованию трансформации традиционных подходов в регулировании деятельности организаций в сфере таможенных услуг в условиях цифровой экономики. В статье рассматриваются основные направления и тенденции цифровой трансформации регулирования деятельности организаций в сфере таможенных услуг. Выделяются ключевые результаты внедрения в процесс регулирования деятельности организаций в сфере таможенных услуг цифровых и инновационных технологий.

Ключевые слова: сфера таможенных услуг, государственное регулирование, бизнес, таможенные органы, цифровые технологии, участники ВЭД.

In today's business environment the digital transformation regarding state regulation of organizations activities in the customs services field is a key factor for sustainable and balanced development of the customs sphere. The digital transformation of approaches towards the regulation of organizations activities in

the customs services field is characterized by the reconsideration and adaptation of traditional administrative approaches towards regulatory policy regarding the processes implemented within the frameworks of the concept of the digital economy [1, 6967].

The main objective of this transformation is to create an effective regulatory system, based on the principles such as:

– optimization and balance measures in regulation and support the organizations activities in the customs services field;

– maintenance of the business climate in the customs services field;

– minimization of costs for legal entities carrying out business activity in the customs field.

The peculiarity of the issues under investigation is that there are two entities operating in this sphere. The first group of entities is represented by agents of customs services that may be, on the one hand, customs authorities providing state customs services and, on the other hand, performing control and supervision functions in the customs field. Legal entities that constitute the second group carry out business activities in the customs field and provide customs services. That is why, the organizations activity as an object of state regulation is characterized by a number of particular features regarding elements and processes of the customs services sphere.

Given this uniqueness of the customs services sector, the digital transformation is to cover a wide range of tools, methods and processes within two dimensions: customs authorities and business [2, 8].

Figure 1 presents the main tools, means and processes for implementing state regulation of organizations activities in the customs services field, some of which are currently being performed as a part of this digital transformation.

First of all, it should be noted that the tools and processes, in question, are congruent and integrated both within and beyond these dimensions.

In the context of applying digital technologies to improve the efficiency of state regulation of organizations activities in the customs services field, 10 innovative sets of approaches can be highlighted [3].

1. The perspective models and concepts for the organization and implementation of forms and measures of customs control, that is, "digital duplicate", customs monitoring, electronic customs control, automation of control objects selection.

2. The improvement of the system of interdepartmental electronic communication and Agreements as are, both points including technological maps of electronic interaction; obtaining of documents necessary for receiving public services the frameworks of interdepartmental electronic information communication.

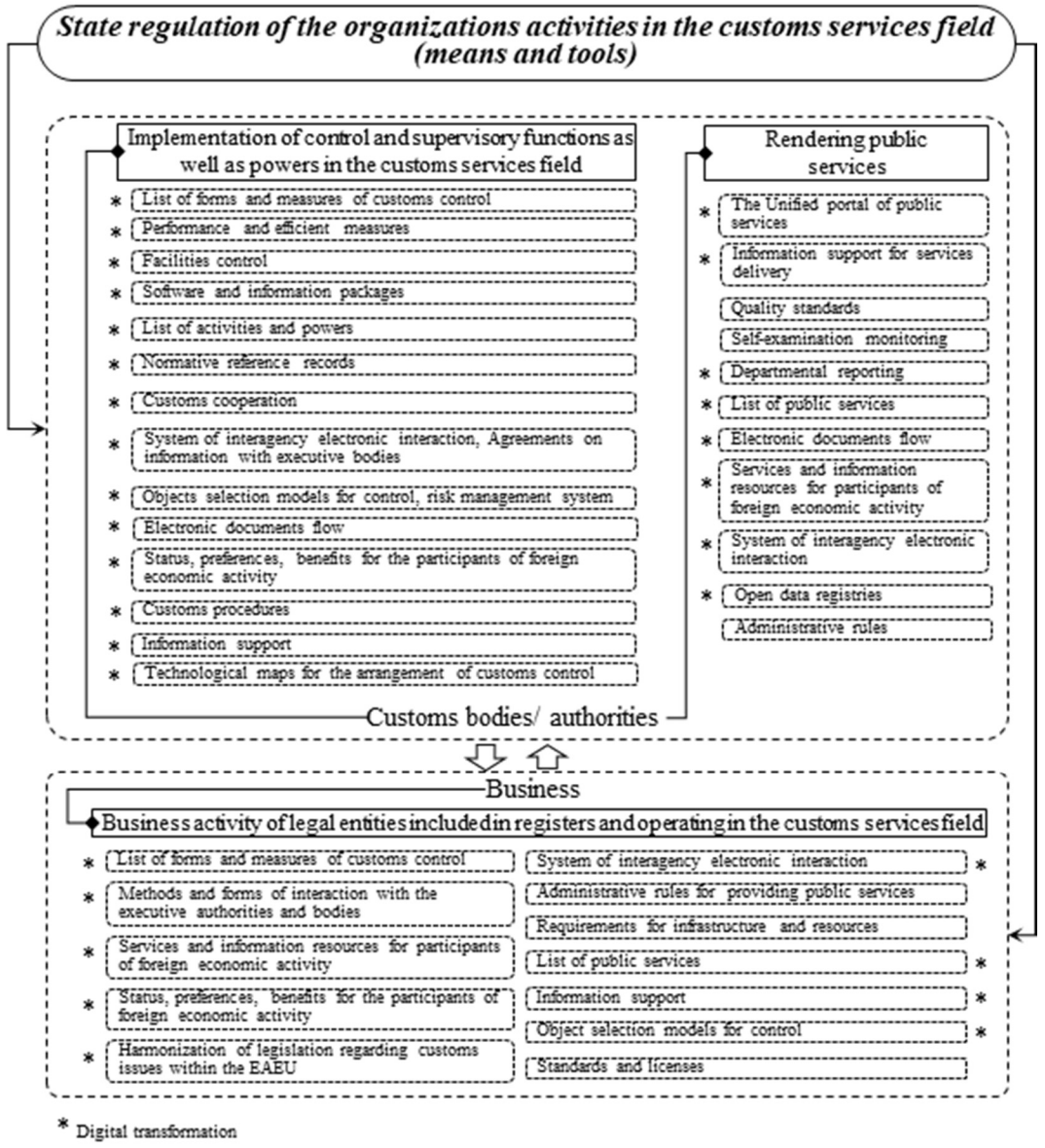


Figure 1. Digital transformation of the main tools, means and processes for implementing state regulation of organizations activities in the customs services field

3. The development of an electronic document management system, that is, digitization of documentation on the results of control and oversight activities as well as providing of public services (setting up information array and templates of

electronic documents, combination of open and closed contours of information systems, database of normative-reference and normative-technical documents, data registers).

4. The expansion of the areas of interaction of customs authorities with participants of foreign economic activity through Internet services "Personal Office of participants of foreign economic activity", that is, the development of its new services and the mobile version.

5. The improvement of performance and efficiency indicators, namely the level of participants satisfaction in foreign economic activity, the level of automated selection and decision-making regarding control objects without any officials, the level of digitalization interaction: electronic files or complaints, documents for customs payments collection.

6. The improvement of the international regulatory framework and customs cooperation, that is, the harmonization of the EAEU customs legislation, integration of information for the EAEU system as well as for common processes.

7. Updating of information support for businesses, including interactive services and webinars on current customs issues.

8. The development of information infrastructure facilities, that is, automation of customs procedures, expansion of algorithms, display cases, data dashboard.

9. The development of the institute of authorized economic operator, including test on both monitoring the application of traceability and product accounting system.

10. The improvement of public services providing, that is, updating of processes registers and reflecting the status a client centrality principles.

However, in a number of the areas approaches towards regulation continue to retain traditional features, including the structure of administrative rules, standards, the list of public services, requirements for infrastructure, resources of the participants of foreign economic activity and so on [4, 8].

Thus, the digital transformation regarding state regulation of organizations activities in the customs services field is a complicated process of integrating digital technologies for regulation of both a practical activity of customs bodies and business activities in the customs field. In addition, the comprehensive implementation of this digital transformation in all above considered areas will allow to move on a new conceptual model of the State administration and regulation in the customs services sphere.

REFERENCES

1. Frik O. V., Kuznetsova E. K. (2024). Tsifrovaya transformatsiya i obespecheniye informatsionnoy bezopasnosti deyatel'nosti tamozhennykh organov v Rossii [Digital transformation and ensuring information security of customs authorities in Russia]. *Ekonomika, predprinimatel'stvo i pravo* [Journal of Economics, Entrepreneurship and Law], 14(11), 6963-6982 (in Russian).
2. Chernev R. S. (2024) Napravleniya razvitiya sistemy predostavleniya elektronnykh tamozhennykh uslug v Rossiyskoy Federatsii [Development directions of the electronic customs services system in the Russian Federation]. *Mezhdunarodnyy zhurnal gumanitarnykh i yestestvennykh nauk* [International Journal of Humanities and Natural Sciences], 6-3(93), 60–64 (in Russian).
3. Ofitsial'nyy sayt Federal'noy tamozhennoy sluzhby RF (Official website of the Federal Customs Service of the Russian Federation) Available at: http://www.customs.ru (accessed 20.02.2026).
4. Dmitrieva O. A., Morkovkin D. E., Umarova K. A., Kerimova Ch. V., Artamonova K. A., Aleeva G. I. (2024) Tsifrovaya tamozhnya: sovremennyye trendy i perspektivy razvitiya [Digital customs: current trends and development prospects]. *Vestnik Yevraziyskoy nauki* [The Eurasian Scientific Journal], 16(4), 8-11 (in Russian).

USING A DOMAIN SEMANTIC GRAPH TO IDENTIFY ACTIVITIES AND COST DRIVERS IN ABC COSTING: APPLICATION TO AQUACULTURE

A. A. Lyubarskii

Research advisor: P. I. Kolykhalov, Cand. Sc. (Phys.- Math)

Moscow, National Research Nuclear University MEPhI,
AALyubarskii@mephi.ru

Abstract: The paper considers the use of a domain semantic graph to identify activities and cost drivers when applying ABC costing in aquaculture. The methodology is oriented towards small farms and makes it possible to formalize the process structure, increase the completeness of indirect cost accounting, and improve the accuracy of product cost calculation.

Keywords: aquaculture, ABC costing, semantic graph, cost drivers, management accounting, product cost.

ИСПОЛЬЗОВАНИЕ СЕМАНТИЧЕСКОГО ГРАФА ПРЕДМЕТНОЙ ОБЛАСТИ ДЛЯ ВЫЯВЛЕНИЯ АКТИВНОСТЕЙ И ДРАЙВЕРОВ ЗАТРАТ В ABC-КОСТИНГЕ: ПРИМЕНЕНИЕ В АКВАКУЛЬТУРЕ

А. А. Любарский

Аннотация: В работе рассматривается использование семантического графа предметной области для выявления активностей и драйверов затрат при применении ABC-костинга в аквакультуре. Методика ориентирована на малые хозяйства и позволяет формализовать структуру процессов, повысить полноту учёта косвенных затрат и точность расчёта себестоимости продукции.

Ключевые слова: аквакультура, ABC-костинг, семантический граф, драйверы затрат, управленческий учёт, себестоимость продукции.

Aquaculture occupies a strategic position in ensuring food security and the socio-economic development of the Russian Federation. However, the development of aquaculture is constrained by low production efficiency, which is due, among other factors, to the lack of scientifically grounded cost management methods.

The traditional process (stage-by-stage) costing method, based on a vertical chain, is applicable to linear production, but in aquaculture, with its numerous parallel processes (monitoring, feeding, correction of bioparameters), it fails to capture hidden links and indirect costs, unlike ABC costing. Activity-Based Costing (ABC) focuses on activities and their cost drivers, providing more complete cost allocation.

Although there are no recent studies on the effectiveness of ABC costing in aquaculture, earlier work shows that traditional identification approaches (interviews, analysis of financial reports, observations) require 2–4 months of intensive work and often remain incomplete, missing 20–30% of actual drivers. [2].

In aquaculture this problem is exacerbated by the non-linearity and interdependence of processes. The production chain is not a simple sequence of stages; instead, water quality monitoring (temperature, pH, O_2), feeding, equipment maintenance, and fish grading run in parallel. Each of these processes generates indirect costs (energy for sensors, labor for measurements, culling), which cannot be directly assigned to a single product but significantly affect unit cost.

The subjectivity of identification is that, without a formal model, employees tend to use only familiar operational labels (“feeding”, “harvesting”), overlooking systemic factors such as “response to O_2 anomalies” or “seasonal mode switching”. Under such conditions, omitting part of the cost drivers in cost calculation may lead to systematic underestimation of actual cost, which is critical for high-cost

technologies used for certain fish species (e.g., trout), where the margin for error is very small [1].

The proposed methodology is based on constructing a semantic graph of the production domain, formed manually from empirical data: observations of production processes and structured staff interviews. In the aquaculture context, observations include recording IoT parameters (pH, O_2 , temperature), feeding cycles, events such as anomalies and biological outcomes, while interviews focus on resource consumption by operations in each workshop or unit. The graph is a network in which nodes represent entities (resources such as feed and energy; production objects such as tanks and fish), and directed edges represent semantic relationships. Graph construction is carried out using the Protege visualization tool.



Figure 1. Semantic graph of the enterprise domain

The transition from the graph to ABC elements involves interpreting clusters of nodes and edges as activity groups. Activities are identified as dense, connected subgraphs united by a common purpose or resource: for example, the "sensor – water" cluster corresponds to the "monitoring and regulation" activity, while the "feed – feeding – fish" cluster corresponds to the "feeding" activity.

Cost drivers are extracted from the subgraph structure and edge typology. Direct drivers correspond to direct "resource → activity" links (e.g., kilograms of feed per feeding cycle determined by the number and average weight of fish). Indirect drivers are detected through transitive paths: O_2 drop → activation of aeration equipment → additional energy consumption; the corresponding driver is then the number of O_2 anomalies per day. Mathematically, the weight Dj for cluster j is computed as the normalized sum of weights of inbound and outbound edges of the subgraph:

$$D_j = \sum w(e),$$

where $w(e)$ – is the empirically estimated weight of an edge based on the frequency of its occurrence and intensity in observations.

Graph validation and its interpretation are carried out iteratively with the participation of plant experts (2–3 correction cycles), which ensures consistency with real processes and eliminates artefacts. At the final stage, a qualitative completeness analysis compares the set of ABC activities and drivers with the stages of the vertical chain using a coverage matrix to identify "hidden" elements not captured by the linear approach (biological anomalies, parallel costs, systemic influences).

Examples of applying the methodology to RAS farms demonstrate its effectiveness. A traditional vertical chain for RAS identifies six main stages (water preparation, stocking, feeding, monitoring, harvesting, processing) and allocates costs by output volume (raw materials 60%, labor 20%, energy 20%).

Applying ABC without graph support identifies about 12 activities and 8 drivers (production cycles, equipment hours), improving the completeness of indirect cost allocation. However, completeness remains subjective because identification is based on the staff's customary operations.

With a semantic graph built from observations and interviews (5–10 days of work with personnel), the methodology identifies 18–20 activities and 12–14 cost drivers, including aquaculture-specific ones: number of pH anomalies per day (driver for about 5% of energy costs for correction), size-grading cycles (about 3% of labor), filter cleaning events (about 2% of energy), and transitions between temperature regimes (about 1% of biomass loss).

The graph provides an approximately 25% improvement in completeness: visualizing all links between entities reveals previously omitted drivers that cannot be reliably captured by a purely linear chain or unstructured interviews. The method also reduces expert analysis time from about 30 days (traditional ABC) to around 10 days due to its systematic nature, preventing duplication and omissions.

Further research should include testing the methodology on a representative sample of farms (5–10 enterprises of different types: ponds, RAS, cages), validating the identified drivers by comparing calculated and actual costs, developing template graphs for typical aquaculture configurations, and training on-site specialists. Integrating graph-oriented ABC into management and analytics systems will allow small farms to track unit costs in real time and make timely managerial decisions, thereby increasing the competitiveness of Russian aquaculture and its contribution to national food security.

REFERENCES

1. Engle C. R., Fornshell G. The economic impact of proposed effluent treatment options for production of trout Oncorhynchus mykiss in flow-through systems // Aquaculture Economics & Management. 2005. Vol. 9. No. 1–2. P. 65–85.

2. Koutouzidou G., Vazakidis A., Theodoridis A., Batzios C. A review of ABC methodology for agricultural sector // Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (HAICTA 2015 in Agriculture, Food and Environment). Kavala, Greece, 2015. P. 20–25.

ADDRESSING FRAUD IN RUSSIA AND ABROAD

E. A. Mashinistova

Research advisor: M. A. Vlasenko, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
maschinistovaliza@yandex.ru

Abstract: This paper is devoted to the analysis of fraud counteraction systems in Russia and the United States. The legal and regulatory frameworks and mechanisms for combating this type of crime in the two countries are examined. Special attention is paid to statistical data on registered fraud cases for 2023-2024, which makes it possible to assess the actual crime trends under the condition of counteraction by the states.

Keywords: Russian Federation, USA, fraud, comparative analysis, crime statistics, counteraction, legal frameworks.

К ВОПРОСУ О ПРОТИВОДЕЙСТВИИ МОШЕННИЧЕСТВУ В РОССИИ И ЗА РУБЕЖОМ

Е. Ф. Машинистова

Аннотация: Данная работа посвящена анализу систем противодействия мошенничеству в России и США. Рассматриваются нормативно-правовые основы и механизмы борьбы с данным видом преступлений в двух странах. Особое внимание уделяется статистическим данным зарегистрированных мошенничеств за 2023-2024 годы, что позволяет оценить реальную динамику преступности при условии противодействия со стороны государств.

Ключевые слова: РФ, США, мошенничество, сравнительный анализ, статистика преступлений.

The roots of fraud stretch far back into the past, but the true flourishing of this phenomenon came with the era of commodity-money relations. In the early days of civilization, fraud was limited to short-weighting at the market or forging seals, but the appearance of money gave rise to counterfeiting and financial pyramids. The industrial age «gifted» the world with stock forgery and insurance scams, while the digital age brought phishing and fraudulent call centers.

Constantly evolving, fraud penetrates all spheres of life, utilizing the most modern scientific and technological advances - from cryptocurrencies to neural networks. It creates challenges not only for ordinary citizens, undermining their trust in digital services and financial institutions, but also for states, forcing them to continuously expend enormous resources on protecting infrastructure and seeking new methods to combat various fraudulent schemes. This is confirmed in academic literature [6, 9].

To assess the counteraction to fraud, this article examines the experience of two leading world powers: the Russian Federation and the United States. These states not only set the agenda on the political arena but also demonstrate fundamentally different approaches to regulating the digital environment – from strict state control to market self-regulation - which allows for the most comprehensive comparative analysis, presented in Table 1.

Table 1 – Fraud counteraction systems.

Criterion	Russia	USA
Lead Regulator	Central Bank	Multiple agencies (state banking regulators)
Data Sharing (on money transfers)	Mandatory (Central Bank platforms)	Recommendatory (private platforms)
Combating Propaganda	Criminal cases, databases of «suspicious» accounts	Transaction monitoring, blocking accounts based on similar patterns (actions)
Social Engineering	Emphasis on blocking suspicious transfers that are atypical for the bank's client	Emphasis on client education, risk insurance, and subsequent investigations based on the incident

Compiled by the author based on [2-5].

The Russian system is built on the principle of preemptive blocking and state coercion. It is effective for protecting the mass consumer and responding quickly to typical threats, but it requires banks to spend enormous resources on a set of measures to prevent fraudulent transactions and on total user control.

The American system is built on the principle of after the fact investigation and technological freedom. It stimulates innovation in private systems for preventing fraudulent transactions but places the burden of proof and the risks of social engineering on the citizen themselves, which, in the era of deepfakes and complex schemes, is becoming an increasingly vulnerable point.

Now, let us examine the results of the fraud counteraction systems in the Russian Federation and the USA using statistical data provided in the annual reports of the ministry of internal affairs (MVD) and the FBI, shown in table 2.

Table 2. Number of fraud crimes in the Russian Federation and the USA for 2023-2024.

Indicator		2023	2024	Change (+; -)	Growth Rate, %
Russia, [7]	Registered	433 708	445 690	+ 11 982	+ 2,76
	Cleared	75 642	70 924	- 4 718	- 6,24
USA, [1]	Registered	880 418	859 532	- 20 886	- 2,37
	Cleared	609 513	631 201	+ 21 688	+ 3,56

Thus, based on the data in table 2, it can be concluded that the situation in the USA is more favorable, as they not only saw a decrease in the number of registered crimes but also an increase in the number of cleared cases. In Russia, the picture is different: the number of crimes is rising, while the effectiveness of their investigation is falling.

However, it is worth remembering that the population of the Russian Federation is almost 2.5 times smaller than that of the USA. Therefore, to obtain more objective data for a comparative analysis of the current situation, the crime rate (CR) was calculated using Formula 1. The results of these calculations are presented in table 3.

$$CR = \frac{(\text{Number of crimes} * 100\,000)}{\text{Population size}}. \quad (1)$$

Thus, it turns out that in 2024, the Russian Federation averaged 305 crimes per 100 000 people, while the USA had only 252. The situation regarding cleared crimes is even more dire, as in 2024, Russia had only 49 cleared cases per 100 000 people, compared to 185 in the USA. Therefore, at first glance, this might indicate greater effectiveness of the foreign law enforcement system. However, the current situation in Russia is largely explained not by ineffective fraud counteraction, but by the specifics of the modern geopolitical situation.

Starting in 2022, in connection with the special military operation, ill-wishers who are trying not just to steal money but to inflict damage on the country as a whole by funding the armed forces of Ukraine have sharply intensified their activities. It is this

external factor that has created an additional burden, which is reflected in the statistics.

Table 3 – Crime rate in the Russian Federation and the USA for 2023-2024, relative to population

Indicator		2023	2024
Russia	Population, million people [8]	146,4	146,1
	CR for registered crimes, per 100 000 people.	296	305
	CR for cleared crimes, per 100 000 people.	52	49
USA	Population, million people [8]	338,51	341,15
	CR for registered crimes, per 100 000 people.	260	252
	CR for cleared crimes, per 100 000 people.	180	185

And even under these conditions, created by external factors, the Russian law enforcement system demonstrates high adaptability: it effectively neutralizes fraudulent schemes and makes life more difficult for criminals, meaning it achieves a tangible reduction in the number of offenses. However, on the flip side, this very effectiveness provokes the criminal world to seek ever more sophisticated ways to circumvent the law, which our law enforcement agencies do not always keep pace with, creating new challenges for the system.

Therefore, it would be a mistake to deny the strengths of foreign experience. The USA has a longer history of working with the public in the field of digital security, and their developments in the area of prevention deserve attention. Since our system is in a phase of active improvement, the adaptive adoption of their successful practices would be a logical step in the development of the current system. Such a step could not only improve counteraction statistics but also more reliably protect our citizens from new challenges and threats.

REFERENCES

1. *Annual Reports* (Internet Crime Complaint Center (IC3)) Available at: https://www.ic3.gov/AnnualReport/Reports (accessed 21.02.2026).

2. *Dodd-Frank wall street reform and consumer protection act* (Congress.gov) Available at: https://www.congress.gov/111/plaws/publ203/PLAW-111publ203.pdf (accessed 19.02.2026).

3. *Federalnii zakon «O natsionalnoi platezhnoi sisteme» ot 27.06.2011 № 161-FZ* (Consultant Plus) Available at: https://www.consultant.ru/document/cons_doc_LAW_115625/ (accessed 18.02.2026).

4. *Federalnii zakon «O protivodeistvii legalizatsii* (*otmivaniyu*) *dokhodov, poluchennikh prestupnim putem, i finansirovaniyu terrorizma» ot 07.08.2001 № 115-FZ* (Consultant Plus) Available at: https://www.consultant.ru/document/cons_doc_LAW_32834/ (accessed 18.02.2026).

5. *S.1241 - Combating Money Laundering, Terrorist Financing, and Counterfeiting Act of 2017* (Congress.gov) Available at: https://www.congress.gov/bill/115th-congress/senate-bill/1241/text#toc-S1 (accessed 19.02.2026).

6. Safonov V. N., Chigrinets V. S. (2024) Sovremennoe moshennichestvo: k voprosu o sposobakh sovershenіya i perspektivakh protivodeistviya [Modern Fraud: Methods and Prospects for Counteraction]. *Zakon. Pravo. Gosudarstvo* [Law. Right. State], 3(43), 138-142. (accessed 18.02.2026).

7. *Sostoyanie prestupnosti* (Ministry of Internal Affairs of the Russian Federation) Available at: https://mvd.rf/reports/1/ (accessed 21.02.2026).

8. *Strani* (Trading Economics) Available at: https://ru.tradingeconomics.com/russia/population (accessed 21.02.2026).

9. Tikhomirova M. S., Palatnikova A. D. (2024) Meri protivodeistviya sovremennim sposobam moshennichestva v otnoshenii naseleniya [Measures to counteract modern methods of fraud against the population]. *Rossiiskie issledovaniya. Pravo i politika* [Russian Studies in Law and Politics], 8(2), 54-69. (accessed 18.02.2026).

DIAGNOSING CORPORATE BANKRUPTCY: METHODOLOGICAL FOUNDATIONS

A. A. Melentyev[1], I. V. Baranova[2]

[1,2]*Novosibirsk State Technical University, Novosibirsk,*
mr.take.95@mail.ru

Abstract. The choice of a bankruptcy prediction model for enterprises remains relevant today. This is because to respond promptly to negative trends in a company's activities, it is necessary not only to have reliable methods for predicting insolvency but also to develop an effective financial recovery program. This article compares models for predicting the likelihood of bankruptcy in organizations (both domestic and foreign) and presents a classification of authors' bankruptcy prediction models.

Keywords: bankruptcy prediction, bankruptcy, models, likelihood of bankruptcy assessment.

ДИАГНОСТИКА КОРПОРАТИВНОГО БАНКРОТСТВА: МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ

А. А. Мелентьев, И. В. Баранова

Аннотация. Проблема выбора модели диагностики банкротства предприятий остаётся актуальной в современных условиях. Это связано с тем, что для своевременного реагирования на негативные тенденции в деятельности компании необходимы не только надёжные методы прогнозирования неплатёжеспособности, но и разработка эффективной программы финансового оздоровления. В данной статье проводится сравнение моделей диагностики вероятности банкротства организаций (как отечественных, так и зарубежных), а также представлена классификация авторских моделей диагностики банкротства.

Ключевые слова: диагностика, банкротство, модель, оценка вероятности банкротства.

The activities of any business entity are inextricably linked to a variety of risks, among which the most critical is the risk of losing solvency and, as a result, becoming insolvent (bankrupt). To avoid this, it is necessary to conduct a financial analysis, the main purpose of which is to identify problems in the current financial situation of the company in order to prevent bankruptcy.

Bankruptcy is a financial condition in which an organization or an individual is unable to meet their debt obligations, leading to a formal bankruptcy procedure.

In the scientific literature, models for diagnosing the probability of bankruptcy by E. Altman, R. Lys, R. Tafler, W. Beaver, R. S. Saifulin, G.G. Kadykov, and others are widely discussed. After analyzing research and publications on this topic, it was found that some authors, such as N.N. Trushina, review the most popular models for diagnosing the probability of bankruptcy, including those mentioned above. Also, some authors, for example, K. S. Bodrova, O. G Blazhevich, omit regulatory models used by government agencies when analyzing bankruptcy diagnosis models. At the moment, the development of methodological approaches to diagnosing the probability of bankruptcy is driven by the sectoral aspect; for example, the model developed by Yu. I. Sigidov, S. A. Kucherenko, and N. S. Zhminko, for agricultural enterprises.

Thus, it is clear that the methods and models for diagnosing the likelihood of bankruptcy are being improved, and this is influenced by a variety of factors, including the need to adapt to crises, changes in legislation and macroeconomic conditions, industry-specific aspects, etc.

All methodological approaches to diagnosing the likelihood of bankruptcy can be divided into qualitative and quantitative. The quantitative approach is based on

the creation of economic and mathematical models and the analysis of financial ratios. The mathematical framework used divides bankruptcy prediction methods into two categories: K-prediction models and logistic models. Within these categories, methods are classified according to their geographical origin, either foreign or domestic (Russian). Edward Altman, who proposed his methodology in 1968, is considered the pioneer of K-prediction models. The information base for calculations is usually based on public accounting data, which ensures that these tools are accessible to most interested parties.

Qualitative methods are the opposite of quantitative methods. They do not involve the calculation of integrated indicators and are based on subjective expert assessments. The essence of this method is an intuitive and logical analysis of the problem: an expert collects data, models the situation, and conducts a comparative analysis of different solutions.

Next, Figure 1 presents a classification of authors' models for predicting bankruptcy of organizations.

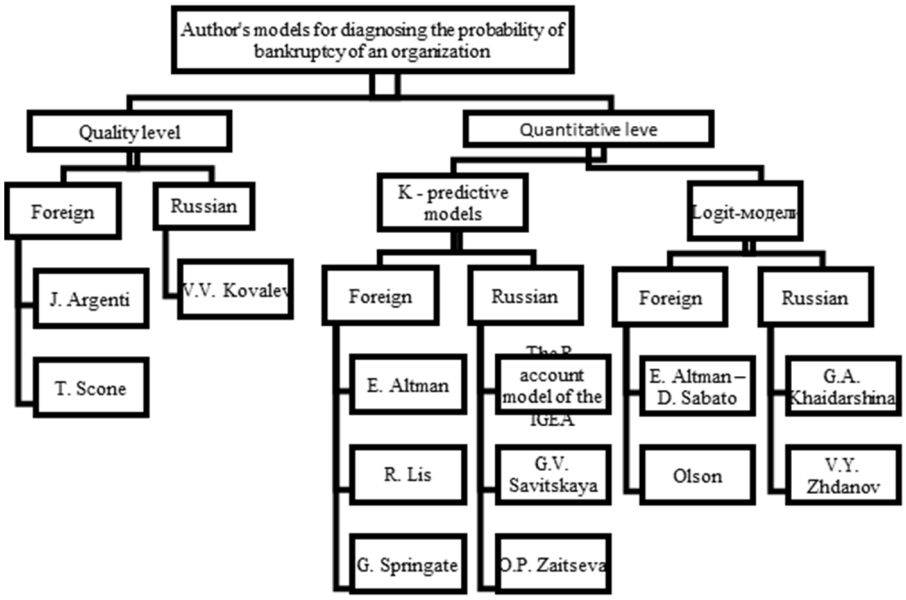


Figure 1. Classification of Author's Models for Diagnosing Bankruptcy of Organizations

In addition to the author's approaches to predicting the likelihood of bankruptcy, the regulatory acts of the Russian Federation establish official methods for predicting the likelihood of bankruptcy. Currently, the following methods are established by regulatory documents:

- "The Federal Tax Service's methodology" for accounting and analyzing the financial condition and solvency of strategic enterprises and organizations is designed for strategic enterprises. These are enterprises included in the list specified in Presidential Decree No. 1009 of August 4, 2004 (as amended on October 30, 2017), "On Approval of the List of Strategic Enterprises and Strategic Joint-Stock Companies."

Classification of accounting objects into financially stable (group 1) and unstable (group 2) is carried out based on the financial reporting data as of the last reporting date. The key criteria for differentiation are:

- Assessment of the ability to repay short-term liabilities (time criterion).
- Current (total) liquidity ratio (structural criterion).

Group 1 (solvent entities) includes accounting objects that are able to pay off their current debts within 6 months and have a current liquidity ratio of 1 or more.

Group 2 (insolvent entities) includes entities whose projected short-term debt maturity exceeds 6 months and whose current liquidity ratio is less than 1.

- "Rules for conducting financial analysis by arbitration managers" The methodology based on the calculation of ten key indicators is considered the most relevant due to its comprehensive nature, which covers all aspects of the company's financial and economic analysis.

At the same time, a set of limitations has been identified that reduce the effectiveness of its application:

- Subjectivity of interpretation of results due to uncertainty of benchmark values;
- Methodological inaccuracies (for example, the inclusion of profitability ratios in the "business activity" block);
- The complexity of calculations due to complex formulas with many adjustments;
- Dependence on an extensive information base;
- Methodological obsolescence, which is expressed in the lack of adaptation to current forms of accounting (financial) reporting;
- The provisional rules for checking the presence of signs of false and deliberate bankruptcy by an arbitration manager contain two methods:

The methodology for identifying signs of fictional bankruptcy is fully consistent with the provisions of federal insolvency legislation, where the criteria for bankruptcy are specifically defined in accordance with the law. The use of this information allows for the formation of accurate conclusions about the indicators of fictitious bankruptcy. However, this approach has a limitation in that it relies solely on financial statements, specifically the balance sheet and income statement. Given that financial statements in Russian practice may not always reflect the actual situation, there is a potential for errors in assessing the true state of an organization.

The methodology for identifying signs of deliberate bankruptcy provides a clear definition of this phenomenon, detailing both quantitative calculations and the analysis of completed transactions in terms of their reasonableness and validity. However, the second part of the analytical process outlined in this methodology is characterized by high complexity and the need for a significant amount of information. For external users of financial statements, this method may not be accessible, as it is primarily intended for bankruptcy trustee and employees working with the company's internal reporting.

The methodology for calculating the financial condition of agricultural producers, being a specialized tool for assessing the agricultural sector, has a number of undeniable advantages. Its main positive feature is its targeted consideration of the specific characteristics of agriculture. Unlike universal approaches, it is adapted to the realities of the industry, taking into account the high level of equipment wear and tear, the seasonal nature of production, and the critical role of government subsidies, which are included in the calculation of income. This allows for a more accurate assessment of the financial condition of farms. In addition, the methodology ensures standardization and uniformity of assessment, which makes it transparent and allows for comparison of different agricultural enterprises, as well as tracking their dynamics over time. This is a convenient and effective tool for government monitoring and decision-making on support.

These methods combine the analysis of the company's asset ratio and expert assessment methods based on a large amount of additional qualitative information. The low predictive power of these methods is due to their reliance on subjective judgments and the lack of specific guidelines for analysts' actions during various procedures.

Despite the variety of existing methods and models for assessing the likelihood of bankruptcy, this field is characterized by a number of unresolved issues. The existing bankruptcy diagnosis models differ in terms of their information base, the amount of analytical work, the complexity of calculations, the speed of solving analytical and managerial tasks, and other conditions. Additionally, while many models are currently universal, there are also models that have limited application. For example, the models by G. V. Savitskaya, Yu. I. Sigidov, S. A. Kucherenko, and N. S. Zhminko are suitable for calculating the financial condition of agricultural producers, while the model by V. Yu. Zhdanov is suitable for aviation companies, but can also be used by companies with a large volume of current assets. The models by G.V. Savitskaya, O.P. Zaitseva, A. Yu. Belikov, G.V. Davydova, and V.V. Kovalev are suitable for industrial companies. As for the models of foreign authors, although they are used to assess the probability of bankruptcy of domestic organizations, their

application may be limited due to their insufficient adaptation to the specifics of the Russian economy.

The further development of the methodological framework for diagnosing the probability of bankruptcy is associated with the improvement of methods, indicators, software, and the regulatory framework, which should ultimately improve forecasting accuracy and the accuracy of predicting the probability of bankruptcy of organizations.

REFERENCES

1. Blazhevich O. G., Karachun, A. I., & Suleymanova, A. L. (2017). Sravnitel'nyy analiz i primeneniye metodov prognozirovaniya bankrotstva [Comparative analysis and application of bankruptcy prediction methods]. Byulleten' nauki i praktiki – Bulletin of Science and Practice, (5(18)), 161-175. (in Russian)

2. Buivis T. A., Ivanova E. V., & Kasatskaya, A. A. (2025). Cravnitel'nyy analiz metodik prognozirovaniya bankrotstva dlya effektivnogo antikrizisnogo upravleniya predpriyatiyem [Comparative analysis of bankruptcy prediction methodologies for effective anti-crisis management of an enterprise]. Vestnik Sibirskogo gosudarstvennogo industrial'nogo universiteta – Bulletin of the Siberian State Industrial University, (2), 128-139. (in Russian)

3. Pravitel'stvo RF. (2003, June 25). Postanovleniye N 367 "Ob utverzhdenii Pravil provedeniya arbitrazhnym upravlyayushchim finansovogo analiza" [Decree No. 367 "On approval of the Rules for conducting financial analysis by an arbitration manager"]. Konsul'tant Plyus: sprav. pravovaya sistema – Consultant Plus: Legal Reference System. Moscow, 1992-2025. Retrieved from https://www.consultant.ru/ (in Russian)

4. Pravitel'stvo RF. (2003, January 30). Postanovleniye N 52 (red. ot 27.11.2014) "O realizatsii Federal'nogo zakona 'O finansovom ozdorovlenii sel'skokhozyaystvennykh tovaroproizvoditeley'" (vmeste s "Metodikoy rascheta pokazateley finansovogo sostoyaniya sel'skokhozyaystvennykh tovaroproizvoditeley", "Trebovaniyami k uchastniku programmy finansovogo ozdorovleniya sel'skokhozyaystvennykh tovaroproizvoditeley") [Decree No. 52 (amended November 27, 2014) "On the implementation of the Federal Law 'On financial rehabilitation of agricultural producers'" (together with the "Methodology for calculating financial condition indicators of agricultural producers," "Requirements for a participant in the program of financial rehabilitation of agricultural producers")]. Konsul'tant Plyus: sprav. pravovaya sistema – Consultant Plus: Legal Reference System. Moscow, 1992-2025. Retrieved from https://www.consultant.ru/ (in Russian)

5. Pravitel'stvo RF. (2004, December 27). Postanovleniye N 855 "Ob utverzhdenii Vremennykh pravil proverki arbitrazhnym upravlyayushchim nalichiya priznakov fiktivnogo i prednamerennogo bankrotstva" [Decree No. 855 "On approval of the Provisional rules for checking by an arbitration manager for signs of fictitious and deliberate bankruptcy"]. Konsul'tant Plyus: sprav. pravovaya sistema – Consultant Plus: Legal Reference System. Moscow, 1992-2025. Retrieved from https://www.consultant.ru/ (in Russian)

6. Ministerstvo ekonomicheskogo razvitiya RF. (2006, April 21). Prikaz N 104 (red. ot 13.12.2011) "Ob utverzhdenii Metodiki provedeniya Federal'noy nalogovoy sluzhboy ucheta i analiza finansovogo sostoyaniya i platezhesposobnosti strategicheskikh predpriyatiy i organizatsiy" (Zaregistrirovano v Minyuste RF 21.06.2006 N 7953) [Order No. 104 (amended December 13, 2011) "On approval of the Methodology for the Federal Tax Service to account for and analyze the financial condition and solvency of strategic enterprises and organizations" (Registered with the Ministry of Justice of the Russian Federation on June 21, 2006, No. 7953)]. Konsul'tant Plyus: sprav. pravovaya sistema – Consultant Plus: Legal Reference System. Moscow, 1992-2025. Retrieved from https://www.consultant.ru/ (in Russian)

7. Reshetov K. Y., & Bodrova K. S. (2017). Sravneniye metodov analiza nesostoyatel'nosti (bankrotstva) predpriyatiya [Comparison of methods for analyzing the insolvency (bankruptcy) of an enterprise]. Vestnik NIB – Bulletin of NIB, (28), 347-359. (in Russian)

8. Savitskaya G. V. (2021). Analiz khozyaystvennoy deyatel'nosti predpriyatiy APK [Analysis of economic activities of agricultural enterprises] (8th ed.). Moscow: INFRA-M. (in Russian)

9. Sigidov Y. I., Kucherenko S. A., & Zhminko, N. S. (2019). Metodika analiza finansovogo sostoyaniya i otsenka potentsial'nosti bankrotstva sel'skokhozyaystvennykh organizatsiy [Methodology for analyzing the financial condition and assessing the bankruptcy potential of agricultural organizations] [Monograph]. Moscow: INFRA-M. (in Russian)

10. Trushina, N. N. (2020). Sravnitel'naya kharakteristika modeley otsenki veroyatnosti bankrotstva predpriyatiya [Comparative characteristics of models for assessing the probability of enterprise bankruptcy]. Ekonomika i biznes: teoriya i praktika – Economics and Business: Theory and Practice, (9-2), 18-20. (in Russian)

11. Rossiyskaya Federatsiya. (2002, October 26). Federal'nyy zakon N 127-FZ "O nesostoyatel'nosti (bankrotstve)" [Federal Law No. 127-FZ "On insolvency (bankruptcy)"]. Konsul'tant Plyus: sprav. pravovaya sistema – Consultant Plus: Legal Reference System. Moscow, 1992-2025. Retrieved from https://www.consultant.ru/ (in Russian)

INVESTIGATING THE RELATIONSHIP BETWEEN NON-FINANCIAL PERFORMANCE METRICS AND FINANCIAL OUTCOMES

S. K. Mkrtchyan

Research advisor: T. V. Zhukova, Cand. Sc. (Econ.)

Novosibirsk, Novosibirsk State Technical University,
susanmkrtcan4@gmail.com

Abstract. The relevance of studying the impact of ESG factors (environmental, social, and governance) on companies' financial performance in the current context is indisputable. The integration of sustainable development principles into corporate

strategies is becoming not merely a global trend but also a crucial factor in ensuring long-term competitiveness and financial stability. For Russian companies, understanding this interrelationship takes on particular significance in the context of regulatory requirements, demands from the state and society, as well as the need for effective risk management.

Keywords: ESG model, non-financial reporting, financial performance, environmental responsibility, social responsibility.

ИССЛЕДОВАНИЕ ВЗАИМОСВЯЗИ МЕЖДУ НЕФИНАНСОВЫМИ ПОКАЗАТЕЛЯМИ ДЕЯТЕЛЬНОСТИ КОМПАНИИ И ЕЕ ФИНАНСОВЫМИ РЕЗУЛЬТАТАМИ

С. К. Мкртчян

Аннотация. Актуальность исследования влияния ESG-факторов (экологических, социальных и управленческих) на финансовые показатели компаний в современных условиях не вызывает сомнений. Интеграция принципов устойчивого развития в корпоративные стратегии становится не просто глобальным трендом, но и важным фактором обеспечения долгосрочной конкурентоспособности и финансовой стабильности. Для российских компаний понимание этой взаимосвязи приобретает особое значение в контексте регуляторных требований, запросов со стороны государства и общества, а также необходимости эффективного управления рисками.

Ключевые слова: ESG-модель, нефинансовая отчетность, финансовый результат, экологическая ответственность, социальная ответственность.

The founder of stakeholder theory, developed in 1984, is Edward Freeman. According to this theory, companies should consider the interests not only of shareholders but also of all stakeholders, including employees, consumers, suppliers, government, and society as a whole [1].

Examining stakeholder theory in the context of the ESG agenda, it can be said that when a company cares for the environment, treats its employees and the surrounding community responsibly, and manages its business transparently, this is valued by all stakeholders – from investors to clients and employees. It is quite logical that this contributes to the business becoming more sustainable and the company's development strategy becoming more attractive to stakeholders.

Resource-based theory views a company as a unique set of resources and capabilities that can become a source of sustainable competitive advantage. The implementation of ESG practices can generate valuable strategic resources for an

organization. This theory, developed by Jay Barney, emphasizes the importance of the resource-based approach in strategic management. In the context of sustainable development, it allows environmental responsibility and social orientation to be considered as strategic resources. Strict adherence to the principles of the agenda makes an organization attractive to investors compared to competitors, owing to the value of these resources for all interested parties [1].

The aforementioned theories laid the foundation for understanding the interrelationship between non-financial factors and corporate performance. However, they were all formed within the context of developed market institutions with established corporate governance practices. Applying these constructs to Russian realities requires substantial adaptation, as the economic environment, the historically formed role of large businesses, and the nature of companies' interaction with the state and society in Russia have distinct specificities. Therefore, there arises a need to turn to domestic theoretical developments that have emerged in recent years in response to the challenges of the national sustainable development agenda.

In Russian economic science, approaches to analyzing the relationship between ESG and financial performance have been formed, adapted to Russian realities. Thus, the Concept of a "Sovereign ESG Model," developed by the National Alliance (an association of major companies with support from the Administration of the President of the Russian Federation), proceeds from the premise that the global agenda cannot be mechanically transplanted onto Russian soil [2].

The concept is based on three principles reflecting national specifics:

1. *Priority of the social function of business*. In Russia, large companies bear responsibility for the development of the regions where they operate and for the quality of life of employees. This is not a "voluntary initiative" but a characteristic of the business model, embedded in public expectations. As noted by Irina Bakhtina, Chairperson of the Supervisory Board of the National Alliance, companies pay maximum attention to "the demands of those who come into contact with or depend on the activities of large Russian businesses – residents of Russian regions, small and medium-sized enterprises in our supply chains" [4].

An example of the implementation of this principle can be seen in NLMK Group, which took an important step in developing the professional competencies of the population by creating the first multidisciplinary qualification assessment center in Russian industry, where metallurgy and mechanical engineering workers can confirm their compliance with professional standards [5].

2. *Environmental modernization* as a response to technological challenges. Unlike the Western model, where ecology serves as a tool for market positioning, in Russia the environmental component is implemented through programs of technological

renewal and the introduction of the best available technologies, which brings the sustainable development agenda closer to the objectives of industrial policy [2].

For example, the subsidiary "Transneft – Western Siberia" carries out systematic work to restore biodiversity in the regions of its operation. As part of environmental activities, tens of thousands of juvenile valuable fish species are released annually into the rivers of the Ob basin. Furthermore, large-scale tree planting is carried out in the forests of Tomsk and Novosibirsk regions, and environmental analytical control laboratories operate at production facilities, conducting constant monitoring of water condition, atmospheric air, soil, etc. [3]. Such solutions clearly demonstrate how the environmental agenda is implemented through specific technological and infrastructural measures.

3. *Transformation of the governance component under sanctions pressure*. The partial non-disclosure of information by companies becomes a defensive reaction to external threats. At the same time, basic corporate principles (ethics, anti-corruption, protection of shareholder rights) retain their significance. For instance, Rosneft maintains a leading position in the field of sustainable development; its shares are included by the Moscow Exchange in all relevant indices, including the climate resilience level and the balanced ESG index. For the period since 2022, the volume of Rosneft's investments in sustainable development has reached two hundred billion rubles [6].

Thus, for public companies, the Concept of the "Sovereign ESG Model" holds particular importance, as it allows for understanding that social responsibility in the form of supporting regions and ensuring employment, as well as environmental safety (prevention of emergencies, restoration of natural resources), are not additional "ESG initiatives" but integral elements of the business model, embedded in strategic documents and public expectations.

To compare Western and domestic theories, a comparative characteristic was compiled, based on the analysis and synthesis of the studied material. The comparative characteristic demonstrates that the differences between Western and domestic theoretical approaches are fundamental in nature. While in the Western paradigm ESG factors are viewed primarily as a tool for enhancing investment attractiveness and market capitalization, in the Russian model they are embedded in a broader context: fulfilling state objectives, maintaining social stability in the regions of operation, and ensuring technological modernization of production. This fundamentally changes the understanding of how exactly the impact of ESG on the financial results of Russian companies should be assessed. Instead of seeking a direct short-term link with profitability, characteristic of most Western studies, Russian specifics require an analysis of long-term effects associated with reducing regulatory

risks, preserving the "social license," and strengthening reputation among key stakeholders.

Summarizing the foregoing, it can be noted that the conducted study of the interrelationship between a company's non-financial performance indicators and its financial results allows not only for recording conceptual differences but also for substantiating the choice of methodology for further empirical analysis. It is the Russian theoretical framework of the "Sovereign ESG Model" concept that sets the benchmarks for researching public companies in the infrastructure sector.

REFERENCES

1. ESG Performance and Financial Stability: A Bibliometric and Meta-Analysis // Sage Journals. 2025. URL: https://journals.sagepub.com/doi/10.1177/21582440251381772 (accessed 28.02.2026).

2. ESG Alliance Summed Up the Results of Three Years of Work // AK&M. 2025. URL: https://www.akm.ru/news/esg_alyans_podvel_itogi_tryekh_let_raboty_kak_razvivalas_esg_povestka_chego_udalos_dostich_i_kakie_o/ (accessed 28.02.2026).

3. Transneft Subsidiary Planted 120 thousand Seedlings in Tomsk and Novosibirsk Forests // Tomsk Internet Newspaper. 2026. URL: https://gt-tomsk.ru/news/dochka-transnefti-vysadila-120-tysyach-sazhencev-v-tomskix-i-novosibirskix-lesax/ (accessed 28.02.2026).

4. Irina Bakhtina Heads Supervisory Board of the ESG Alliance // BFM.ru. 2025. URL: https://www.bfm.ru/news/572199 (accessed 28.02.2026).

5. NLMK Opens Multidisciplinary Qualification Assessment Center in Lipetsk // GTRK "Lipetsk". 2025. URL: https://vesti-lipetsk.ru/novosti/obshestvo/nlmk-otkryl-v-lipecke-mnogoprofilnyj-centr-ocenki-kvalifikacij/ (accessed 28.02.2026).

6. Rosneft Confirms Leader Status in Sustainable Development // Izvestia. 2026. URL: https://iz.ru/2038408/2026-02-06/rosneft-podtverdila-status-lidera-v-oblasti-ustoichivogo-razvitiia (accessed 28.02.2026).

CO-FINANCING IN PARTICIPATORY BUDGETING

M. A. Nazarov

Research advisor: I. V. Baranova, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*, *Russia*,
ehottik@ehottik.ru

Abstract: Participatory budgeting has become a sustainable element of the regional financial policy of the Russian Federation. A distinctive feature of participatory projects is their co-financing by citizens and/or businesses. The article

examines the institutional differences between existing models of co-financing participatory projects and their financial and socio-economic consequences.

Keywords: participatory budgeting, co-financing, participatory project, regional finances.

СОФИНАНСИРОВАНИЕ В ИНИЦИАТИВНОМ БЮДЖЕТИРОВАНИИ

М. А. Назаров

Аннотация: Инициативное бюджетирование стало устойчивым элементом региональной финансовой политики Российской Федерации. Отличительной особенностью инициативных проектов является их софинансирование со стороны граждан и/или бизнеса. В статье рассматриваются институциональные различия существующих моделей софинансирования инициативных проектов и их финансовые и социально-экономические последствия.

Ключевые слова: инициативное бюджетирование, софинансирование, инициативный проект, региональные финансы.

Participatory budgeting is no longer perceived as an experimental mechanism for managing regional finances. Over the past decade, it has become part of everyday financial practice at the regional and municipal levels. In many cases, participatory budgeting acts not only as an instrument of civic participation but also as a mechanism that influences the structure of budget expenditure priorities.

One of the key issues in the development of participatory budgeting programs is the requirement for project co-financing. In many regions, projects proposed by citizens are implemented only on the condition of attracting a certain share of additional funds from the population, businesses, or other extra-budgetary sources. This institutional feature significantly affects both access to financing and the distribution of financial responsibility.[6]

The question arises: Does co-financing of a participatory project actually increase the efficiency of budget expenditures, or does it merely redistribute part of the financial burden onto local communities? The answer cannot be purely theoretical; an analysis of the implementation practices of various participatory budgeting models and their results is necessary.[5]

Co-financing of participatory projects can be viewed from various theoretical perspectives. From the point of view of fiscal decentralization, citizen participation in project financing can increase the efficiency of resource allocation, as residents are better informed about local needs. Financial participation helps reduce information asymmetry between authorities and communities.

Public choice theory offers another explanation. When citizens invest their own funds, they receive additional incentives to monitor project implementation. This can reduce the risk of opportunistic behavior and promote more responsible spending of funds. Institutional economics emphasizes the importance of formal rules and informal norms. The effectiveness of co-financing of participatory projects is determined not only by the volume of funds raised but also by the level of transparency, trust, and administrative capacity of governing bodies. These theoretical propositions indicate the potential advantages of co-financing of participatory projects; however, their implementation depends on the specific institutional design [1].

Regional practice in the Russian Federation demonstrates several approaches to organizing the co-financing of participatory projects.

The first approach involves mandatory financial participation by the population. A project is admitted to the competitive selection only on the condition that a predetermined share of its cost is covered by extra-budgetary sources. This model ensures a predictable level of private participation and increases financial mobilization. However, it may limit the opportunities of economically weak territories.

The second approach is incentive-based. In this case, citizen contributions are taken into account when evaluating projects but are not a mandatory condition for admission. Projects with a higher level of private participation receive additional points. This model is more flexible and socially oriented, but the volume of extra-budgetary funds is less predictable.

The third model is mixed, combining funds from regional and municipal budgets, citizen contributions, and, in some cases, businesses. Such diversification reduces financial risks and promotes sustainability but requires more complex coordination.

None of the models under consideration (Table 1) can be considered universally optimal; their effectiveness depends on the socio-economic conditions of the region.

Table 1 – Comparative characteristics of co-financing models

Model	Advantages	Limitations	Efficiency level
Mandatory co-financing	High level of financial impact; strict accountability	Territories with low income levels may be excluded	Medium – High
Voluntary co-financing	Flexibility; social openness	Lower predictability of financing	Medium
Mixed co-financing from multiple sources	Diversified financing; high sustainability	Complex coordination requirements	High

Source: Compiled by the author based on [2, 6]

Co-financing of participatory projects transforms the financial architecture of such initiatives. It expands the total volume of resources for project implementation, but simultaneously creates a number of challenges.

One of the key problems is territorial differentiation. Wealthier regions are able to attract additional funds, which can lead to an increase in the number or cost of projects. In the absence of compensating mechanisms, this can exacerbate inter-territorial inequality. Another aspect is the instability of private contributions. Unlike budget allocations, private financing depends on the economic situation. During periods of economic downturn, citizen participation may decrease, which affects project implementation timelines. Furthermore, attracting multiple sources of financing increases administrative complexity. Clear reporting procedures are necessary to ensure transparency.

The effectiveness of co-financing of participatory projects cannot be assessed based on a single quantitative indicator. The share of extra-budgetary funds is important, but it does not reflect institutional and social consequences. A comprehensive assessment of co-financing of participatory projects should consider three aspects:

First, financial, characterizing the mobilization of resources and the efficiency of using budget funds.

Second, operational, reflecting compliance with deadlines, budget, and project completion.

Third, social, showing the level of citizen participation and public perception [3].

In practice, these parameters can be combined into an aggregate indicator:

$$CEI = w_1 \ F + w_2 \ O + w_3 \ S,$$

where F, O, and S are the financial, operational, and social components, and w_1, w_2, w_3 are their weights.

This index should be considered as an analytical tool for interregional comparison.

Digitalization has significantly changed the practice of participatory budgeting, simplifying public participation through online platforms and increasing its transparency. However, problems of the digital divide and cybersecurity persist.

Co-financing of participatory projects fosters a sense of ownership and promotes more responsible use of infrastructure. It strengthens social capital and stimulates local economic activity through the involvement of small businesses [2]. Co-financing of participatory projects should be viewed as an institutional mechanism, not just a financial requirement. Its effectiveness is determined by the regional context, administrative capabilities, and clarity of procedures. Mandatory models

ensure predictability but may limit public participation. Incentive models are more flexible yet financially less stable. Mixed models have high sustainability potential but require well-developed coordination.

A comprehensive assessment of co-financing of participatory projects must take into account financial, operational, and social aspects. Further research is needed for a deeper understanding of the role of participatory project co-financing in modernizing the public finance system.

REFERENCES

1. Levina V.V. Features and problems of regional practices of participatory budgeting // Regional Economics: Theory and Practice. – 2020. – No. 6. – pp. 1123--1135.

2. Mirkin Ya.M. Public finance and financial policy: theory and practice. – M.: Magistr, 2017. – 416 p.

3. Shulga I.E. Participatory budgeting as a tool to increase the efficiency of budget expenditures // Regional Economics: Theory and Practice. – 2017. – No. 10. -- pp. 45–54.

4. Shulga I.E., Vagin V.V. Participatory budgeting as a tool to increase the sustainability of regional finances // Finance and Credit. – 2024. – Vol. 30. – No. 6.

5. Vagin V.V. Participatory budgeting: methodology and implementation practices in the constituent entities of the Russian Federation // Finance. – 2018. --- No. 9. – pp. 3–11.

6. Vagin V.V., Shulga I.E., Khachatryan G.G. Participatory budgeting: Russian experience and development directions. – M.: NIFI of the Ministry of Finance of Russia, 2019. – 112 p.

ANALYSIS OF FINANCIAL RESULTS AS A TOOL FOR ENSURING THE ECONOMIC SECURITY OF AN ENTERPRISE

E. V. Nedelkova, M. A. Vlasenko

Novosibirsk State Technical University, *Novosibirsk*,
enedelkova@mail.ru

Abstract. The article discusses the analysis of financial results as a tool for ensuring economic security. The methods of Sheremet, Svyatokho, and Larionova are applied to the data of a wholesale trade enterprise. The results show that a comprehensive approach allows for the identification of hidden threats, such as a decrease in the quality of profits and inefficiency in the main activity, which are not obvious when using a single method.

Keywords: economic security, financial results, profitability analysis, factor analysis, profit quality, and the DuPont model.

АНАЛИЗ ФИНАНСОВЫХ РЕЗУЛЬТАТОВ КАК ИНСТРУМЕНТ ОБЕСПЕЧЕНИЯ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ ПРЕДПРИЯТИЯ

Е. В. Неделкова, М. А. Власенко

Аннотация. В статье рассмотрен анализ финансовых результатов как инструмент обеспечения экономической безопасности. Методики Шеремета, Святохо и Ларионовой применены к данным предприятия оптовой торговли. Результаты показывают, что комплексный подход позволяет выявить скрытые угрозы: снижение качества прибыли и неэффективность основной деятельности, неочевидные при использовании одного метода.

Ключевые слова: экономическая безопасность, финансовые результаты, анализ рентабельности, факторный анализ, качество прибыли, модель Дюпона.

The economic security of an enterprise is an important key factor in its sustainable functioning and development. Therefore, creating an effective economic security system requires a more comprehensive approach and constant analysis of both internal and external factors, which will allow the enterprise to not only protect its vital interests but also effectively adapt to environmental changes, ensuring its competitiveness [6].

Indicators are used to assess the state of economic security. Threshold values are used to signal risks and threats to economic security. Financial results are the basis for calculating most indicators. Unlike many other indicators, financial results are highly sensitive to negative changes [1, с. 65].

Various analysis methods are used to diagnose the financial condition and identify threats to economic security. In this study, we will analyze financial results using the methodology of A.D. Sheremet, O.A. Larionova, and N.V. Svyatokho.

A.D. Sheremet's methodology is a comprehensive system consisting of 11 stages and including analysis of income and expenses, assessment of break-even points, and factor analysis of profit and profitability. The approach is characterized by a detailed decomposition of financial results into components and identification of the factors that have the greatest impact [7].

In his works, N.V. Svyatokho suggests evaluating the profitability level of an enterprise by determining the profit formation zone based on two key indicators: commercial margin and transformation coefficient [5].

Larionova's methodology includes an analysis of the structure and dynamics of financial results, a factor analysis of sales profit (using the Russian methodology and direct costing), an analysis of profitability indicators, and the DuPont model [2].

The analysis was conducted based on the company's annual reports for 2023-2024. The company's main activity is the wholesale of solid fuel. Due to privacy

policies and to maintain commercial confidentiality, the company's actual name has been changed.

At one of the stages of analysis according to A.D. Sheremet's methodology, the dynamics of financial results are examined. In 2023, the growth rate of expenses at JSC «X» exceeded the growth rate of revenues, resulting in a decrease in net profit to 2,878 million rubles. In 2024, net profit increased to 7,496 million rubles, but this increase was solely due to improvements in other activities, while regular activities continued to decline [7].

The key stage of the analysis according to A.D. Sheremet's methodology is the factor analysis of sales profitability, performed using the chain substitution method. The results are presented in Table 1.

Table 1 – Results of the factor analysis of changes in the profitability of sales at JSC «X» in 2024

Change in sales profitability due to:	
Cumulative effect	5,63%
Cost of sales	-22,87%
Period expenses	33,86%
Balance of other income and expenses	5,08%
Current income tax	-1,44%
Revenue	-9,01%
Total changes	5,63%

A factor analysis of the sales profitability showed that its increase by 5.63% was due to a sharp decrease in period expenses (+33.86%), but there was also a strong negative effect from the increase in cost of sales (-22.87%).

In addition, a comparison was made with the industry average. In 2023, the sales profitability of JSC «X» (2.98%) was lower than the industry average (3.6-5.1%), but in 2024, it significantly exceeded the industry average (8.61% compared to the industry average of 3.5-4.5%), which is a positive factor for economic security [3,4].

To assess the profitability of an enterprise from the perspective of economic security, N.V. Svyatokho's methodology was used to identify the zone of financial result formation. The dynamics of the relevant indicators of JSC "X" for 2023-2024 are presented in Table 2 [5].

In 2024, the company moved from an ideal profitability zone to a neutral zone. A decrease in commercial margin from high to medium levels, while maintaining the transformation ratio within acceptable limits, indicates an acceptable but controlled level of economic security.

Table 2 – Assessment of the profitability of JSC "X" using the method of N.V. Svyatokh

Indicator	2023		2024	
	Value	Level	Value	Level
Commercial margin, (%)	49,7	High	18,8	High
Transformation coefficient	1,39	High	1,25	Average
Profit zone	Ideal		Neutral	

The main feature of O.A. Larionova's methodology is the use of the DuPont three-factor model, which allows for the decomposition of return on equity into its components: net margin, asset turnover, and equity multiplier. The results of the factor analysis of the change in ROE for JSC «X» in 2024 are presented in Table 3 [2].

Table 3 – Impact of factors on the change in the return on equity of JSC «X» in 2024

The change in ROE was due to:	
Net margin	16%
Asset turnover	-2%
Equity multiplier	-2%
Total change	12%

The DuPont model revealed that the 12% increase in ROE was solely due to an increase in net margin, while business activity and financial leverage decreased, which indicates an increase in operational efficiency from an economic security perspective, but requires monitoring of a slowdown in asset turnover.

Timely detection of problems in economic security allows for timely measures to be taken to improve the company's financial and economic situation. The analysis of JSC «X» based on the methods of financial results analysis allows for the effective identification of hidden threats. The combined use of the approaches of Sheremet A.D., Larionova O.A., and Svyatokho N.V. provides the most comprehensive and objective assessment of financial results in the context of the company's economic security.

REFERENCES

1. Koroleva T. A. Analysis of Financial Results in the Context of Ensuring the Economic Security of an Enterprise (on the Example of PJSC MTS) / T. A. Koroleva, E. A. Shnyukova // The Role of Accounting, Control, and Management in the System of Ensuring Sustainable Development of the Public and Commercial Sectors of the Economy, Simferopol, April 29, 2021. – Simferopol: Crimean Federal University named after V. I. Vernadsky, 2021. –

Pp. 64-67. — Text : electronic. - URL: https://www.elibrary.ru/item.asp?id=46371819&pff=1 (accessed: 15.02.2026).

2. Larionova O. A. Analysis and Diagnostics of the Production and Economic Activities of an Enterprise. Part 3. Analysis of Expenses and Financial Results of an Enterprise's Activities : Study Guide / O. A. Larionova. — Ryazan : RGRTU, 2022 — Part 3 : Analysis of Expenses and Financial Results of an Enterprise's Activities — 2022. — 48 p. — Text : electronic // Lan : electronic library system. — URL: https://e.lanbook.com/book/310541 (accessed: 21.02.2026).

3. Profitability of Sales // TestFirm URL: https://www.testfirm.ru/finfactor/ gross-margin/ (accessed: 23.02.2026).

4. Information on the average industry indicators of the tax burden, profitability of sold goods, products, works, services, and profitability of assets of organizations by economic activities that characterize the financial and economic activities of taxpayers // Federal Tax Service - Official Website URL: https://www.nalog.gov.ru/rn77/taxation/ reference_work/ conception_vnp/ (accessed: 23.02.2026).

5. Svyatokho, N.V. Analysis of Profitability in the Context of Researching the Economic Security of an Enterprise / Scientific Bulletin: Finance, Banks, Investments. — 2020. — No. 2. — Pp. 145-153. — Text : electronic // Lan : electronic library system. — URL: https://e.lanbook.com/journal/issue/349556 (accessed: 23.02.2026).

6. Khmelev S.A. Improving the Economic Security of Business Entities through the Use of Business Insurance Mechanism // RUSSIAN JOURNAL OF MANAGEMENT Vol. 11 No. 4. - 2023. - Vol. 11, No. 4. - Pp. 313-325. // URL: https://naukaru.ru/ru/nauka/article/ 72871/ view#author1 (accessed: 29.03.2025).

7. Sheremet, A. D. Analysis and Diagnostics of the Financial and Economic Activity of an Enterprise : Textbook / A. D. Sheremet. — 2nd ed., add. — Moscow : INFRA-M, 2024. — 374 p. — Text : electronic. - URL: https://znanium.ru/catalog/product/2067389 (accessed: 29.03.2025).

SPECIFIC FACTORS AFFECTING THE PERFORMANCE OF COMPANIES IN THE OIL INDUSTRY

V. A. Nezbudey

Research advisor: I. V. Baranova, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
nezbudey.slava@mail.ru

Abstract: In the context of ongoing sanctions pressure, assessing economic security is an important element of analyzing the economic activities of companies, including those in the oil industry. To provide an objective assessment of economic security, it is important to consider the industry-specific factors that influence the company's operations, including its financial performance.

Keywords: companies, sanctions, oil industry, financial result, activity, factors.

СПЕЦИФИЧЕСКИЕ ФАКТОРЫ, ВЛИЯЮЩИЕ НА РЕЗУЛЬТАТЫ ДЕЯТЕЛЬНОСТИ КОМПАНИЙ НЕФТЯНОЙ ОТРАСЛИ

В. А. Незбудей

Аннотация: В условиях продолжающегося санкционного давления оценка экономической безопасности является важным элементом анализа хозяйственной деятельности компаний, в том числе нефтяной отрасли. Для объективной оценки экономической безопасности важным является учет отраслевых факторов, влияющих на функционирование компании, в том числе на ее финансовый результат.

Ключевые слова: компании, санкции, нефтяная отрасль, финансовый результат, деятельность, факторы.

In the process of analyzing economic security, it is important to systematize the factors that have a direct impact on the functioning of the organizations under study. The following factors are considered to be the main factors affecting the activities of oil companies:

1. A significant predominance of non-current assets over current assets.
2. Difficult climatic conditions for oil production, which increases the costs of oil production and leads to an increase in the cost of equipment that can operate in permafrost conditions.
3. A long distance between the complex assembly points of the fields and the seaports where the oil is shipped for further sale.
4. The imposition of tariffs by the United States on countries that import Russian oil, as well as political pressure exerted by the United States on India and China.
5. The inclusion of the three largest Russian oil companies, Rosneft, LUKOIL, and Surgutneftegaz, in the sanctions lists [5].

In addition to the specific factors affecting the performance of oil companies, this article also examines the financial results of the four largest oil companies in the Russian Federation, which were directly affected by these factors. The companies analyzed are:

1. Rosneft PJSC [3].
2. LUKOIL PJSC [2].
3. Surgutneftegas PJSC [4].
4. Gazprom Neft PJSC [1].

The first distinguishing factor of the Russian oil industry is the significant predominance of fixed assets over current assets (Table 1).

The main assets of oil companies include vehicles, buildings, structures, and equipment that are directly used in the process of oil extraction, transportation, and refining.

Table 1 – Share of current and non-current assets in company's assets, %

Indicator	Rosneft	LUKOIL	Surgutneftegas	Gazprom Neft
Non-current assets	59%	54%	79%	65%
Current assets	41%	46%	21%	35%

Next, we will consider the combined impact of two factors: the challenging climate conditions of oil production and the long distances between oil fields and seaports (Table 2), as they have a significant impact on the amount of fixed assets and additional costs that increase the cost of sales.

Table 2 – Dynamics of fixed assets and sales cost for 2020-2024, billion rubles

Fixed assets					
Company name	Year				
	2020	2021	2022	2023	2024
Rosneft	1 403	1 450	1 998	2 183	2 391
LUKOIL	15	17	5	7	5
Surgutneftegas	992	1 061	1 643	1 781	1 960
Gazprom Neft	6	5	3	3	4
Cost price					
Company name	Year				
	2020	2021	2022	2023	2024
Rosneft	3 641	5 626	n/a	6 323	7 451
LUKOIL	16	1 545	1 785	1 895	2 163
Surgutneftegas	788	1 362	1 654	1 693	n/a
Gazprom Neft	1 360	2 285	n/a	3 188	2 635

Since 2022, all the companies under consideration have experienced an increase in the value of their fixed assets, which is due to restrictions on oil supplies through the Druzhba pipeline. As a result, the companies have been forced to reorient their supply chains by acquiring offshore vessels, leading to an increase in the value of their fixed assets. The exception is LUKOIL [6], which has reduced the volume of oil processed at its own refineries in order to optimize its operations, resulting in a decrease in its fixed assets.

Considering the cost of sales, it can be noted that all companies have experienced a significant increase in cost over the period 2020-2024, which is due to the increased

sanctions pressure since 2022, as well as the changing conditions for the operation and shipment of petroleum products. The significant increase in cost for LUKOIL [6] in 2021 is related to the company's decision to independently engage in trading operations with petroleum products, as previously, this function was handled by the company's subsidiaries.

Next, we will consider the factors of political and sanctions pressure on the states that are the main importers of Russian oil and the largest oil companies together in Table 3.

Table 3 – Revenue and net profit for 2020-2024, billion rubles.

Revenue					
Company name	Year				
	2020	2021	2022	2023	2024
Rosneft	4 835	7 594	n/a	8 405	9 345
LUKOIL	323	2 389	2 753	2 753	3 047
Surgutneftegas	992	1 061	1 643	1 781	1 960
Gazprom Neft	1 513	2 675	n/a	3 303	3 792
Net profit					
Company name	Год				
	2020	2021	2022	2023	2024
Rosneft	156	603	n/a	664	542
LUKOIL	198	636	790	655	733
Surgutneftegas	788	513	61	1 334	923
Gazprom Neft	344	163	n/a	3 188	2 635

Despite the increasing sanctions and political pressure on India and China, as the main importers of oil, the revenue of Russia's largest oil companies remained at the same level or increased. However, it is worth noting that the maintenance of revenue in rubles was influenced by the exchange rate of the US dollar, which has significantly fluctuated since 2020. Additionally, it is important to consider the changes in the cost of production, as shown in Table 2. As we can see, the increase in cost of production over the period significantly exceeded the increase in revenue. Therefore, we can conclude that the sanctions and political pressure on countries that import Russian oil have led to a decrease in revenue for Russian companies.

Considering the factor of sanctions pressure on oil companies, it can be noted that it had a significant negative impact on the final financial results of all companies,

with the exception of LUKOIL [6], as this company actively changed its activities: it redirected its main supply volumes to domestic routes, reduced its oil refining volumes, and increased the number of gas stations to sell its surplus reserves. Additionally, during the рассматриваемый period, the company sold its foreign assets that were subject to sanctions and could not be used in its operational activities.

Based on the above, it can be noted that it is important to consider the main characteristics of the industry in which the company under study operates when assessing its economic security. This has a direct impact on the financial performance of the organization and, therefore, allows for more objective conclusions to be drawn.

REFERENCES

1. Buhgalterskaya (finansovaya) otchetnost' PAO «Gazprom neft'» (Accounting (financial) statements of Gazprom Neft PJSC) Available at: https://www.e-disclosure.ru/portal/files.aspx?id=347&type=3 (accessed 22.02.2026).

2. Buhgalterskaya (finansovaya) otchetnost' PAO «LUKOJL» (Accounting (financial) statements of PJSC LUKOIL) Available at: https://www.e-disclosure.ru/portal/files.aspx?id=17&type=3 (accessed 22.02.2026).

3. Finansovaya (bukhgalterskaya) otchetnost' PAO «NK «Rosneft» (Financial (accounting) statements of PJSC NK Rosneft) Available at: https://www.rosneft.ru/Investors/ statements_and_presentations/Statements/ (accessed 22.02.2026).

4. Godovaya buhgalterskaya (finansovaya) otchetnost' PAO «Surgutneftegaz» (Annual accounting (financial) statements of PJSC Surgutneftegaz) Available at: https://www.surgutneftegas.ru/investors/essential_information/reporting/ (accessed 22.02.2026).

5. Nezbudey V.A. (2025) K voprosu o metodike ocenki ehkonomicheskoj bezopasnosti organizacij neftyanoj otrasli [On the issue of the methodology for assessing the economic security of oil industry organizations] Ehkonomika i upravlenie: problemy, resheniya [Economics and management: problems, solutions] 12 (2). URL: https://scinetwork.ru/articles/49314#article--main (accessed 22.02.2026).

6. Shestakov R.A., Zajkin D.V. (2024) Formirovanie sistemy indikatorov ehkonomicheskoj bezopasnosti kompanii TEK [Formation of a system of indicators of the economic security of the fuel and energy Complex company] Delovoj zhurnal «Neftegaz.RU» [Business Magazine «Neftegaz.RU»] 5. URL: https://magazine.neftegaz.ru/articles/ekonomika/834708-formirovanie-sistemy-indikatorov-ekonomicheskoy-bezopasnosti-kompanii-tek/ (accessed 22.02.2026).

ASSESSMENT OF THE LEVEL OF ECONOMIC SECURITY OF A MANUFACTURING ENTERPRISE

A. A. Radich

Research advisor: I. V. Baranova, Doctor of Sciences (Economics)

Novosibirsk, *Novosibirsk State Technical University*,
alinaradich03@gmail.com

Abstract: This article substantiates the relevance of assessing the economic security of enterprises. An analysis of the economic security level of KAMAZ PJSC is conducted, risks and threats to the enterprise's business activities are identified and described, vulnerabilities are identified, and recommendations for ensuring the economic security of the enterprise under study are proposed.

Keywords: economic security, analysis, assessment, indicators, risks, threats.

ОЦЕНКА УРОВНЯ ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ ПРОИЗВОДСТВЕННОГО ПРЕДПРИЯТИЯ

А. А. Радич

Аннотация: В данной статье обосновывается актуальность оценки экономической безопасности предприятий. Проведен анализ уровня экономической безопасности ПАО «КАМАЗ», выявлены и описаны риски и угрозы для хозяйственной деятельности предприятия, определены уязвимости и предложены рекомендации по обеспечению экономической безопасности рассматриваемого предприятия.

Ключевые слова: экономическая безопасность, анализ, оценка, показатели, риски, угрозы.

Enterprises play a key role in ensuring the independence and integrity of the state, as well as the country's socioeconomic development. Therefore, it is essential to ensure the economic security of each enterprise. For companies operating in the truck manufacturing industry, assessing their level of economic security is particularly important, as they ensure transport independence and logistics, active import substitution, and the technical equipment of key economic sectors, which entails reliable and effective technological development and the maintenance of the country's transport security.

The purpose of this study was to analyze the level of economic security at the KAMAZ PJSC manufacturing enterprise. To achieve this goal, the following

objectives were addressed: indicator-based approaches to assessing an enterprise's economic security were studied, an assessment of KAMAZ PJSC's economic security was provided, and recommendations for strengthening it were developed.

The most common approach to assessing the economic security of an enterprise is the indicator approach, which was considered by E. G. Tokmakova, E. V. Kieva, A. N. Shchapov, A. Yanioglo, V. I. Tamkovich, O. B. Ilyina, and others [9–12]. Within the framework of this study, the assessment of the level of economic security of PJSC KAMAZ was carried out using the methodology of A. Yanioglo [12].

PJSC KAMAZ is the largest enterprise for the production of heavy trucks in the Russian Federation and ranks among the twenty largest global manufacturers [3–7].

The company's facilities include design and production, including the assembly of equipment and components, as well as sales of manufactured products and service support [3].

By the end of 2025, the net loss of KAMAZ PJSC increased to 37 billion rubles [4, 6]. The group's revenue amounted to 315.2 billion rubles, of which 294.6 billion rubles were received on the domestic Russian market and 20.6 billion rubles on foreign markets [4, 6].

The negative dynamics of financial indicators are influenced by the conditions of operations: increased geopolitical instability, the introduction of sanctions, including those affecting financial institutions, individuals and certain sectors of the economy, restrictions on certain types of transactions and others [2, 5].

The oversaturation of the Russian truck market and active competition from Chinese manufacturers, the restructuring of supply chains, as well as a noticeable shortage of qualified specialists and drivers also have a significant impact on the decline in the financial performance of KAMAZ PJSC [2].

To assess the level of economic security at KAMAZ PJSC, indicators characterizing financial, technical and technological, production and sales, and personnel components were calculated. The resulting values were then assigned corresponding points depending on their compliance with the threshold value. An aggregate security indicator was determined for each component, based on which a summary indicator reflecting the overall level of economic security at KAMAZ PJSC was calculated (see Table 1).

Thus, based on an analysis of all components, the level of economic security of KAMAZ PJSC is characterized by the following aggregate indicators: 0.58 (2023), 0.35 (2024), and 0.31 (2025). In 2023, the company's economic security level is assessed as average, and in 2024 and 2025, it is assessed as low.

Despite the low level of economic security, an important factor in the activities of KAMAZ PJSC is active support from the state, which includes direct subsidies, preferential leasing programs, tax incentives, etc., which ensures the sustainability of the enterprise in conditions of economic instability.

Table 1 – Results of the economic security assessment of KAMAZ PJSC for 2023–2025

Components of economic security	2023	2024	2025
Financial component	0,40	0,30	0,30
Production and sales component	0,75	0,25	0,13
Technical and technological component	0,83	0,67	0,50
Personnel component	0,33	0,17	0,33
Consolidated coefficient of economic security of the enterprise	0,58	0,35	0,31

Source: compiled by the author based on data [1, 12].

Government subsidies (Table 2) effectively offset the recycling fee. Without this support, operating losses would have exceeded 100 billion rubles, highlighting the organization's critical dependence on government funding.

Table 2 – State aid to PJSC KAMAZ for 2023–2025, thousand rubles

Name of the indicator	2023	2024	2025
Total funds received, including:	38 784 233	52 819 649	73 065 280
to compensate expenses	37 489 126	51 713 205	72 580 280
of which to compensate for expenses included in the cost price	*36 260 820*	*43 641 974*	*66 746 456*
to finance capital expenditures	1 295 107	1 106 444	485 000

Source: compiled by the author based on data [1].

State support is supported by several factors:

First, KAMAZ PJSC plays a role in ensuring the country's transport security and technological autonomy;

Second, the company is one of the country's leading employers, which ensures employment;

Third, KAMAZ PJSC fulfills state defense contracts and actively supplies humanitarian aid to combat zones.

Based on an analysis of KAMAZ PJSC's economic security, as well as a detailed study of its components, potential risks that could be critical for the company were identified: geopolitical tensions and sanctions pressure, decreased liquidity and solvency, the risk of falling sales volumes, and potential staff turnover.

Based on the conducted research, to ensure the economic security of PJSC KAMAZ, it is possible to propose maintaining sufficient cash balances and available

credit limits, technological modernization of production, diversification of the product portfolio and sales markets, improving the quality and consumer properties of manufactured products, and increasing operational efficiency.

REFERENCES

1. Financial Statements of KAMAZ PJSC // KAMAZ URL: https://kamaz.ru/investors-and-shareholders/financial-statements/ras/ (Accessed: February 26, 2026).

2. Annual Report // KAMAZ URL: https://kamaz.ru/investors-and-shareholders/information-disclosure/annual-report/ (Accessed: February 26, 2026).

3. For Investors and Shareholders > Key Indicators // KAMAZ URL: https://kamaz.ru/investors-and-shareholders/key-indicators/ (Accessed: February 26, 2026).

4. KAMAZ increased its net loss under RAS by 11 times to 37 billion rubles in 2025 // Interfax URL: https://www.interfax.ru/business/1071487 (accessed on February 26, 2026).

5. Consolidated financial statements under IFRS // KAMAZ URL: https://kamaz.ru/investors-and-shareholders/financial-statements/ifrs/ (accessed on February 26, 2026).

6. About the company > General information // KAMAZ URL: https://kamaz.ru/about/general-information/ (accessed on February 26, 2026).

7. About the company // KAMAZ URL: https://kamaz.ru/about/ (accessed on February 26, 2026).

8. Sustainable Development Report // KAMAZ URL: https://kamaz.ru/investors-and-shareholders/information-disclosure/otchet-ob-ustoychivom-razvitii/ (date of access: 26.02.2026).

9. Tamkovich V. I., Ilyina O. B. Features of assessing the economic security of enterprises in the agricultural sector // Bulletin of youth science. 2023. No. 2 (39). pp. 16 - 23

10. Tokmakova E. G., Kieva E. V. Assessing the economic security of a trade organization: stages, methods, features of the indicator approach // Proceedings of the V All-Russian Forum in Tyumen on Economic Security. Tyumen: Tyumen State University, 2024. pp. 520 - 525.

11. Shchapov A. N. The system of indicators of economic security of an enterprise and their threshold values // Bulletin of the Moscow University of Finance and Law. 2022. No. 1. Pp. 134–143.

12. Yanioglo A. Comprehensive system for ensuring economic security of enterprises (using the ATU Gagauzia as an example): dis. ... Doctor of Economics. – Chisinau, 2017. – 188 p.

INTERNAL AUDIT OF THE ENERGY COMPANY'S FIXED ASSETS: RISK ASSESSMENT BASED ON THE INTEGRATION OF ACCOUNTING AND TECHNICAL DATA

A. A. Radchenko, N. V. Fribus

Novosibirsk, *Novosibirsk State Technical University*,
ar904004@yandex.ru

Abstract: The article examines approaches to internal audit of fixed assets in an energy company, with a focus on wear- and reliability-related risks in the digital era. Given the significant share of non-current assets and the substantial proportion of property, plant and equipment (PPE) in the company's asset base, ensuring financial stability and operational reliability requires internal audit to focus not only on the accuracy of accounting, but also on the effectiveness of interaction between accounting data, the actual technical condition of equipment, and management decisions on maintenance and renewal. The paper highlights the role of internal audit as a means of assessing the effectiveness of the internal control system and risk management in the operation of fixed assets and the monitoring of their technical condition. Key wear-related risks are systematized, and a risk-oriented audit program is proposed, including a description of risks, their consequences, and typical audit procedures using digital data sources.

Keywords: fixed assets; energy company; internal audit; risks; accounting; technical condition; digitalization; internal control.

ВНУТРЕННИЙ АУДИТ ОСНОВНЫХ СРЕДСТВ ЭНЕРГОКОМПАНИИ: ОЦЕНКА РИСКОВ НА ОСНОВЕ ИНТЕГРАЦИИ БУХГАЛТЕРСКИХ И ТЕХНИЧЕСКИХ ДАННЫХ

А. А. Радченко, Н. В. Фрибус

Аннотация: В статье рассматриваются подходы к внутреннему аудиту основных средств энергетической компании с фокусом на рисках износа и надежности в условиях цифровой эпохи. При значительном удельном весе внеоборотных активов и весомой доле основных средств в имуществе компании, для обеспечения её финансовой стабильности и надежности особое внимание внутреннего аудита должно быть уделено не только точности бухгалтерского учета, но и эффективности взаимодействия между учетными данными, фактическим техническим состоянием оборудования и управленческими решениями по его ремонту и обновлению. Освещена роль внутреннего аудита как метода оценки эффективности системы внутреннего контроля и управления рисками при эксплуатации основных средств и мониторинге их технического

состояния. Систематизированы основные риски, связанные с износом, разработана риск-ориентированная программа аудита, содержащая описание рисков, их последствия и типичные аудиторские процедуры с использованием цифровых источников данных.

Ключевые слова: основные средства; энергетическая компания; внутренний аудит; риски; бухгалтерский учет; техническое состояние; цифровизация; внутренний контроль.

Fixed assets form the foundation of the property complex of energy enterprises and ensure their ability to perform their core functions reliably and on a continuous basis. Electric grid companies are characterized by high capital intensity; therefore, the quality of fixed asset management directly affects both infrastructure reliability and the company's financial performance. The 2024 annual report of JSC "Rosseti Novosibirsk" indicates that non-current assets account for 88.6% of the company's total assets, while property, plant and equipment (PPE) make up 85.0% of non-current assets [3, pp. 85–86]. Such an asset profile implies that risks associated with the operation, valuation, and wear of fixed assets are material and require systematic control.

In the digital era, energy companies gain access to an expanded set of data sources: in addition to accounting records and primary documents, digital operational records of equipment are generated (inspection, diagnostics, and testing results), data on maintenance activities and failures, and information on the implementation of technical measures. This changes the capabilities of internal audit: instead of predominantly sample-based documentary checks, risk-oriented, data-driven diagnostics becomes possible, followed by deeper procedures in the areas with the highest risk. Under these conditions, internal audit acts as a linking element between the financial/accounting domain and the technical control domain, since accounting depreciation does not always reflect the actual reliability of an asset, while managerial decisions on maintenance and renewal must be supported by robust evidence.

An analysis of the annual report demonstrates a stable upward trend in the value of fixed assets. In 2024, the amount of PPE within non-current assets increased by 4.6% compared with 2023 (RUB 25,971,315 thousand as of 31 December 2024) [3, pp. 83–86]. At the same time, construction in progress is recorded within fixed assets; in 2024 its value decreased by 7.1% (RUB 1,518,673 thousand) [3, pp. 83–86]. These changes indicate an ongoing investment process and, consequently, the need to control the accuracy of asset cost formation and the timeliness of commissioning.

The wear (depreciation) indicator is of particular significance for internal audit. According to the annual report, the overall level of accounting depreciation of fixed

assets owned by the company is about 50% at the end of 2024 [3, pp. 105–106]. At the same time, depreciation varies across asset groups; for example, the level for electric power transmission facilities is above average [3, pp. 105–106]. A high level of depreciation increases the risk of accidents, unplanned repairs, and resource losses, as well as the risk of inefficient allocation of funds between repairs and capital investments. Therefore, an internal audit of wear management should cover both accounting risks and operational risks.

In accordance with Federal Law No. 402-FZ, an organization is required to prepare reliable accounting (financial) statements and ensure the functioning of internal control over economic transactions [2]. Additional requirements for accounting for fixed assets and capital investments are set out in FAS 6/2020 and FAS 26/2020, which define the rules for recognizing assets, forming initial cost, calculating depreciation, and distinguishing between period expenses and capital investments [4]. Non-compliance with these requirements creates risks of misstatement of financial results and balance sheet indicators and leads to lower-quality management decisions regarding assets.

A separate block of risks is related to the potential divergence between actual technical condition and accounting depreciation. The company's annual report states that continuous and periodic monitoring of the technical condition of electric grid facilities has been organized, responsible persons have been designated, and technical documentation is maintained on identified defects and the results of their remediation [3, pp. 105–106]. This forms the basis for using technical data sources as audit evidence: internal audit can assess the completeness, regularity, and effectiveness of technical control and evaluate how its results influence maintenance plans, investment decisions, and accounting judgments.

A risk-oriented approach implies linking significant risks with control activities and sources of corroboration. In the COSO framework, internal control is viewed as a system aimed at achieving the organization's objectives in operations, reporting, and compliance [1]. Applied to the fixed assets of an energy company, this means assessing the entire chain: the existence of regulations and accountability, the regularity of technical condition monitoring, the quality of accounting and documentation, and the effectiveness of managerial decisions based on monitoring results. Professional internal audit standards also emphasize the need to plan and perform audits with due consideration of risks and the sufficiency of evidence.

The materiality of these risks is supported by the annual report data: the high share of non-current assets and PPE in the asset structure [3, pp. 85–86], the increase in the value of fixed assets and the significant volume of construction in progress [3, pp. 83–86], as well as the high level of accounting depreciation and the existence of an organized framework for technical inspections and examinations [3, pp. 105–106].

Table 1 – Key risks of depreciation and reliability of an energy company's fixed assets and internal audit objectives

Risk	Risk manifestation	Potential consequences	Role of internal audit
Misstatement of the accounting estimate of wear (depreciation, useful lives)	No review or merely formal review of useful lives when operating conditions change; significant deviations in depreciation parameters across PPE groups	Incorrect management decisions on maintenance/repairs; unreliable assessment of investment needs	Verify compliance with FAS 6/2020; analyze the distribution of useful lives and depreciation; compare accounting parameters with technical monitoring data (load, defects, inspection results)
Divergence between accounting depreciation and actual technical condition	High/moderate accounting depreciation inconsistent with the actual condition; insufficient granularity of technical data by accounting objects	Increased accident rate; underestimation of equipment failure risk; errors in allocating repair activities; growth of unplanned work	Assess completeness and quality of technical control data (inspections, diagnostics, technical examinations); trace and verify assets across accounting records and technical documentation
Low effectiveness of repair activities	Repeated defects and failures after repairs; no assessment of repair outcomes/effectiveness	Higher maintenance costs; reduced reliability; overspending of the repair budget	Assess whether repair measures are properly planned and justified based on the technical condition of assets
Ignoring critical defects and failure to comply with remediation deadlines	Defects are recorded but not closed; no evidence of remediation; weak status traceability; breaches of regulatory deadlines	Increased accidents and technological disturbances; risk of damage/loss; more unplanned repairs	Assess the effectiveness of defect monitoring and closure control

Incorrect classification of expenditures	Works affecting service life/reliability are recorded as current expenses (or vice versa); lack of unified capitalization criteria; incomplete technical justifications	Misstatement of financial results and PPE carrying amounts; incorrect wear assessment; lower investment efficiency; tax and reporting risks	Verify classification of subsequent expenditures under FAS 6/2020 and FAS 26/2020; match the technical effect of works with accounting treatment; perform sampling on the most material repairs
Insufficient focus on renewal of worn-out assets	The investment program does not consider the company's individual financial capacity and risk appetite	Continued operation of high-risk assets; higher losses and accidents; reduced reliability; inefficient capital allocation	Compare technical monitoring data with maintenance and investment plans

The practical value of a risk-oriented internal audit of fixed assets lies in increasing the transparency of operations and enabling well-grounded management decisions on maintenance and renewal. The use of integrated accounting and technical data makes it possible to identify discrepancies between the accounting estimate of wear and the actual condition of assets, assess the effectiveness of repairs, and reduce the risk of failures. Thus, in the digital era, the internal audit of an energy company's fixed assets should evolve as an integrated function for assessing wear- and reliability-related risks, combining accounting requirements with data on the technical condition of assets. A risk-oriented audit program based on data integration contributes to enhancing the effectiveness of internal control and achieving the key objectives of an energy company: reliability, resilience, and efficient capital utilization.

REFERENCES

1. Committee of Sponsoring Organizations of the Treadway Commission (COSO). Internal Control-Integrated Framework: Executive Summary. 2013.

2. Federal'nyi zakon ot 06.12.2011 № 402-FZ «O bukhgalterskom uchete» [Federal Law No. 402-FZ of 06 Dec 2011 "On Accounting"]. (in Russian).

3. Godovoi otchet AO «RES» (AO «Rosseti Novosibirsk») za 2024 god [Annual report of JSC "RES" (JSC "Rosseti Novosibirsk") for 2024]. (in Russian).

4. Prikaz Minfina Rossii ot 17.09.2020 № 204n «Ob utverzhdenii FSBU 6/2020 "Osnovnye sredstva" i FSBU 26/2020 "Kapital'nye vlozheniia"» [Order of the Ministry of Finance of Russia No. 204n of 17 Sep 2020 "On approval of FSBU 6/2020 'Property, Plant and Equipment' and FSBU 26/2020 'Capital Investments'"]. (in Russian).

THE IMPACT OF LAST-MILE DELIVERY INNOVATIONS ON REPEAT SALES GROWTH

V. V. Shumskaya

Research advisor: E. L. Shishko

Brest, Brest State Technical University,
vladasatohina966@gmail.com

Abstract. In this article, the author examines the impact of innovative last-mile delivery solutions on repeat business growth. Three areas of innovation are considered: technological, based on the implementation of artificial intelligence and machine learning to optimize routing and forecast demand; organizational, including the development of alternative pickup points, contactless delivery, and crowdsourcing models; and service, aimed at personalizing the customer experience and improving the quality of communication.

Keywords: last mile, logistics innovations, repeat sales, artificial intelligence, crowdsourcing, predictive analytics, contactless delivery.

ВЛИЯНИЕ ИННОВАЦИЙ В ДОСТАВКЕ «ПОСЛЕДНЕЙ МИЛИ» НА ПОВТОРНЫЕ ПРОДАЖИ

В. В. Шумская

Аннотация. В данной статье автор рассматривает влияние инновационных решений в области доставки последней мили на рост повторных продаж. Выделены три направления инноваций: технологические, основанные на внедрении искусственного интеллекта и машинного обучения для оптимизации маршрутов и прогнозирования спроса; организационные, включающие развитие альтернативных пунктов выдачи заказов, бесконтактной доставки и краудсорсинговых моделей; а также сервисные, направленные на персонализацию клиентского опыта и повышение качества коммуникации.

Ключевые слова: последняя миля, логистические инновации, повторные продажи, искусственный интеллект, краудсорсинг, прогнозная аналитика, бесконтактная доставка.

Today's e-commerce and retail markets are characterized by a highly competitive environment. In this environment, traditional competitive factors such as product range and pricing are gradually losing their importance, giving way to service quality and customer experience. This is where last-mile delivery, the final stage of the logistics chain from the distribution center to the end consumer, comes into play. This shortcut is both the most expensive, accounting for up to half of all logistics costs, and the most important in terms of forming a customer's impression of the company, as it is the final interaction with the brand that is most memorable and appreciated by the buyer. This is critical for business development, as retaining an existing customer is several times cheaper than acquiring a new one, and a loyal audience ensures stable cash flow and long-term business sustainability.

Research confirms that the quality of work performed during the last mile, adherence to deadlines, and effective customer interaction during this period have the greatest impact on how customers evaluate the entire logistics system and the retailer as a whole. Last-mile services account for 41% of total supply chain costs, more than twice the amount of any other expense, including warehousing and packaging. The last mile is especially important when selling complex products that require installation or connection, where service quality becomes not just desirable but a critical success factor. In such cases, even a perfect ordering process is worthless if a careless, late local installer undermines customer trust and ruins any long-term partnership plans. Today's consumers value not only speed of delivery, but also control, transparency, and predictability [1;2].

Modern technologies encompass three key areas: technological innovations related to digitalization and process automation; organizational innovations that change the very structure of interaction with the recipient; and service innovations aimed at personalization and improving the quality of the customer experience. The most significant trend of recent years has been the active implementation of systems based on artificial intelligence and machine learning, which are fundamentally changing the approach to routing and demand forecasting. Machine learning algorithms can predict traffic jams, order peaks, and even driver behavior, helping to optimize delivery and reduce costs. In 2025, logistics will transition from static routes to predictive routing based on big data analysis and self-learning algorithms that take into account traffic congestion, weather conditions, delay statistics, and customer behavior. A striking example of the effectiveness of this approach is the experience of the Cooper delivery service, where the implementation of machine learning models allowed them to predict the number of orders by region with 95% accuracy and optimize the number of couriers, leading to a 20% increase in delivery productivity. The introduction of "live batching" technology—combining orders directly during their fulfillment—reduced overall delivery time by 7% and reduced

mileage by 12% without sacrificing service quality. This technology is especially important for entrepreneurs, as the algorithm predicts when a courier will be available and adds a new order to their current route, allowing them to deliver more orders in less time and without sacrificing quality [3].

Another impressive example is the experience of the Maria furniture factory, which, thanks to the implementation of Yandex Routing, reduced its last-mile costs by 35%, while the time for creating routes decreased by 4 times, the number of visited points on the route increased by 2 times without increasing the driver's working time, and the mileage per address decreased by 25%, and all customers are now notified of exact delivery times, which directly affects their satisfaction [4].

Technological innovations related to service integration and simplified order collection procedures deserve special attention. International logistics operator SDEK, recognized as the best in the "Last Mile" category of the "Big Turnover" award, has integrated QR code parcel delivery services, revived the "Reverse" service, whereby the courier immediately delivers documents after signing, and introduced a loading and unloading service for oversized cargo, significantly simplifying the delivery process for customers. Particular attention has been paid to marketplace sellers, for whom the DBS delivery model has been launched, ensuring full automation and optimization of last-mile processes. In parallel with the launch of new products, the company is improving existing service standards, including an improved courier robocall algorithm, which has made communication with customers more friendly and effective [5].

A growing area of technological innovation is the use of augmented reality and smart glasses in delivery. These allow couriers to see a 3D navigation line directly in their field of view, leading to the next location, receive a highlight of the exact box needed for the current address ("visual sorting," which increases picking efficiency by 20%), see house numbers superimposed on real buildings, and receive voice prompts with intercom codes or special requests. Amazon's experiments with smart glasses for delivery demonstrate that even a small reduction in stop time – 5-10 seconds for 200 stops – results in a savings of approximately 20 minutes per route, which, when scaled up to millions of daily deliveries, translates into significant cost savings [6].

Organizational innovations include the development of alternative pickup points. Pickup points are becoming more than just a place to pick up goods, but part of an ecosystem where customers can choose the most convenient delivery method. SDEK's infrastructure already includes over 5,500 pickup points in 45 countries, making the service accessible to millions of customers. Contactless delivery and photo confirmation of receipt have become standards in today's market, where customers value the ability to minimize personal contact while still receiving confirmation that their order has been delivered correctly [5].

Crowdsourcing delivery models, actively developed by platforms like Yandex.Courier, allow entrepreneurs to scale delivery without maintaining their own fleet, engaging couriers during peak periods and optimizing costs. Service innovations are aimed at personalizing delivery as an extension of the brand. For example, the delivery service Cooper creates over 14,000 user segments using machine learning algorithms, analyzing purchases, behavior, and individual customer preferences. This enables targeted communications at all stages of interaction and predicts what customers want to see or buy right now. Express delivery within an hour and even 15 minutes is already available to many services, and it's important for entrepreneurs to understand that speed is becoming an integral part of their value proposition.

The analysis of the impact of innovative solutions in last-mile delivery conducted in this article suggests that it has become a powerful marketing tool and a key element of the customer experience, directly influencing consumer loyalty and their willingness to repeat purchases. This is due to the "last impression effect," whereby the final stage of interaction with a brand is most vividly remembered by customers and largely determines their subsequent behavior, including their willingness to recommend the company to friends and make repeat orders. For today's entrepreneur, implementing innovative solutions in last-mile delivery is not just desirable, but a necessary condition for growth in a highly competitive market.

REFERENCES

1. Poslednyaya milya v logistike: chto eto, pochemu dorogaya i kak eyo optimizirovat' (Last mile in logistics: what it is, why it is expensive and how to optimize it). Available at: https://glsystem.net/news/poslednyaya-milya-v-logistike-chto-eto-pochemu-dorogaya-i-kak-eyo-optimizirovat2 (accessed 27.02.2026)

2. Poslednyaya milya (last mile) v logistike: chto eto i kak rabotaet dostavka posledney mili (Last mile in logistics: what it is and how last mile delivery works). Available at: https://www.tvl.net.ua/ru/novosti/poslednyaya-milya-last-mile-v-logistike-chto-eto-i-kak-rabotaet-dostavka-poslednej-mili/3 (accessed 27.02.2026)

3. Kuper povysil effektivnost' kur'erov na 20% s pomoshch'yu ML-algoritmov (Cooper increased courier efficiency by 20% using ML algorithms). Available at: https://ecomhub.ru/cooper-e-retail-week-machine-learning-last-mile-delivery-optimization-ml-efficiency/ (accessed 27.02.2026)

4. Keys «Marii»: kak my avtomatizirovali logistiku posledney mili i sokratili raskhody na dostavku na 35% (The case of "Maria": how we automated last mile logistics and reduced delivery costs by 35%). Available at: https://vc.ru/services/2560638-avtomatizatsiya-logistiki-na-fabrike-mariya (accessed 27.02.2026)

5. SDEK priznan luchshim v nominatsii «Poslednyaya milya» premii «Bol'shoy Oborot» (CDEK was recognized as the best in the "Last Mile" nomination of the "Big Turnover" award). Available at: https://www.cdek.ru/ru/press/view/2025-10-22-sdek-priznan-lucsim-v-nominacii-poslednaa-mila-premii-bolsoj-oborot/ (accessed 27.02.2026)

6. Amazon predstavila «umnye» ochki dlya kur'erov — oni pomogut nakhodit' nuzhnye posylki i prokladyvat' poshagovyy marshrut k adresu dostavki (Amazon introduced "smart" glasses for couriers — they will help find the right packages and plot a step-by-step route to the delivery address). Available at: https://vc.ru/tech/2293143-amazon-predstavila-umnye-ochki-dlya-kurerov (accessed 27.02.2026)

COMPARATIVE ANALYSIS OF REGIONAL COMPETITIVENESS AND ECONOMIC SECURITY INDICATORS (A CASE STUDY OF NOVOSIBIRSK AND NIZHNY NOVGOROD REGIONS)

A. S. Tomenko, E. A. Prikhodko

Novosibirsk, *Novosibirsk State Technical University*,
atomenko373@gmail.com

Abstract. The article explores the relationship between a region's competitiveness and its level of economic security. The author proposes a unique methodology based on the construction of a regional positioning matrix.

Keywords: regional economic security, regional competitiveness, comparative analysis, integral index, competitiveness-security matrix, Novosibirsk region, Nizhny Novgorod region, economic diversification.

СРАВНИТЕЛЬНЫЙ АНАЛИЗ ПОКАЗАТЕЛЕЙ РЕГИОНАЛЬНОЙ КОНКУРЕНТОСПОСОБНОСТИ И ЭКОНОМИЧЕСКОЙ БЕЗОПАСНОСТИ (НА ПРИМЕРЕ НОВОСИБИРСКОЙ И НИЖЕГОРОДСКОЙ ОБЛАСТЕЙ)

А. С. Томенко, Е. А. Приходько

Аннотация. В статье исследуется взаимосвязь между конкурентоспособностью региона и уровнем его экономической безопасности. Предложена авторская методика, построения матриц позиционирования регионов.

Ключевые слова: экономическая безопасность региона, конкурентоспособность региона, сравнительный анализ, интегральный индекс, матрица «конкурентоспособность-безопасность», Новосибирская область, Нижегородская область, диверсификация экономики.

The relevance of this study stems from the fact that under conditions of geopolitical instability and structural transformation of the economy, ensuring the economic security of regions becomes a priority. The key factor for strengthening security is the competitiveness of the territory; however, an imbalance between competitive advantages and economic security generates hidden threats [4].

The economic security of a region is based on its competitiveness, and its imbalance with financial stability generates hidden threats [2].

Purpose of the study

This study aims to identify threats to the economic security of the Novosibirsk region arising from the imbalance between its competitiveness and security (in comparison with the Nizhny Novgorod region).

To achieve the goal, a competitiveness assessment methodology was developed, including the following stages:

Formation of a system of indicators

The indicators are grouped into four blocks characterizing different aspects of competitiveness and security [3].

Block A. Production and export potential (competitiveness factors). GRP per capita (billion rubles) (stimulant). Share of manufacturing industries in GRP structure (%) (stimulant). Volume of exports of goods and services (billion rubles) (stimulant).

Block B. Financial stability and independence (basic security conditions). Net financial result per capita (billion rubles) (stimulant). Share of unprofitable enterprises (%) (destimulant). Investments in fixed capital (billion rubles) (stimulant).

Block C. Social sphere and quality of life (attractiveness for the population). Unemployment rate (%) (destimulant). Share of population with income below the subsistence minimum (%) (stimulant). Number of people leaving the region (stimulant).

Block D. Infrastructure and resources (sustainability). Retail trade turnover (billion rubles) (stimulant). Agricultural production volume (billion rubles) (stimulant).

Normalization of indicators

To bring indicators to a common scale, linear normalization (min-max) is used, taking into account the direction of influence.

For stimulant indicators (higher is better)

$$:I_i = \frac{x_i - x_{min}}{x_{max} - x_{min}}$$

For destimulant indicators (lower is better):

$$I_i = \frac{x_{max} - x_i}{x_{max} - x_{min}}$$

Where x_i is the value of the indicator for the region, Xmin and Xmax are the minimum and maximum values among all compared regions (or reference values).

The average for each block is calculated.

Calculation of integral indices

The Competitiveness Index (CII) is calculated as the arithmetic mean of the normalized indicators of blocks A and C (they reflect dynamic potential):

$$\text{ИК} = \frac{\bar{A} + \bar{C}}{2}$$

where $\overline{A}$ is the average for block A, $\bar{C}$is the average for block C.

The Security Index (SII) is obtained by averaging blocks B and D (they characterize stability and reliability):

$$\text{ИБ} = \frac{\bar{B} + \bar{D}}{2}$$

where $\bar{B}$ is the average for block B, $\bar{D}$ is the average for block D.

The positions of regions are plotted on a plane with axes CII (OX) and SII (OY).

Table 1 – Regional positioning matrix within the "competitiveness – security" framework.

Region Type	*CII Value*	*SII Value*	*Characteristic*
Leaders	High	High	Balanced development, resilience to threats
Risk Zone ("soap bubble economy")	High	Low	Economic growth not supported by stability, high risk of crisis
Stagnation	Low	High	Stability without development potential
Underperformers (Depression)	Low	Low	Weak economy, high vulnerability to threats

To test the methodology, two regions were selected that are comparable in basic parameters but differ in economic structure: the Novosibirsk (NSR) and Nizhny Novgorod regions (NNR). Both subjects are major regional centers with similar populations (2.8 and 3.1 million) and play the role of crucial scientific, industrial, and transport hubs. The similarity of macroeconomic characteristics makes them ideal objects for comparison, where the key contrasting factor is specialization: a powerful

scientific and IT sector in the Novosibirsk region versus developed mechanical engineering and chemical industry in the Nizhny Novgorod region.

Table 2 – Indicators for competitiveness assessment for 2024 [1, 5]

Indicators	(NSR)	(NNR)	Boundaries	
	2024	2024	Min	Max
Block A				
GRP per capita (billion rubles)	832,73	908,65	832,73	908,65
…	…	…	…	…
Investments in fixed capital (billion rubles)	0,428	0,750	0,428	0,750

Based on these data, using normalization formulas, individual indices for each block and then the integral indices CII and SII were calculated.

Table 3 – Normalized indicators for calculating integral indices of competitiveness and security, 2024

Indicators	(NSR)	(NNR)
	2024	2024
Block A		
GRP per capita	0	1
…	…	…
Investments in fixed capital	0	1

Average values for blocks A, B, C, and D.

Block A: Novosibirsk region = 0.33; Nizhny Novgorod region = 0.67
Block B: Novosibirsk region = 0; Nizhny Novgorod region = 1
Block C: Novosibirsk region = 1; Nizhny Novgorod region = 0
Block D: Novosibirsk region = 0.67; Nizhny Novgorod region = 0
CII indicator: NSR = 0.67; NNR = 0.33.
SII indicator: NSR = 0.33; NNR = 0.5.
"Competitiveness – Security" Matrix

The analysis revealed fundamentally different models of regional development. The Nizhny Novgorod region falls into the "stagnation" category (CII = 0.33; SII = 0.5): stability with insufficient dynamic potential. The Novosibirsk region, on the contrary, is a risk zone (CII = 0.67; SII = 0.33): highly competitive advantages (scientific and IT sector) are not supported by financial stability, which creates hidden threats of crisis under external shocks.

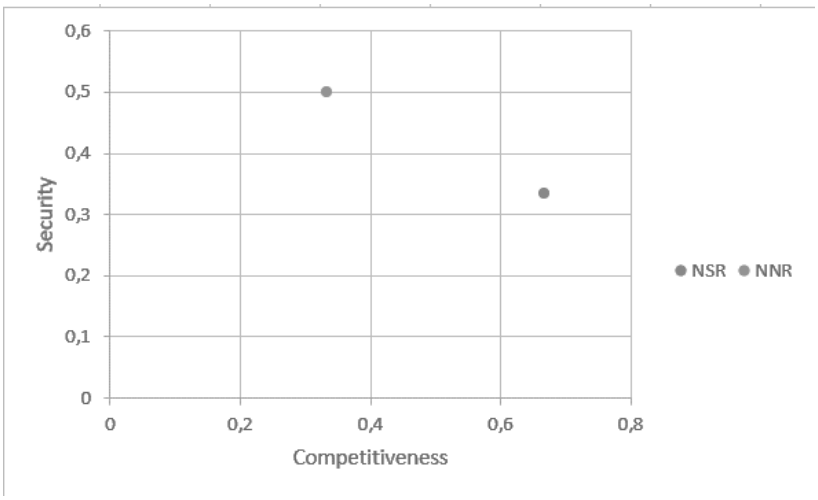


Figure 1. Positioning of the Novosibirsk and Nizhny Novgorod regions in the "Competitiveness – Security" matrix

REFERENCES

1. EMISS: Gosudarstvennaia statistika [EMISS: State Statistics. Available at: https://www.fedstat.ru/] (accessed: 24.02.2026) (in Russian).

2. Kormishkina, L. A., Sausheva O. S. (2016) Obschaia ekonomicheskaia bezopasnost': uchebnoe posobie [General Economic Security: a study guide]. Saransk (in Russian).

3. Mazilkina, E. I., G. G. Panichkina (2017) Upravlenie konkurentosposobnost'yu [Competitiveness Management]. Moscow: Omega-L. (in Russian).

4. Strategii ekonomicheskoj bezopasnosti Rossijskoj Federacii na period do 2030 goda: Ukaz Prezidenta RF ot 13 maia 2017 g. № 208 [On the Strategy for Economic Security of the Russian Federation through 2030: Decree of the President of the Russian Federation of May 13, 2017, № 208.]. // Konsul'tantPlyus [ConsultantPlus:]: Available at: https://www.consultant.ru/document/cons_doc_LAW_216629 (accessed: 24.02.2026) (in Russian).

5. Rosstat. Federal'naia sluzhba gosudarstvennoj statistiki [Rosstat: Federal State Statistics Service] Available at: https://rosstat.gov.ru (accessed: 24.02.2026) (in Russian).

CAPITAL: AN OVERVIEW OF APPROACHES TO DEFINING THE CONCEPT

L. A. Ternopolskaia

Research advisor: O.V. Usacheva, Cand. Sc. (Econ.)

Novosibirsk, Novosibirsk State Technical University,
ternopolskaaliana@gmail.com

Abstract. The article examines the evolution of the concept of 'organisational capital' in economic theory. Based on a systematisation of the author's definitions, the expansion and complication of the category is revealed. Synthesising historical approaches, the article proposes an integral interpretation of organisational capital based on its ability to transform and move between different forms.

Keywords: organisational capital, economic theory, physiocrats, classical political economy, Marxism, value, investment resource, factor of production, financial resources, modern interpretations of capital.

КАПИТАЛ: ОБЗОР ПОДХОДОВ К ОПРЕДЕЛЕНИЮ ПОНЯТИЯ

Л. А. Тернопольская

Аннотация. В статье рассматривается эволюция понятия «организационный капитал» в экономической теории. На основе систематизации авторских определений выявляются расширение и усложнение категории. Обобщая исторические подходы, в статье предлагается интегральная трактовка организационного капитала, основанная на его способности к трансформации и переходу между различными формами.

Ключевые слова: организационный капитал, экономическая теория, физиократы, классическая политическая экономия, марксизм, стоимость, инвестиционный ресурс, фактор производства, финансовые ресурсы, современные интерпретации капитала.

The definition of the concept of 'capital' has different approaches to interpretation depending on the scientific school. Let us consider the approaches of physiocrats, classics, Marxists, as well as modern economists to the concept of organizational capital.

The founder of the physiocrat school, François Quesnay, and his followers formed an original concept of capital, focused exclusively on the agricultural sector, which they considered to be the only source of net product. In their interpretation,

capital was the totality of the means of production used in agriculture and was divided into two fundamental categories.

The first category, referred to as 'annual advances,' covered the current, recurring costs of the agricultural cycle. These included the cost of seeds, labor, livestock maintenance, and other expenses that were fully consumed during a single production year and needed to be reimbursed annually from the harvest.

The second category, 'initial advances,' represented long-term investments. This type of capital consisted of basic equipment, tools, buildings, and land improvement costs—that is, all assets that served over multiple production cycles, transferring their value to the product being created gradually.

A representative of the classical school, Adam Smith, derived the concept of 'capital' from the nature of consumption of the reserves at an individual's disposal. According to his approach, only those reserves of goods that are not used for immediate personal use but are directed into economic circulation for the purpose of generating income can be recognized as capital. This transformation occurs when resources are invested in the production or acquisition of goods for their subsequent profitable sale, or invested in tools of labor that themselves generate profit without changing ownership in the process.

The Marxist school of economics interprets capital primarily as a category of socio-economic relations, rather than simply as a collection of material values. In this paradigm, capital embodies a specific type of production relations that arise between the owner of the means of production and the proletarian who sells his labor power. From the point of view of the mechanism of value creation, Marxist theory makes a key distinction within capital: between constant capital, represented by the value of the means of production, which is transferred to the finished product without quantitative increase, and variable capital, advanced for the purchase of labor power and capable of creating new value, including surplus value, in the process of labor.

Thus, the importance of capital for an enterprise cannot be overestimated, since it is used in various aspects of activity, ranging from reinvesting profits in new production turnover to acquiring new fixed assets.

For a better understanding, let us consider the concept of capital from the point of view of different authors (Table 1).

To summarize the above, we define an organization's capital as an integrated set of value resources with economic, legal and functional certainty, mobilized by a business entity to carry out its activities with the aim of creating and appropriating value.

This interpretation synthesizes the key aspects of previous theories, adapting them to modern economic reality. The emphasis on the purpose of capital – its use for further production and income generation – is borrowed from the classical school.

Table 1 – Authors' interpretations of the concept of 'capital'

Author	Interpretation
A. Smith	'Capital is accumulated labor.'
K. Marx	'Capital is money advanced with the aim of obtaining surplus value. Capital is the movement of value represented in money, goods, and commodity capital.'
I.A. Blank	'Capital is a stock of economic goods accumulated through savings in the form of cash and real capital goods, attracted by its owners into the economic process an investment resource and factor of production with the aim of obtaining income, the functioning of which in the economic system is based on market principles and is associated with factors of time, risk or liquidity.'
V.M. Rodionova	'The capital of an enterprise is the monetary income and receipts at the disposal of the economic entity and intended for the fulfilment of financial obligations, the implementation of costs from the expanded reproduction of economic incentives for employees.'
B.P. Kudryashov	'The capital of an enterprise is the value of material assets, financial investments and cash necessary to ensure the economic activity of the enterprise.'
P. Samuelson	'Capital is capital goods produced by the economic system itself to be used for the further production of other goods and services.'

The Marxist theory's understanding of capital not as a mere thing, but as a certain type of economic relationship mediated by value, has been adopted, but in the context of an organization, these relationships are viewed more broadly: not only between the employer and the employee, but also between the organization and investors, creditors, and the state, which shapes its legal certainty (own, borrowed).

The modern approach, reflected in the definitions of I.A. Blank, V.M. Rodionova and others, expands on the materialistic views of the physiocrats and classical economists, emphasizing the complex nature of capital. It is not limited to physical assets ('real capital goods') but also includes financial and, in modern conditions, intellectual and digital resources capable of generating economic benefits. The key feature is the ability to transform and move between different forms (monetary, productive, commodity), which echoes Marx's idea of the movement of value.

REFERENCES

1. Garifullin K. M. Capital: concept and accounting issues // Everything for the accountant. 2013. No. 6. URL: https://cyberleninka.ru/article/n/kapital-ponyatie-i-problemy-ucheta (accessed: 26.02.2026) (in Russian).

2. Tusmaganbetova, D. G. On the transformation of the economic essence of capital / D. G. Tusmaganbetova // Economics. Theory and practice. Prospects for the 21st Century. — 2014 (in Russian).

3. Sheremet A. D. Methods of Financial Analysis of Commercial Organisations: A Practical Guide / A. D. Sheremet, E. V. Negashev. — 2nd ed., rev. and expanded. — Moscow: INFRA-M, 2022. — 208 p. - ISBN 978-5-16-003068-5. - Text: electronic. - URL: https://znanium.com/catalog/product/1860855 (date of access: 22.02.2026). – Access mode: by subscription. As (in Russian).

APPLICATION OF PRINCE2 IN FINANCIAL IT RISK MONITORING PROJECTS: A COMPARATIVE AND CONCEPTUAL ANALYSIS

A. S. Zhaksylyk

Research advisor: G.K. Mukhanova, PhD (Economics)

Astana, *Astana IT University*,
255177@astanait.edu.kz

Abstract. This paper presents a comparative analysis of PRINCE2 application in financial IT risk monitoring projects through systematic review of scholarly sources (2021-2025). The research examines how PRINCE2's structured governance framework compares with PMBOK, Agile, Scrum, and Kanban in financial technology contexts. Findings reveal that PRINCE2's systematic risk management and phase-based control make it suitable for complex financial IT projects requiring regulatory compliance. The practical significance is substantiated by alignment with Kazakhstan's national priorities for countering the shadow economy and enhancing financial monitoring systems in accordance with FATF standards.

Keywords: PRINCE2, Financial IT, Risk Monitoring, Project Management, Regulatory Compliance, FATF.

ПРИМЕНЕНИЕ PRINCE2 В ПРОЕКТАХ МОНИТОРИНГА ФИНАНСОВЫХ IT-РИСКОВ: СРАВНИТЕЛЬНЫЙ И КОНЦЕПТУАЛЬНЫЙ АНАЛИЗ

А. С. Жаксылык

Аннотация. В данной статье представлен сравнительный анализ применения PRINCE2 в проектах мониторинга рисков в сфере финансовых ИТ на основе систематического обзора научных источников (2021-2025 гг.). Исследование рассматривает, как структурированная система управления PRINCE2 соотносится с PMBOK, Agile, Scrum и Kanban в контексте финансовых технологий. Результаты показывают, что систематическое управление рисками и поэтапный контроль, обеспечиваемые PRINCE2, делают его подходящим для сложных проектов в сфере финансовых ИТ, требующих соблюдения нормативных требований. Практическая значимость подтверждается соответствием национальным приоритетам Казахстана по борьбе с теневой экономикой и совершенствованию систем финансового мониторинга в соответствии со стандартами FATF.

Ключевые слова: PRINCE2, финансовые ИТ, мониторинг рисков, управление проектами, соблюдение нормативных требований, FATF.

1. Introduction

The financial services industry has significantly digitalized its processes through technological innovations and increasing regulatory demands [1]. Financial institutions have become significantly dependent on complex IT systems, which have now become an integral part of their operations. This digital dependence has introduced new risks, thereby making financial IT risk monitoring an important organizational activity [1, 3].

The significance of this research is particularly important, especially against the backdrop of Kazakhstan's national priorities. According to President Kassym-Jomart Tokayev, at the V National Kurultai, it is imperative to develop effective measures to counter the shadow economy, money laundering, and improve the financial monitoring system.

These priorities will be addressed by the upcoming National Risk Assessment of the Republic of Kazakhstan, which will be conducted according to Financial Action Task Force (FATF) standards. The 40 Recommendations by FATF cover risk management, which is related to financial monitoring, thereby making it imperative to have structured project management methodologies for implementing IT systems for financial oversight [1].

The scientific novelty of this research is the contextualization of the PRINCE2 methodology in the domain of financial IT risk monitoring, in which the level of research in the field of project management is limited. In contrast to other studies that analyzed the PRINCE2 methodology in the general field of IT or construction, this paper is focused specifically on the link between project governance and the compliance of financial regulatory requirements, providing a framework for the selection of the methodology based on the risk profiles in the Kazakhstani context.

PRINCE2 is recognized as one of the most used project management methodologies in the world, especially in Europe, in the context of the public sector [5, 6].

2. Literature review

2.1 PRINCE2: Principles, Themes, and Processes

PRINCE2 is composed of seven principles, seven themes, and seven processes, providing full coverage of project governance [2, 6]. The seven principles include continued business justification, learning from experience, defined roles and responsibilities, management by stages, management by exception, focus on products, and tailoring to the project environment [2, 6]. The seven themes of PRINCE2 include business case, organization, quality, plans, risk, change, and progress, providing continuous management strands throughout the project life cycle [2, 6]. The risk theme is particularly relevant to financial IT risk monitoring, providing a systematic approach to dealing with operational risk [2, 4, 6].

2.2 Comparative Analysis of Methodologies

The literature indicates major differences between PRINCE2 and other methodologies. Simonaitis, Dauksys, and Mockiene [5] conducted a survey of 104 project management experts and found that PRINCE2 is considered more appropriate for projects with formal governance structures compared to PMBOK, with PRINCE2 being preferred by 67%. This is due to PRINCE2's focus on formal roles, phased approach, and quality control [5].

In the IT domain, Zelek, Kuboszek, and Kupczyk [6] conducted a survey of 108 IT professionals, which confirmed that, although Agile methodologies are perceived as more flexible, being utilized in 75% of organizations, PRINCE2 is also commonly used, around 30%, particularly for complex projects that involve high risks, where systematic risk management and clear roles must be defined [6].

A detailed comparison of the two methodologies, PRINCE2 and Agile, is provided in the paper presented by Rahman and Ahmed [4], which indicates that

PRINCE2 is based on meticulous planning and control, making it applicable to projects where the scope is clearly defined, whereas Agile methodologies focus on flexibility.

Table 1 – Comparative Analysis of PRINCE2 and Alternative Methodologies

	PRINCE2	PMBOK	Agile/Scrum	Kanban
Risk Management	Highly developed, systematic, integrated throughout stages	Systematic but less structured	Primarily in retrospectives, less formal	No formal approach
Planning Approach	Stage-based, detailed, prescriptive	Formal planning and control	Iterative, adaptive sprint planning	Continuous flow with WIP limits
Roles and Responsibilities	Clearly defined with specific accountabilities	Clearly defined but flexible	Three core roles (PO, SM, Team)	Informal, flexible roles
Formalization Level	High - extensive documentation	Highly formalized	Moderate - emphasis on working software	Minimal formalization
Adaptive Flexibility	Limited - requires adaptation within structure	Moderate - context-dependent	High - rapid adaptation to change	Very high - no fixed iterations
Best Application Context	Large, complex, high-risk, regulated projects	Varied, large technical projects	Small to medium, dynamic projects	Continuous workflow, support

2.3 Project Management in Financial IT and Regulatory Contexts

Bonifazi [1] discusses the implementation of the EU's Digital Operational Resilience Act, which demonstrates the value of structured project management in ensuring regulatory compliance. As part of the EU's Digital Operational Resilience Act, financial entities must improve their ICT risk management and establish robust governance systems, which closely mirrors the structured approach that PRINCE2 promotes [1].

In another study, Mutuku and Chege [3] discuss the effects of Agile and PRINCE2 methodologies on the performance of mobile banking in Kenya. They report that the use of the Agile and PRINCE2 methodologies improves the performance of mobile banking significantly. The overall system up-time was improved from 75% to 90%, and the overall user satisfaction was improved from 70% to 85%. More importantly, the study indicates that the Agile methodology is effective for managing small projects, whereas the PRINCE2 methodology is effective for managing large projects.

2.4 Hybrid Approaches: PRINCE2 Agile Integration

Another important theme is the increasing trend towards the use of hybrid methodologies, which blend the governance aspects of PRINCE2 with the flexibility

of Agile methodologies [4, 6]. Rahman and Ahmed, in their paper, outline a conceptual model of the blend of PRINCE2 and Agile methodologies, showing how PRINCE2 processes align with Scrum methodologies. With regard to financial IT risk monitoring, the benefits of a hybrid methodology are significant, as it would ensure compliance with regulations and FATF requirements while being responsive to new risks using Agile methodologies.

3. Research methods

In this paper, the research methodology adopted is conceptual and comparative in nature, using the systematic literature review method. In this study, six literature sources were chosen from the literature published between 2021-2025. These literature sources were journal articles [3, 5, 6], conference papers [4], and master's theses [1, 2]. The comparative analysis framework was designed to compare the literature in terms of methodological principles, risk management, governance structures, and regulatory compliance support [5, 6].

4. Comparative analysis and discussion

4.1 PRINCE2 Strengths for Financial IT Risk Monitoring

The comparative analysis has highlighted some of the advantages that PRINCE2 has, which are applicable to financial IT risk monitoring projects.

First, PRINCE2's approach to risk management, which is incorporated throughout all stages, is vital for financial IT risk monitoring projects, as it provides risk identification, assessment, and response mechanisms, which are important for financial IT risk monitoring projects [2, 4, 6]. Financial IT risk monitoring projects involve identifying and managing risks related to technology, which might have an impact on financial operations, and PRINCE2 provides risk identification, assessment, and response mechanisms, which can be applied to financial IT risk monitoring projects [1, 3].

Second, PRINCE2's approach to role definition is important for financial IT risk monitoring projects, as it is important for financial institutions to demonstrate their ownership of risk management processes, which PRINCE2 provides [5, 6].

Finally, PRINCE2's stage-based approach is important for financial IT risk monitoring projects, as it provides phased control and review, which is vital for financial IT risk monitoring projects [2, 5].

4.2 Limitations and Challenges

From the literature, some of the limitations of PRINCE2 are the high level of formalization, which results in a lot of documentation, leading to administrative

burden on the organization [4, 6]. In a financial technology arena where new money laundering typologies are surfacing every day, this could prove to be a hindrance to responding to these new typologies. Zelek et al. [6] identified that the most frequently mentioned problem by IT professionals using PRINCE2 was the low level of flexibility along with the complexity of documentation.

4.3 Practical Significance for Kazakhstan's Financial Monitoring System

As Kazakhstan is gearing up to conduct its next National Risk Assessment in line with FATF requirements, financial institutions would undertake a number of IT projects to strengthen their monitoring capabilities. PRINCE2 methodology would provide a framework to ensure that these IT projects are completed in a way that ensures financial institution requirements are met, while at the same time accountability, documentation, and other requirements necessary to conduct a FATF assessment are met. Hybrid methodologies would provide a way to introduce flexibility necessary to deal with new money laundering typologies that keep surfacing in the financial technology arena.

5. Conclusion

As such, this analysis confirms that the structured approach to governance, risk management, clear roles, and phase control that PRINCE2 provides make it particularly suited for complex financial IT projects, especially where regulatory compliance is of the utmost importance. Indeed, empirical evidence exists that demonstrates the benefits of structured project management, including system uptime and end-user satisfaction [3].

The scientific novelty of the paper lies in the context provided for the application of PRINCE2 in the context of financial IT risk monitoring, as well as its alignment with FATF standards and Kazakhstan's national priorities for the enhancement of financial monitoring systems. Moreover, the practical significance of the paper is evidenced through its direct applicability to the upcoming National Risk Assessment, as well as the implementation of IT solutions for the achievement of anti-money laundering objectives.

Future research should empirically examine hybrid PRINCE2-Agile approaches in financial IT risk monitoring projects across different regulatory environments, focusing on measurable risk reduction outcomes in the Kazakhstani context.

REFERENCES

1. Bonifazi, F. (2025) Project Management for the Compliance with DORA Regulation: A Case Study of a Leading Institution in the Payment Sector [Master's Thesis]. Politecnico di Torino. Available at: https://webthesis.biblio.polito.it/35655/ (accessed 06.03.2026).

2. Iturregui Gamboa, I. (2023) Treatment, Comparison and New Processes Proposals Related to the Finance of Projects for the Most Representative Project Management Standards [Master's Thesis]. Universidad del País Vasco. Available at: https://addi.ehu.es/bitstream/handle/10810/62812/TFM%20IturreguiItziar.pdf (accessed 06.03.2026).

3. Mutuku M., Chege, D. B. (2025) Effects of Project Management Adoption as Enabler for Successful Financial Technology Performance: A Case of Mobile Banking Application in Kenya. Journal of African Narrative, 5(2), 2958-7999.

4. Rahman M. S., Ahmed, E. (2024) Integrating PRINCE2 and Agile Methodologies in Software Development: Unveiling Opportunities and Addressing Challenges. In 2024 IEEE Conference on Project Management, Kuala Lumpur, Malaysia, 30-31 October 2024.

5. Simonaitis A., Dauksys, M., Mockiene, J. (2023) A Comparison of the Project Management Methodologies PRINCE2 and PMBOK in Managing Repetitive Construction Projects. Buildings, 13(7), 1796.

6. Zelek L., Kuboszek A., Kupczyk T. (2025) The Application of PRINCE2 in IT Project: A Comparative Analysis of Methodologies. Journal of Project Management, 14(3), 1575-1591.

EFFECTIVE APPROACHES TO USING LOGISTICS AND MARKETING TOOLS FOR BUSINESS DEVELOPMENT

PROMOTION OF A TOURIST PRODUCT IN THE INTERNET ENVIROMENT

M. A. Bakanova, V. A. Nazarkina

Novosibirsk, *Novosibirsk State Technical University*,
marlett20082003@gmail.com

Abstract. Nowadays, most potential tourists begin interacting with travel companies via the internet. Therefore, modern companies need to be able to use various promotional tools in the Internet. The article examines current tools for promoting tourist services on the Internet, and highlights their advantages and disadvantages. The case study focuses on the tour operator Parnas LLC. As part of the study, specific tools were proposed to promote the tourist product, along with recommendations.

Keywords: tourist product, on-line tools, landing page, e-mail marketing, social media promotion, promotion of a tourist product.

ПРОДВИЖЕНИЕ ТУРИСТИЧЕСКОГО ПРОДУКТА В ИНТЕРНЕТ-СРЕДЕ

М. А. Баканова, В. А. Назаркина

Аннотация. На сегодняшний день большинство потенциальных туристов начинают взаимодействие с туристическими компаниями через интернет. Поэтому современным компаниям необходимо уметь использовать различные инструменты продвижения в интернет-среде. В статье рассмотрены актуальные инструменты продвижения туристических услуг в интернет-среде, а также выделяются плюсы и минусы их использования. В качестве кейса рассматривается туроператор ООО «Парнас». В рамках исследования были предложены конкретные инструменты для продвижения тура продвижения и рекомендации.

Ключевые слова: туристический продукт, инструменты в интернет-среде, лендинг, email-маркетинг, продвижение в социальных сетях, продвижение туристического продукта.

The relevance of this topic is due to the fact that nowadays a modern tourist carries out information search and reviews potential choices through the internet. It is also due to the development of digital technologies and increased competition in the tourism market. Objective: to show the key tools of internet promotion on a real tour example and give practical recommendations.

According to research, customers independently review 70-80% of the information about a tourist product before contacting an agency. Approximately 37% of tourists are inspired by browsing websites or aggregators [1]. Before purchasing, users analyze an average of 10.4 posts by comparing options, reading reviews, studying tour conditions and prices. This requires tourism companies to have an active presence on the internet and to know how to work with content. Often customers, the younger generation in particular, come from social media such as VKontakte, so it is important to take into account the visual part of the content, such as blogging on a website or posts with photos of local attractions. It is also possible to post information on social networks about employees, travel and leisure news and give various travel tips.

The most active internet tourists are young people aged 25-28. These people have grown up in the era of global digitalization and rely on social media and Internet information when choosing to travel. The following are also key features of such tourists:

1. This is an opportunity to travel remotely at any time
2. Transparency of payments
3. Support at all stages of tour selection
4. The number of reviews and whether they are positive or negative is also taken into account
5. Among such tourists is popular net jetting - trips to the places where movies are being made [2]
6. Series, computer games or shows of popular bloggers
7. They seek information through social media, review sites, travel forums.

Thus, the promotion of a tourist product in an Internet environment remains a current direction that determines the success of companies in the modern market. It requires an integrated approach, including website design, social media, and other digital marketing tools. Promotion of a tourist product - a set of measures aimed at selling of a tourist product, various advertisements, participation in specialized exhibitions, fairs, organization of tourist information centers, publication of catalogues, brochures and other types of promotions.

At the moment, successful travel companies use several tools to promote their product. Consider three of the most important.

The first tool is social networks. Social media promotion (SMM) is a method that uses various social networks and blogs to increase brand recognition or promote products and services. The key idea of SMM is to create useful, high-quality, and interesting content, as a result of which the user will want to submit a request or leave their contact information.

Therefore, content quality plays a very important role in the success of a company's social media presence. Social media helps travel companies connect with potential customers, build long-term relationships with them, and increase their loyalty to the company.

Irregular posting – breaks longer than 3–4 days – reduces reach.

Next is Telegram. Telegram is a messenger that combines messenger and social media features and uses a channel format to deliver information. Over time, it has evolved into a multifunctional platform for distributing various types of content, from short videos to simple texts [2]. Primary users are aged 25–35. They usually look for non-standard routes, active and themed tourism. Telegram's most popular formats include various guides, expert personal stories, short videos and reels, photo collections, and various bots. The most popular format is reels. The most commonly used feature is the chatbot for mailing.

Positive features usually highlighted include:

Of the positive features, usually highlight:

1. High engagement with subscribers in channels more often reacts to information than in

2. social networks.

3. Automation capability - Bots and newsletters reduce time costs and make

4. Advertising offers are more personalized.

5. Telegram's flexible formats use almost all types of content, allowing it to adapt to any audience and task.

6. Downsides: Technical issues, for example file download delay with weak internet. And overload of subscriptions, users can lose interest when channels are overrun

"Odnoklassniki" is a social network owned by Mail.ru group. Initially, the social network was used to search for classmates and friends [5]. This project was not intended as a resource for advertising products and services aimed at users over 35 who value nostalgia and warmth. The best places to visit are family and budget holiday posts.

Tools to promote group posting and mailing through private messages. Main advantages: low competition in the niche of family and mature tourism and high loyalty of the audience. Among the disadvantages, the network is mainly focused

on mature audiences, which can be a disadvantage for promoting young or extreme tours.

Vkontakte is an area with a wide audience of Russian speakers, mainly aged 18-45. Here is effective format of posts with photos and stories in the format of short videos, live broadcasts with hints, surveys and quizzes about travel, chat-bots for booking [4]. Key benefits: high audience engagement. Variety of advertising formats. Main disadvantages: is a big expenditure of time and resources on Group Management, content creation, advertising setup.

Based on the above social networks, one can distinguish common positive and negative features of social networks as a tool for promotion. The benefits include broad audience reach, high engagement and interactivity, visual appeal, flexible content formats, speed and the ability to automate the booking process. From the negative points one can distinguish high competition, time costs that can be created difficulties without a separate specialist, overload of content and technical barriers. Thus, social media is a good enough tool for promotion if you are willing to invest in it and make the content well.

Second, email – no less importance. Email promotion is the promotion of services and products of a company by sending emails to the post office. Email and messages in messengers allow you to keep in touch with the audience, remind about new tours and advantageous offers, warm interest [3].

Email marketing in tourism provides a direct channel of communication with customers without intermediaries, is highly cost-effective as one of the cheapest tools, allows personalization of communication through segmentation and triggers and ensures long-term effect: base is growing, and letters continue to work for years. Of the negative points stand out: the likelihood of spam, cooling interest in newsletters and the need to constantly search for ideas to engage the consumer.

And the third is a website. Promotion of a travel product through the website is a complex process that includes site optimization, advertising setup, content management, analytics and integration with other channels. The goal is to attract a target audience, enhance conversion and gather contacts. Creating a landing page is one of the most efficient ways to get applications in short time. Landing page is a one-page website aimed at promoting products and services and collecting targeted action. Also, when creating a Lending page it is necessary to take into account the conversion should be about 2.5 - 3%, if it is less than this value, then the advertisement will not pay off [6].

The main advantages of using a user's own feed can be phased to lead the consumer to perform a target action, has high conversion, and allows you to optimize information for search queries. Some negatives: the complexity of creation, there are advertising costs on different platforms.

Characteristics of the tourist company *Parnas*:

Parnas is a tour operator for children, providing a wide range of services in the tourist market of Novosibirsk. The company has been on the market for 15 years. Website: *parnas-tour.com*. Company address: Karl Marx Avenue, 30/1. Services: tours in Russia, hot tours, cruises, sightseeing tours, sale of air tickets, sale of bus tickets.

Parnas provides a range of services for people who prefer to travel on vacation. Children's services include: team games, themed parties, camping trips, tour programs, discos, and others.

Some of the popular modern destinations in tourism is Vladivostok this due to the following factors: location, developing infrastructure, unique nature, diversity of historical sites.

In 2025, a new tour of Vladivostok was developed for *Parnas LLC*. The tour is called "city-ship, city-dock". It is a panoramic bus-pedestrian, cultural-educational route through Vladivostok with visits to historical places and the most important monuments, bays, bridges, museums and other attractions in 4 days. The tour price for school groups usually includes accommodation, tickets, meals and public transport. The total cost of the tour is 55,000 rubles per person.

The main advantages of the tour:

1. New experiences.
2. Rich cultural program.
3. Free time.

Problem: The tour operator faced the need to promote a new direction, but despite the favorable location of the route, the only destination gaining popularity among tourists from Novosibirsk. The company needed to choose tools for informing and meeting requests from customers.

To solve the problem described above, an advertising campaign was created that included two marketing tools for the tour and a group on VKontakte. The 6-month campaign was held in Novosibirsk.

Created promo - posts in the group in VC, assigned to the post with all necessary links, fill out the sections of the header, menu, products and current information, posts. Create a series of props with descriptions and photos, post with link to the feed-in and feedback form, publish link hooks for travel.

Publication plan. Series of posts describing the tour, main attractions of Vladivostok in the first week, post with reading and reference to the application form 2 week, answers to questions on Fridays 3 weeks, Internet chat about travel with children and a quiz about attractions of Vladivostok on weekends.

Created a Tilda design template. This is a page layout that includes the following sections: site cover with information about the route, UTP and benefits, program

description on days with descriptions of activities. Create a form to collect users' contact data using prebuilt Tilda blocks. And a block with company contacts. Place a button or link on the page that encourages the user to take the action of creating a pop-up.

Expected Result: More than 30 cases in the month after launch.

Sales by school groups in Vladivostok increased by 15% during the six months.

The landing page conversion rate = 2.8% for the entire period of Landing visited 10,000 users out of which 280 left a request.

$$\text{The conversion formula: Conversion} = \frac{\text{Number of visitors}}{\text{Number of applications}} \times 100\%$$

The cost of the trip was 5000 rubles.

Repeat customer share was 20%

Increase target audience reach.

Thus, the marketing of the tour «City-ship, City-dock» and the community in contact will help the tour operator «Parnas» to attract new customers, thereby increasing sales and enhancing the attractiveness of this destination for tourists.

Further, recommendations for the promotion of the tour to Vladivostok «City-ship, City-dock» are proposed. In the future, a company can use the model to promote other tours by using other promotion tools and testing different content formats.

Add another tool to increase audience reach, such as a telegram, a bot or an email. View the various sites and work through the feedback response process.

Every 3 months monitor the performance in the VC group and once a month watch activity, follow current trends on social media in the travel industry and gather ideas for your own content

In summary, the ability to interact with consumers in a digital environment and analyze their behavioral characteristics is now providing companies with consumer understanding and becoming important competencies for successful tourism businesses. Social network influence is one of the main tools for influencing a modern consumer. And knowledge and the ability to properly apply the right promotion tools help to effectively promote a tourist product in an internet environment. Which allows to form a good and competitive tour product in the market.

REFERENCES

1. ATOR — Assotsiatsiya turoperatorov Rossii. URL: https://www.atorus.ru/node/57602 (data obrashcheniya: 20.02.2026).

2. Lemeshko T. B. Internet-vozmozhnosti prodvizheniya turisticheskikh uslug // Dostizheniya vuzovskoy nauki. 2013. №7. URL: https://cyberleninka.ru/article/n/internet-vozmozhnosti-prodvizheniya-turisticheskih-uslug (data obrashcheniya: 21.02.2026). (in Russian).

3. Petrova Dar'ya Aleksandrovna, Panchenko Ol'ga L'vovna Rol' Sotsial'nykh Setey v Prodvizhenii Turisticheskogo Produkta // Kazanskiy vestnik molodykh uchënykh. 2021. №1. URL: https://cyberleninka.ru/article/n/rol-sotsialnyh-setey-v-prodvizhenii-turisticheskogo-produkta (data obrashcheniya: 20.02.2026). (in Russian).

4. Radygina Yevgeniya Gennad'yevna Vozmozhnosti prodvizheniya turprodukta v internet-prostranstve // Kontsept. 2019. №7. URL: https://cyberleninka.ru/article/n/vozmozhnosti-prodvizheniya-turprodukta-v-internet-prostranstve (data obrashcheniya: 21.02.2026). (in Russian).

5. Rukomoynikova, V. P. Reklama v turizme / V.P. Rukomoynikova ; Povolzhskiy gosudarstvennyy tekhnologicheskiy universitet. – Yoshkar-Ola : PGTU, 2017. – 104 s. (in Russian).

6. Tsyganova V. O. Sovremennyye metody prodvizheniya turistskogo produkta // Colloquium-journal. 2020. №9 (61). URL: https://cyberleninka.ru/article/n/sovremennye-metody-prodvizheniya-turistskogo-produkta (data obrashcheniya: 20.02.2026). (in Russian).

AUTOMATION OF CUSTOMER INTERACTION AND BOOKING MANAGEMENT IN CATERING ESTABLISHMENTS USING TELEGRAM BOTS

K. A. Ershova, L. I. Tolstobrova

Novosibirsk, *Novosibirsk State Technical University*,
ershovacclara@gmail.com

Abstract. The article discusses the use of Telegram bots as a tool for automating customer interaction and booking management in catering establishments. The study is based on a real case study of the introduction of the multifunctional Telegram bot that combines access to a digital menu, table reservations, a loyalty system, promotions and administrative management. The results show that Telegram-based solutions can improve operational efficiency, reduce staff workload, and increase customer engagement without significant financial costs.

Keywords: Telegram bot, business process automation, catering, customer interaction, booking management, digital transformation.

АВТОМАТИЗАЦИЯ ВЗАИМОДЕЙСТВИЯ С КЛИЕНТАМИ И УПРАВЛЕНИЯ БРОНИРОВАНИЕМ В ПРЕДПРИЯТИЯХ ОБЩЕСТВЕННОГО ПИТАНИЯ С ИСПОЛЬЗОВАНИЕМ TELEGRAM-БОТОВ

К. А. Ершова, Л. И. Толстоброва

Аннотация. В статье рассматривается использование Telegram-ботов в качестве инструмента автоматизации взаимодействия с клиентами и управления бронированием в предприятиях общественного питания. Исследование основано на реальном кейсе внедрения многофункционального Telegram-бота, объединяющего доступ к цифровому меню, бронирование столов, систему лояльности, акции и административное управление. Полученные результаты показывают, что решения на базе Telegram позволяют повысить операционную эффективность, снизить нагрузку на персонал и увеличить вовлечённость клиентов без значительных финансовых затрат.

Ключевые слова: Telegram-бот, автоматизация бизнес-процессов, общественное питание, взаимодействие с клиентами, управление бронированием, цифровая трансформация

Introduction

Catering companies interact with customers on a daily basis through various communication channels. Visitors contact the institution to book tables; clarify information about the menu, opening hours or current promotions. In many small and medium-sized catering enterprises such interactions are still carried out manually by employees using phone calls or personal messages on social networks. This approach requires constant staff involvement and often leads to delays, missed requests, or the transmission of inaccurate information.

During peak hours, employees are forced to combine operational duties with customer communication which increases the workload and negatively affects the quality of service. At the same time, the implementation of complex customer management systems is often impossible due to the high cost, technical complexity and the need for additional staff training. In this regard, catering companies are increasingly turning to simpler digital tools that can solve practical problems without significant investment.

Messengers are widely used by clients and do not require additional training. Telegram, in particular, provides technical capabilities for creating automated bots that can process user requests, store data, and interact with administrators. From the user's point of view, such solutions are convenient because they work in a familiar interface and do not require the installation of separate applications.

This article discusses the practical case of using Telegram bot to automate customer interaction and booking management in a catering company. The main focus is on describing the implemented functionality and analyzing how the bot has affected everyday business processes. The aim of the study is to evaluate the possibility of using the Telegram bot as the practical digital tool to simplify communication with customers and reduce the share of manual labor in operational activities.

Methodology

The study is based on the analysis of real Telegram bot developed and implemented for the catering company. The bot functions as the single digital platform combining customer services and administration tools. It is available to users at any time and does not require the installation of additional applications.

When interacting with the bot for the first time, the user goes through a simple registration procedure. The user specifies the name and confirms the phone number using the Telegram functionality. After registration, a personal profile is created that contains a unique user ID and information about accrued bonus points.

One of the key functions of the bot is table reservations. Users select the date, time, number of guests and, if necessary, leave a comment. Each booking request is sent to the administrator and receives a temporary status until it is confirmed or rejected. This approach allows employees to control the booking process and at the same time reduces the number of phone calls. Booking reminders are used to reduce the number of no-shows.

The loyalty system is based on bonus points. Points are not awarded automatically. Users send a request for payment, specifying the receipt number, after which the administrator manually checks the correctness of the request. This solution was chosen to prevent mistakes and abuse. All transactions with bonus points are recorded and users receive notifications about balance changes.

In addition, the bot contains sections with event announcements, promotions and information about the institution and birthday greetings. Content management is carried out through an administrative interface accessible only to authorized users. The technical implementation provides for operation logging, data storage and the ability to further scale the system.

Results and Discussion

After the introduction of Telegram bot, changes were noted in the organization of customer interaction. The most noticeable effect was related to the booking process. Previously, bookings were handled primarily through phone calls and

personal messages which required constant attention from staff. After the introduction of the bot, booking requests became structured and centralized. All requests were displayed in a single system and processed by administrators in a standard format.

This reduced the number of errors related to incorrect date, time or number of guests. Booking reminders helped reduce the number of missed visits, as guests received automatic notifications before visiting the establishment. The staff also noted the reduction in the time spent answering recurring questions about seat availability.

The loyalty system has changed the approach to accounting for customer data. Instead of informal records or memorizing information, administrators gained access to the structured history of user activity. Despite the fact that manual verification of bonus point requests required additional attention, this approach improved the reliability of the system and prevented incorrect scoring. Informing users about all balance changes has increased the transparency of the system.

The distribution of promotions and announcements through the bot made it possible to avoid direct individual contact with each client. This simplified communication and ensured the uniform presentation of information about events and special offers. Birthday greetings and personal notifications were sent automatically based on profile data which previously required manual control.

In general, Telegram bot served as the simplified digital management tool that combines several disparate processes in one system. Although, this solution does not replace full-featured CRM systems, it proved to be sufficient for solving everyday operational tasks. The results show that even a relatively simple bot can significantly affect the organization of work processes, especially in small catering establishments with limited resources.

Conclusion

The conducted research shows that Telegram bots can be effectively used to automate customer interaction and booking management in catering establishments. The case study demonstrates that even the simple digital solution can combine functions such as booking, loyalty system and information support. Using such tools allow you to reduce the staff workload, improve communication with customers and support data-based management decision-making. Telegram bots can be considered as a practical and cost-effective alternative to complex CRM systems for small and medium-sized enterprises.

REFERENCES

1. Adamopoulou E., Moussiades L. (2021). An Overview of Chatbot Technology. Artificial Intelligence Applications and Innovations, 584, 373–383.
2. Huang M.-H., Rust R. T. (2021). A strategic framework for artificial intelligence in marketing. Journal of the Academy of Marketing Science, 49(1), 30–50.
3. Mariani M. M., Borghi M. (2021). Chatbots and conversational agents in the hospitality industry: A research agenda. International Journal of Contemporary Hospitality Management, 33(6), 2186–2206.
4. Pillai R., Sivathanu B. (2022). Adoption of AI-based chatbots for customer service in the hospitality industry. Journal of Hospitality and Tourism Technology, 13(2), 291–309.

ANALYSIS OF MARKETING ACTIVITIES OF COMPANIES: WEB ANALYTICS TOOLS

S. A. Fedoseeva, V. A. Nazarkina

Novosibirsk, *Novosibirsk State Technical University*,
fdsv.sn03@gmail.com

Abstract. The relevance of the study is driven by the widespread use of analytics tools by companies to collect customer data in order to make informed marketing and business decisions. The main web analytics tools are reviewed. Based on an analysis of the digital activity of Russian tourism companies, recommendations are formulated to improve website performance and the effectiveness of advertising campaigns.

Keywords: web analytics tools, social networks, engagement, user experience, session duration, audience return, travel agencies.

АНАЛИЗ МАРКЕТИНГОВОЙ АКТИВНОСТИ КОМПАНИЙ: ИНСТРУМЕНТЫ ВЕБ-АНАЛИТИКИ

С. А. Федосеева, В. А. Назаркина

Аннотация: Актуальность исследования обусловлена широким применением компаниями инструментов аналитики для сбора данных о клиентах с целью обоснованности маркетинговых и бизнес-решений. Рассмотрены основные инструменты веб-аналитики. На основе анализа цифровой активности российских туристских компаний сформулированы рекомендации по повышению производительности сайтов и эффективности рекламных кампаний.

Ключевые слова: инструменты веб-аналитики, социальные сети, вовлеченность, пользовательский опыт, длительность сессии, возвратность аудитории, туристские агентства.

Introduction

Key marketing decisions are based on datasets processed using digital tools. This places increased demands on the accuracy and depth of understanding of one's target audience. Web analytics tools and social media have become the primary sources of comprehensive analysis. They are used to collect data on purchase history, evaluate the profitability of advertising investments, monitor brand reputation, respond promptly to feedback, and predict demand for services. The primary goal of using these tools is to increase the percentage of users who take targeted actions on the website.

The website remains the leading digital channel for attracting customers, accounting for up to 80% of customers [2]. Therefore, companies aiming to strengthen their competitive position need to systematically optimize this channel.

Aim: to evaluate the effectiveness of modern marketing analytics tools for companies operating in the tourism services market in Novosibirsk.

Objective: to develop recommendations for their application, taking into account the specific features of the tourism market.

Overview of Web analytics tools

Web analytics is a tool that allows you to understand how users interact with your website. In the Russian market, the choice of analytics systems is limited by legal requirements (in particular, Federal Law No. 152 "On Personal Data" [1]). The most popular analytics service is Yandex Metrica. Its popularity is due to its compliance with regulatory requirements, extensive functionality, and free basic version. The system allows you to track traffic, analyze user behavior, segment your audience, and integrate with social media. In addition to Yandex Metrica, there are alternative solutions available for businesses, such as Matomo, Roistat, and SimilarWeb. These services enable you to track metrics, conduct A/B testing, use heat maps, and perform SEO audits.

Next, the focus shifts to studying public communication on social networks, which allows us to assess the loyalty and tone of mentions. VKontakte remains the leading social network in terms of audience reach in Russia. With an audience of 100 million people per month [10], according to Mediascope, users spend an average of 64 minutes per day on the network, with a 20% increase in 2025 [12]. The platform provides community and business page owners with detailed statistics, including

user demographics, engagement rates, and subscriber growth dynamics. For example, the Popsters service allows you to conduct a comparative analysis of accounts identifying correlations between content format and engagement levels, and building predictive models of audience interaction with content [11].

To understand the motives behind website visits, it is necessary to analyze search queries, which can be done using Yandex.Wordstat. This service allows you to collect a semantic core, evaluate seasonality, set up advertising, and plan content for a Russian-speaking audience. Alternatives include Serpstat and SpyWords.

Analytics is complemented by a CRM system (Customer Relationship Management), which is software designed for comprehensive management of the customer lifecycle. The CRM acts as a central hub for data collection, ensuring accurate attribution of leads to traffic sources. The system records requests and monitors their processing, ensuring timely resolution of issues. In the Russian market, programs such as Bitrix24, AmoCRM, and 1C are the most commonly used [8].

These tools provide a comprehensive approach to analyzing digital activity by linking data on website behavior, social media communication, search preferences, and sales history to improve business processes.

Methodology

Three travel agencies with a wide range of services operating in the Novosibirsk market were selected for the study: "The Sea is Nearby", "Globus-Tour", "El-Tour".

We will analyze the key indicators of the websites and social networks of the competing companies using public tools Similarweb [5] and Popsters [3]. The data were collected from November 2025 to January 2026. The choice of the period is based on a combination of factors: November is the period of early booking for winter tours. December is the pre-holiday peak of travel bookings. January is the post-holiday decline and the shift towards budget-friendly vacation options. Additionally, the chosen period is long enough to identify significant patterns.

Analysis and Results

For a travel website, the key performance indicators are the depth of interaction and return rate. Users usually compare offers and directions. Therefore, a high bounce rate and short sessions may indicate that the content is not meeting expectations or that technical problems have occurred.

Using Similarweb, we will analyze the key metrics of the companies' website performance. The overall indicators indicate a significant differentiation between the agencies in terms of the scale and quality of their traffic. The highest monthly visit

volume is recorded for "The Sea is Nearby" at 29,374, which is due to its leadership in organic search (72.97% of traffic). However, high coverage is accompanied by extremely low engagement metrics: the average session duration is only 16 seconds, with 1.34 pages viewed per visit, and the bounce rate reaches a critical 78.64%. At the same time, 87.1% of traffic comes from mobile devices, which indicates possible problems with the site's adaptation to smartphones. The high bounce rate, coupled with the dominance of organic search results, suggests that the site's semantic core does not adequately reflect user interests. The visually appealing and vibrant design lacks functional support. The logo in the header is clickable, and when you scroll, the header disappears, preventing the visitor from quickly accessing navigation. The lack of a structured menu and a personal account can be disorienting for users. The "My Preferences" form allows users to select dates and tour groups, but it does not provide a way to choose a country or city, making it ineffective for initial searches. As the user delves into the information, they encounter a large number of information blocks, but the structure, especially on a mobile screen, can create visual clutter. The key elements - the list of countries and types of recreation - are placed at the very end of the page, which reduces the likelihood of their discovery. The tour's internal page features a list of hotels with detailed descriptions [6].

"El Tour" shows a different picture. With a minimum of 3,281 sessions among competitors, the site shows the best engagement rates: session duration of 50 seconds, 1.77 pages per session and bounce rate of 45.99%. The ratio of sessions to unique visitors 2.06 indicates a high proportion of the returning audience. The distribution across devices is almost uniform, which indicates balanced technical optimization: 49.5% computer, 50.5% mobile devices. The modern and clean design is complemented by well-thought-out navigation: a clickable logo, search, call, favorites, and login buttons are present in the header, which remains visible when scrolling. The expanded menu provides quick access to any section. The main advantage is the comprehensive search block for tours, flights, and hotels, which allows users to specify their departure city, country, resort, dates, and travel companions. This is exactly what a user expects when planning a trip. The website also offers 24/7 support, newsletter subscriptions, articles with tips, and appointment booking. The internal page of the tour contains a detailed description, frequently asked questions and a booking form. This structure increases the likelihood of a targeted action. Low traffic volume in this case is a consequence of the choice in favor of quality and relevance [15].

"Globus-tour" occupies an intermediate position in terms of traffic volume with 21,401 visits and demonstrates the highest return rate of 2.33, which is the maximum value among competitors. The level of engagement is average: 25 seconds per

session, 1.69 pages per visit, and a bounce rate of 52.28%. The distribution by device is skewed towards computers, which account for 57% of traffic, and this does not quite align with general market trends, but can be explained by the specific nature of referral traffic, which accounts for 23.96% of the total. Visually, the site looks outdated and requires an update. The logo is non-clickable, which makes navigation difficult, and the phone numbers, call button, and tour request form are present, but when you scroll down, the header disappears, leaving the user without quick access to the menu. The menu itself is quite comprehensive, but its structure and design feel cluttered. The contact buttons at the bottom partially compensate for the shortcomings, but they do not solve the overall navigation issue. The high return rate indicates audience loyalty, but the average engagement suggests that the website is not fully utilizing its potential for retention and deepening contact [13].

When assessing the presence of the travel agencies under consideration on social media, it is important to consider the situation on VKontakte. Although all three companies have Telegram channels, their activity on VKontakte is either non-existent or of a secondary nature. For example, "Globus-Tour" does not have a VKontakte community at all. While "The Sea is Nearby" is formally present on the social media platform, the last post was published in August 2025 [8]. "El-Tour" has a page, but it is not as active as Telegram [17].

This is why we will take a closer look at how companies have structured their activity on Telegram. Using Popsters data, we will evaluate the activity of companies on the social network [4].

"El-tour" agency has the largest number of subscribers - 8310 and the largest total reach of 303,169 views, which is accompanied by a high rate of 39.2% (VRpost) of views from people who are not subscribed to the page. At the same time, the average level of engagement is 0.48% (ERpost), which is somewhat lower than that of competitors [18]. With a smaller number of 2 571 subscribers and a high frequency of 101 publications, "The Sea is Nearby" agency has the best content quality index of 1.27% (ERpost). However, the complete absence of comments indicates a lack of dialogue with the audience [14]. The "Globus-tour" company with the lowest number of subscribers, 1,520, demonstrates the maximum virality of one post, 41.6% (VRpost). But it also has no comments and shows a low average reach per post of 633 views. All three companies have engagement rates ranging from 0.48% to 0.51% (ERpost), indicating a common issue of passive content consumption [7].

"El-tour" demonstrates a key difference from its competitors. They engage in live and meaningful communication with their subscribers. The employees address users by name, respond within a few minutes, as well as redirect potential customers to private messages or a dedicated bot for collecting contacts and requests [18, 16].

For "The Sea is Nearby", a good content quality score of 1.27% (ERview) indicates that the content is visually appealing, but the lack of dialogue makes it superficial. For "Globus Tour", a high virality score of 41.6% (VRpost) with no comments indicates a missed opportunity: the content is spreading, but it is not leading to discussion or sales. For "The Sea is Nearby" and "Globus Tour", it is crucial to implement active communication practices with the audience to achieve commercial success.

Discussion and Recommendations

The analysis of competing companies in the tourism sector conducted using Similarweb and Popsters tools revealed significant differences in their marketing activity.

The strongest position in terms of traffic volume is held by the company "The Sea is Nearby", but the leadership in organic search is being undermined due to critical bounce rates and low viewing depth, especially on mobile devices. The company should conduct an audit of the mobile version of the website, optimize the semantic core, and simplify navigation by placing key sections at the top of the page. It is also recommended to resume regular posts in the VKontakte community and open comments for discussion with users.

The "Globus-Tour" agency is advised to conduct a redesign with a focus on the mobile version. Create and populate the VKontakte community. Actively work with comments, using the high potential for spreading posts.

"El-Tour" agency is a benchmark for quality interaction. It is recommended to gradually increase your presence in organic search and maintain a high level of communication with customers. Synchronize your content with VKontakte, making it a full-fledged communication channel.

The implementation of the proposed recommendations will allow the companies under study to strengthen their competitive advantages in the Russian tourism services market.

REFERENCES

1. Federal'nyj zakon ot 27.07.2006 N 152-FZ (red. ot 24.06.2025) «O personal'nyh dannyh» [Federal Law No. 152-FZ of 27.07.2006 (as amended on 24.06.2025) "On Personal Data"] // Consultant Plus. – [Electronic resource]. – Access mode: https://www.consultant.ru/ document/ cons_doc_LAW_61801/7336c78762a98b5f4f698b8c3800dca1111acc16/. (in Russian)

2. Popova L. Yu. Sovremennye tekhnologii internet-prodvizheniya (SEO-optimizatsiya, kontekstnaya i bannernaya reklama, kontent- i videomarketing, targeting v sotsial'nykh

setyakh i dr.) [Popova, L. Yu. Modern Technologies of Internet Promotion (SEO Optimization, Contextual and Banner Advertising, Content and Video Marketing, Social Media Targeting, etc.)] / L. Yu. Popova // ppc.world: [website]. – 2022. – № 3(71). – p. 16-20. (date of request: 11.02.2026). (in Russian)

3. Popsters - statistika i analitika kontenta soobshhestv v social'nyh setjah [Popsters - statistics and analytics of community content on social networks] // Popsters URL: https://popsters.ru/?ysclid=mm0q7cqjgg237837505 (date of request: .16.02.2026).(in Russian)

4. Popsters - statistika i analitika kontenta soobshhestv v social'nyh setjah [Popsters - statistics and analytics of community content on social networks] URL: https://popsters.ru/app/dashboard (date of request: 16.02.2026).(in Russian)

5. Similarweb: Reshenija po analizu cifrovyh dannyh [Similarweb: Digital Data Analysis Solutions] // Similarweb PRO URL: https://pro.similarweb.com/#/digitalsuite/home (date of request: 03.02.2026).(in Russian)

6. Gde otdohnut' — tury iz Novosibirska | «More rjadom» [Where to relax — tours from Novosibirsk | "The sea is nearby"] // The sea is nearby URL: https://more-r.ru/ (date of request: 03.02.2026). (in Russian)

7. Globus-tur Novosibirsk [Globus-tour Novosibirsk]// Telegram Web URL: https://t.me/globus_tour_nsk (date of request: 16.02.2026). (in Russian)

8. M. O. Anisimov Skvoznaja analitika kak sovremennyj instrument marketinga vzaimodejstvija [M. O. Anisimov End-to-end analytics as a modern interaction marketing tool] // EGI. 2025. No. 1 (57). URL: https://cyberleninka.ru/article/n/skvoznaya-analitika-kak-sovremennyy-instrument-marketinga-vzaimodeystviya (date of request: 03.02.2026). (in Russian)

9. MORE RJaDOM | Zabotlivoe turagentstvo [THE SEA IS NEARBY | Caring travel agency] // Vkontakte URL: https://vk.com/more_ryadom (date of request: 16.02.2026). (in Russian)

10. nas | VKontakte [About us | VKontakte] // VKontakte URL: https://vk.com/about (date of request: 01.02.2026). (in Russian)

11. Sokolov A.V., Shutkin A.S., Epifanova E.M., Popkova A.A., Beklarjan A.L., Barulina M.A. Primenenie iskusstvennogo intellekta dlja privlechenija klientov v social'nyh setjah: obzor rossijskogo i zarubezhnogo opyta [Sokolov A.V., Shutkin A.S., Epifanova E.M., Popkova A.A., Beklaryan A.L., Barulina M.A. The use of artificial intelligence to attract customers in social networks: an overview of Russian and foreign experience] // Bulletin of Perm University. Mathematics. Mechanics. Computer science. 2025. Issue 1(68). p. 118–144. DOI: 10.17072/1993-0550-2025-1-118-144. https://elibrary.ru/pqgfhj (in Russian)

12. Srednesutochnoe vremja pol'zovatelej «VKontakte» vyroslo v 1,2 raza [The average daily time o

13. f VKontakte users has increased 1.2 times] // Adindex URL: https:// adindex.ru/news/releases/2026/01/30/342116.phtml (date of request: 01.02.2026). (in Russian)

14. Turisticheskoe agentstvo Globus-Tur [Globus-Tour Travel Agency] // Globus-tour URL: https://globus-tour.ru/ (date of request: 03.02.2026). (in Russian)

15. Tury ot More rjadom - zabotlivoe turagentstvo iz Novosibirska [Tours from the Sea is nearby - caring travel agency from Novosibirsk]// Telegram Web URL: https:// t.me/more_ryadom (date of request: 19.02.2026) (in Russian)

16. Jel'-Tur | Glavnaja [El Tour | Home] // El Tour URL: https://el-tours.ru/ (date of request: 03.02.2026). (in Russian)

17. Jel'-Tur podderzhka [El Tour support] // Telegram Web URL: https://t.me/ El_tour_help_bot (date of request: 21.02.2026). (in Russian)

18. Jel'-Tur, kruizy, avtorskie tury, vizy. [El Tour, cruises, author's tours, visas.] // VKontakte URL: https://vk.com/el_tours (date of request: 21.02.2026). (in Russian)

19. Jel'-Tur: kruizy, vizy, puteshestvija. [El Tour: cruises, visas, travel.] // Telegram Web URL: https://t.me/eltours (date of request: 21.02.2026) (in Russian)

IMPLEMENTATION AND DESIGN OF AN AUTOMATED PACKAGING AND LABELING LINE IN THE FOOD INDUSTRY. PRODUCTIVITY AND RELIABILITY

Yu. Yu. Kapitsky

Research advisor: D. M. Litmanovich, Cand. Sc. (Phys.-Math.)

Zelenograd, National Research University MIET,
yura1557@gmail.com

Abstract. Modern operating conditions in the food industry necessitate the implementation of automation at enterprises. Automation of the final stages of production – packaging and labeling – is becoming a critical factor in competitiveness. The article is devoted to analyzing approaches to designing automated packaging lines, as well as assessing their impact on productivity and reliability in food production.

Keywords: Packaging automation, labeling, food industry, line productivity, equipment reliability, PLC.

ВНЕДРЕНИЕ И ПРОЕКТИРОВАНИЕ ЛИНИИ АВТОМАТИЗАЦИИ УПАКОВКИ И ЭТИКЕТИРОВАНИЯ НА ПИЩЕВОМ ПРОИЗВОДСТВЕ. ПРОИЗВОДИТЕЛЬНОСТЬ И НАДЁЖНОСТЬ

Ю. Ю. Капицкий

Аннотация. Современные условия работы для пищевой промышленности требуют внедрения автоматизации на предприятиях. Автоматизация финальных стадий производства — упаковки и этикетирования становится критическим фактором конкурентоспособности. Статья посвящена анализу подходов к проектированию автоматизированных линий упаковки, а также оценке их влияния на производительность и надежность на пищевом производстве.

Ключевые слова: Автоматизация упаковки, этикетирование, пищевая промышленность, производительность линии, надежность оборудования, ПЛК.

Introduction

The final stage of food production is packaging and labeling. These stages are among the most important for maintaining the competitiveness of enterprises [1]. They determine not only the product's safety and its marketable appearance but also compliance with legislative labeling requirements [2]. However, at most food production facilities, labeling and packaging are carried out manually [3]. In the current period of labor shortage in the job market, this becomes a low-productivity and unprofitable operation. Also, packaging defects or illegible markings can lead to product spoilage and significant reputational costs.

An efficient automated packaging line must ensure:

- complete product safety during transportation and storage;
- high speed of processing the finished product flow, compensating for staff shortages;
- accurate compliance of labeling with legislative requirements ("Chestny ZNAK" (Honest Sign), applying expiration dates);
- the possibility of quick changeover for different packaging formats [4].

The use of exclusively manual labor creates a number of systemic problems. Firstly, there is a direct dependence of output volume on the availability and physical capabilities of personnel [5]. Secondly, there is a high percentage of defects in label application (misalignments, bubbles, unreadable codes) due to worker fatigue. Thirdly, there is no possibility for effective traceability of a product unit at the packaging stage. Also, low overall process reliability is recorded: frequent stops and failures associated with the human factor [6].

Modern automated packaging and labeling systems are designed to radically change this situation. Their proper design allows achieving maximum throughput,

synchronized with the bottling or filling line. High reliability is ensured through redundancy and intelligent diagnostics. Compliance with traceability requirements (serialization) is achieved [7]. The proportion of packaging defects is reduced to almost zero.

Key principles of designing automatic packaging and labeling lines, their impact on the final productivity of a food enterprise in conditions of a labor shortage, and also to substantiate methods for increasing the overall reliability of the equipment.

Designing High-Performance Packaging Lines

Designing a packaging section requires a thorough analysis of the incoming product flow and outgoing logistics requirements. Automation based on programmable logic controllers (PLCs) allows flexible management of this complex process, integrating various types of machines: horizontal and vertical packaging machines, heat shrink tunnels, labeling stations. The key economic incentive for automation today is precisely the replacement of expensive and scarce manual labor with the stable operation of mechanisms.

The design process begins with an analysis of the packaging range. If the production facility manufactures products in different types of containers (glass, plastic, bags), the line must be modular and easily changeable. Modern CAD systems and simulation tools allow identifying bottlenecks and optimizing conveyor routing already at the design stage. This helps avoid situations where an already installed line cannot cope with peak loads.

The main task in design is to eliminate the mismatch between the speed of the packaging line and the speed of product supply from previous stages. Traditional approaches based on manual packaging imply either an inevitable lag or the need to maintain a whole staff of packers in several shifts, which is practically unfeasible given the current staff shortage.

Modern solutions offer a different path — intelligent synchronization based on automation [8]. The use of PLC-based conveyor control systems allows dynamic adjustment of the flow speed. Product presence sensors monitor the filling of buffer zones, automatically slowing down or speeding up individual sections of the line. This prevents product collisions and ensures uniform loading of labeling machines, which are often the most critical link in terms of speed, yet do not require human presence.

A key factor in productivity growth is the ability for quick changeover (SMED — Single Minute Exchange of Die) [4]. Automated lines are designed with servo drives, allowing packaging format changes not through mechanical readjustment, but by changing the program in the controller. For example, switching from a 0.5-liter bottle

to a 1.0-liter bottle can take no more than 5-10 minutes and be carried out by a command from the operator's touch panel. This reduces downtime and increases overall equipment effectiveness (OEE), which is critically important when hiring additional setup personnel for each shift is difficult and expensive.

One should also consider such a parameter as the line cycle time (time to produce one product unit). In high-performance lines, it is measured in fractions of a second. To achieve such indicators, distributed control systems are used, where each mechanism (packager, labeler, conveyor) has its own local controller, synchronized via a high-speed industrial network.

Reliability

The reliability of a line is determined not only by its mechanical durability but also by its ability to reject defective units without stopping the entire process. Modern lines necessarily include inspection systems that replace human visual control.

Machine vision systems play a special role here. High-speed cameras check:

- packaging integrity and seam quality (absence of damage, correct heat shrinking);
- correctness of label position (absence of misalignments, bubbles, correct application area) [2];
- readability and compliance of the marking code (e.g., Data Matrix codes for the "Chestny ZNAK" system) [9].

Integrating such systems with PLCs allows instantly removing a defective unit from the conveyor using a blast of air or a mechanical pusher, without interrupting the flow. This increases the reliability of output control compared to visual inspection by a human, who inevitably gets tired, distracted, and makes mistakes, especially in long shifts or at high conveyor speeds.

Furthermore, to ensure traceability, the line is equipped with printers and label applicators that apply unique identifiers to each package. The control system tracks the code's compliance with the recipe and production time, transmitting data to the enterprise's MES system. This allows recalling a batch or conducting a detailed production audit at any time. In the food industry, where requirements for raw material and finished product traceability are constantly tightening, having such tracking becomes a mandatory condition for working with retail chains.

Ensuring Reliability and Uninterrupted Operation

The reliability of a packaging line is a comprehensive indicator, established at the design stage and implemented through the control architecture and component selection. In conditions where every hour of downtime due to a breakdown means a loss of product volume that no one will be able to pack manually in an emergency mode, equipment reliability comes to the forefront.

The main enemy of productivity is unscheduled stops. The design of modern lines is based on the principles of predictive analytics and fault tolerance.

The first level of protection is equipment condition diagnostics. PLCs monitor motor loads, the number of pneumatic valve actuations, bearing temperatures, and current consumption in real time. Deviation of parameters from reference values serves as a signal for the service department about the need for preventive maintenance. For example, the system can warn about a malfunction in the packaging machine's knife or critical conveyor wear several hours before quality becomes unsatisfactory. This allows scheduling repairs during inter-shift time, rather than carrying them out urgently, halting order shipments.

The second level is architectural solutions. For critically important sections (e.g., applying marking codes required by law), redundancy is used. Installing two printers or labeling heads operating in hot standby mode (active/standby) allows, in case of failure of the main unit, to instantly switch to the backup without stopping the conveyor. The control system automatically signals the operator about the need for servicing the failed unit, but production does not stop.

Reliability also implies the system's ability to correctly handle emergency situations. The logic of "controlled stop" and automatic restart is embedded in the PLC algorithms. In case of a package jam, the system does not just shut down, but localizes the problem, lifts transport belts or releases grippers to clear the jam. After the operator clears the lockout and presses the restart button, the system smoothly starts the line, synchronizing the speed of all sections to avoid jerks that could damage the next product.

An important aspect is the control of consumables (film, label tape, ink, glue). End-of-roll sensors warn the system in advance about the need to stop or prepare the operator for a change. Advanced lines use automatic film splicing systems, allowing roll changes on the fly, completely eliminating downtime for this reason. For labelers, there are systems to check for the presence of labels on the reel, preventing missed applications.

Economic Efficiency

Implementing reliable automated systems requires significant initial investment. The cost of design, purchasing high-quality components (servo drives, sensors, controllers), and commissioning can be several times higher than the cost of makeshift lines. However, the analysis of the Total Cost of Ownership (TCO) demonstrates the advantages of this approach.

Reducing downtime by even 1% when operating in three shifts can yield additional production days per year. Reducing the defect rate from 2% to 0.1% through automatic control directly increases marginal profit. The absence of the need to maintain a staff of 10-15 packers per shift (including taxes and social benefits) pays for the line's cost in 2-3 years. Furthermore, automation eliminates the risk of incapacity: downtime associated with employee illness.

Conclusion

The design and implementation of an automated packaging and labeling line is a complex but economically justified goal. Replacing manual packaging labor with machines and creating an integrated system that ensures high throughput and line reliability is a significant advantage for food production facilities. The basis of efficiency becomes changeover flexibility, intelligent flow synchronization, and automated quality control, which make it possible to mitigate the risks associated with a shortage of qualified personnel [4].

Further development of such lines will be associated with the deep integration of machine learning technologies and line condition analysis. Collecting data from sensors into a single system will allow transitioning to full predictive maintenance, where equipment independently schedules repairs without waiting for a breakdown. In addition, the evolution of computer vision systems towards analyzing not only geometry but also color shades and packaging material structure will make it possible to achieve a near-zero level of defect passage. The integration of these solutions with cloud ERP systems will create the foundation for fully automated production facilities, where the final packaging stage will proceed without human intervention, guaranteeing stability, reliability, and maximum productivity regardless of the situation in the labor market.

REFERENCES

1. Magazine "Prodovolstvie XXI veka" (Food of the 21st Century): "Increasing Production Efficiency in the Food Industry through Automation," 2024.
2. Technical Regulation of the Customs Union TR CU 021/2011 "On Food Safety."

3. Research reports of the Institute of Food Industry Economics, Moscow State University, 2023–2024.
4. Official website of the International Organization for Standardization (ISO.org).
5. Guide to HACCP Implementation: A Practical Handbook for Food Industry Enterprises / Ed. by A.V. Kulikov. — M.: Food Industry, 2023.
6. Magazine "Promyshlennost i Ekonomika" (Industry and Economy): "Optimization of Industrial Production by Means of Automation," 2023.
7. GOST R ISO 22000-2019. Food safety management systems. Requirements for organizations in the food chain.
8. Practical Guide to Implementing MES Systems at Food Industry Enterprises / Ed. by I.S. Petrov. — St. Petersburg: Polytechnika, 2022.
9. Website for mandatory product marking (chestniyznak.rf)

ALGORITHMIC PROCEDURE FOR MASS APPRAISAL OF RESIDENTIAL REAL ESTATE

L. I. Kerman

Research advisor: M. E. Tsoy, Cand. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
kermanlev@mail.ru

Abstract. Market prices of residential real estate exhibit spatial dependence and spatial heterogeneity; as a result, models may generate area-specific error biases that overstate or understate cadastral values and distort the tax base [1, 2]. The purpose of this paper is to present a procedure for selecting and applying spatial models.

Keywords: mass appraisal, cadastral value, spatial models, spatial weights matrix, spatial dependence, spatial heterogeneity.

АЛГОРИТМИЧЕСКАЯ ПРОЦЕДУРА МАССОВОЙ ОЦЕНКИ ЖИЛОЙ НЕДВИЖИМОСТИ

Л. И. Керман

Аннотация. Рыночные цены на жилую недвижимость характеризуются пространственной зависимостью и пространственной неоднородностью; модели формируют территориальные смещения ошибок, приводящие к завышению или занижению кадастровой стоимости и искажению налоговой базы [1,2]. Цель доклада состоит в представлении процедуры выбора и применения пространственных моделей.

Ключевые слова: массовая оценка, кадастровая стоимость, пространственные модели, матрица пространственных весов, пространственная зависимость, пространственная неоднородность.

Mass cadastral appraisal is used to establish the cadastral value of real estate properties, which serves as the tax base for property taxation. Therefore, the methodology must ensure not only overall accuracy but also the elimination of systematic area-specific errors. If a model overestimates values in some zones and underestimates them in others, the error becomes directional and requires formal control of the spatial structure of residuals.

Area-specific biases in housing valuation typically stem from two data properties. First, observations are spatially dependent: nearby properties have similar prices both because of observed attributes and because of shared locational conditions that are not always fully measured and included in the regression specification [1,2]. Second, the market is spatially heterogeneous: the effects of determinants on price may differ across space, making the assumption of a single price–factor relationship over the entire study area inappropriate. These properties lead to a practical problem that arises in every empirical implementation. One must determine whether spatial dependence and spatial heterogeneity are present and assess their magnitude. Next, it is necessary to choose the spatial neighborhood structure in the form of a spatial weights matrix and justify its suitability for the given sample, because alternative neighborhood definitions yield different parameter estimates [1,2]. Finally, one must decide whether a global specification with spatially constant parameters is sufficient or whether a local specification allowing spatially varying parameters is required [4,5]. Hence, model choice should rely on a reproducible procedure that diagnoses the type of spatial structure and permits model complexity to increase only when supported by statistical evidence. The overall workflow is shown in Figure 1.

The spatial model design procedure begins by fixing the applied objective of mass appraisal, because the research design and, in particular, the out-of-sample validation setup depend on it. If the task is the initial establishment of cadastral values for newly built housing, accounting for project concentration becomes critical: many observations belong to a limited number of residential complexes, creating within-project dependence and pseudo-replication. In this case, cross-validation splits are formed by residential complexes so that the same complex cannot appear in both training and test parts, and fold comparability is ensured by stratification by submarket, housing class, and price level. If the goal is to update cadastral values in a reassessment, validation should mimic the scenario of updating estimates as the period changes; when temporal labeling is available, this is implemented via time-

based splitting, and when it is not, a reproducible hold-out scheme is used to prevent leakage of structurally similar observations between training and evaluation.

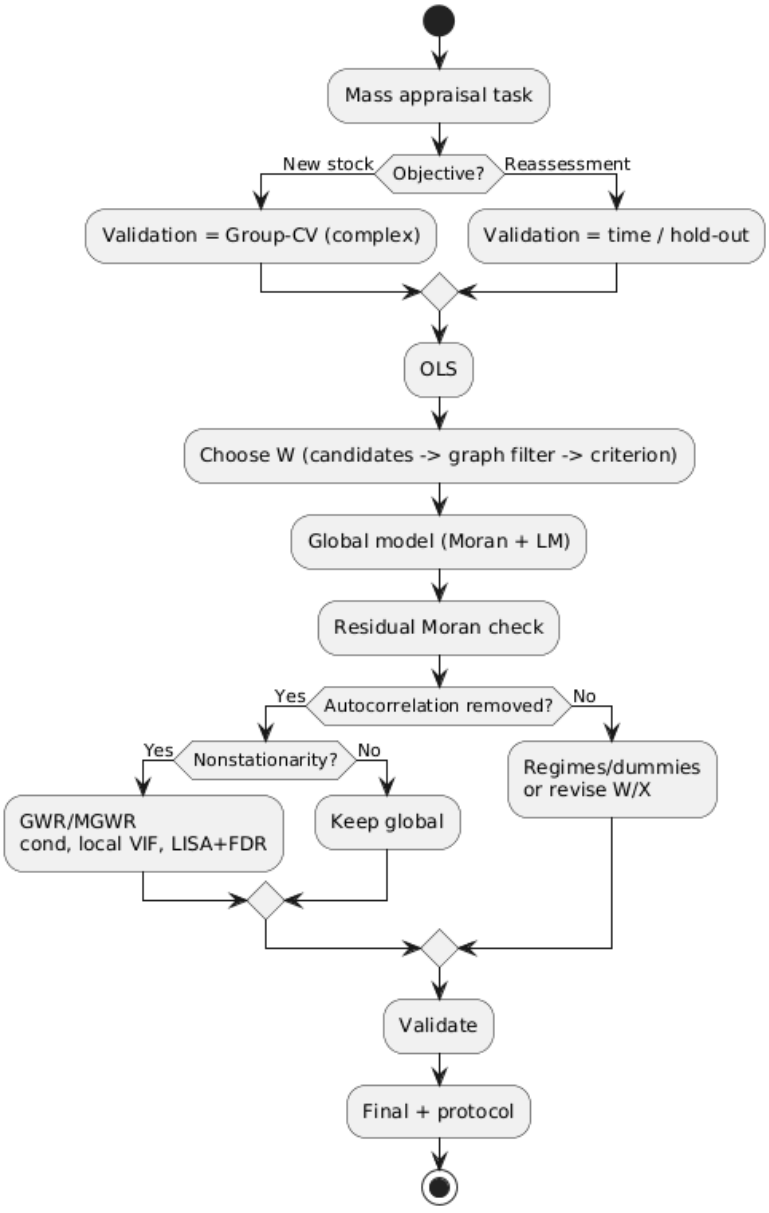


*Figure 1. Alg*orithmic workflow for selecting a spatial model in mass cadastral appraisal of residential real estate

After the objective is fixed, a multiple linear regression estimated by ordinary least squares is fitted. Because tests of residual spatial autocorrelation and spatial dependence are determined by the chosen neighborhood structure, the next step is to define a set of candidate spatial weights matrices. Since there is no generally accepted standard for selecting a spatial weights matrix and practical studies often set neighborhood parameters such as the number of nearest neighbors or a distance threshold heuristically, the procedure proposes a two-stage reduction of the candidate set: first, an expanded set of matrices is generated under alternative neighborhood rules; second, a preliminary graph-based filter is applied using the number of connected components and the share of isolated observations. On the reduced candidate set, the matrix is selected in a formalized way using a criterion aimed at minimizing the expected mean squared error of the estimated conditional mean.

For the final candidate (or a subset of finalists) of the spatial weights matrix, the global Moran's statistic is computed and Lagrange multiplier tests for the spatial lag and spatial error alternatives are carried out, which allows one to diagnose the presence of spatial dependence and identify the dominant mechanism [1,2]. A separate case is considered when the spatial structure cannot be adequately represented by a single weights matrix over the entire territory. The procedure then switches to a discrete representation of space: dummy variables for territorial segments are introduced or regime specifications are estimated, with submarket differences modeled in levels and, if necessary, in coefficients; stability of coefficients across segments may be tested using the Chow test [7].

The next stage addresses the choice between global and local spatial models. If a global spatial model with a reasonable weights matrix removes residual spatial autocorrelation and segmentation tests do not reveal stable coefficient instability, the global specification is retained as more robust for mass appraisal applications [1, 2]. If diagnostics indicate smooth spatial nonstationarity of parameters, the procedure allows a transition to spatially varying coefficient models, including geographically weighted regression and multiscale geographically weighted regression [4, 5]. In this case, in addition to out-of-sample comparison, the stability of local estimation and residual local spatial structure are assessed using local indicators of spatial association; interpretation of local indicators employs multiple-testing adjustment via false discovery rate control [3, 6]. Finally, in both global and local specifications, parametric inference is complemented by covariance matrices that are robust to heteroskedasticity in a spatial framework [8].

The proposed procedure treats the use of spatial models in mass cadastral appraisal as a sequence of reproducible decisions that minimizes the risk of area-

directed errors and ensures comparability when the period or sample composition changes. The key feature is explicit alignment of three components: the applied appraisal objective and the corresponding validation design, the choice of spatial structure through the weights matrix, and the identification of the scale of spatial heterogeneity. In particular, for the initial establishment of cadastral values for new housing, validity is ensured by group-based splits consistent with project concentration; for reassessment, validation is oriented toward inter-period transferability. The selection of the spatial weights matrix is formalized through constructing an expanded candidate set and reducing it using graph-topological properties of the neighborhood graph, which decreases arbitrariness and computational burden. Subsequent decisions rely on residual spatial autocorrelation diagnostics and mechanism testing; when a single weights matrix is inadequate, the procedure switches to discrete spatial specifications based on segments or regimes. Finally, the choice between global and local models is linked to residual diagnostics and estimation stability; for local specifications, multiple testing is explicitly addressed through false discovery rate control. As a result, the procedure provides a unified model design logic in which increased model complexity is permitted only when diagnostically justified and when out-of-sample performance is preserved.

REFERENCES

1. Anselin L. Spatial Econometrics: Methods and Models. – Vol. 4. – Dordrecht: Springer Netherlands, 1988.

2. LeSage J., Pace R. K. Introduction to Spatial Econometrics. – Boca Raton: Chapman and Hall/CRC, 2009.

3. Anselin L. Local Indicators of Spatial Association (LISA) // Geographical Analysis. – 1995. – Vol. 27, No. 2. – P. 93–115. – DOI 10.1111/j.1538-4632.1995.tb00338.x.

4. Brunsdon C., Fotheringham A. S., Charlton M. E. Geographically Weighted Regression: A Method for Exploring Spatial Nonstationarity // Geographical Analysis. – 1996. – Vol. 28, No. 4. – P. 281–298. – DOI 10.1111/j.1538-4632.1996.tb00936.x.

5. Fotheringham A. S., Yang W., Kang W. Multiscale Geographically Weighted Regression (MGWR) // Annals of the American Association of Geographers. – 2017. – Vol. 107, No. 6. – P. 1247–1265. – DOI 10.1080/24694452.2017.1352480.

6. Benjamini Y. and Hochberg Y. (1995), Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. Journal of the Royal Statistical Society: Series B (Methodological), 57: 289-300. DOI: 10.1111/j.2517-6161.1995.tb02031.x

7. Chow G. C. (1960). Tests of Equality Between Sets of Coefficients in Two Linear Regressions. Econometrica, 28(3), 591–605. DOI: 10.2307/1910133

8. Kelejian H. H., Prucha I. R. HAC Estimation in a Spatial Framework // Journal of Econometrics. — 2007. — Vol. 140, No. 1. — P. 131–154. — DOI: 10.1016/j.jeconom. 2006.09.005.

COMPETITIVE ANALYSIS OF MOBILE GAMES USING THE BCG MATRIX

Yu. P. Komarov

Research advisor: M. E. Tsoy, Cand. Sc. (Econ.)

Novosibirsk State Technical University,
yurakom06@gmail.com

Abstract. This article provides a detailed examination of the application of the BCG matrix method for the competitive analysis of the mobile puzzle game market. The conducted research allows for a proper assessment of the situation in the chosen field and the selection of a specific niche for developing an original product. The method used examines the market from various angles, making it possible to identify the strengths and weaknesses of competitors.

Keywords: market, market niche, market share, competitor, competitive analysis, BCG matrix, revenue, growth rate.

КОНКУРЕНТНЫЙ АНАЛИЗ МОБИЛЬНЫХ ИГР ПРИ ПОМОЩИ МАТРИЦЫ БКГ

Ю. П. Комаров

Аннотация. В данной статье подробно рассматривается применение метода матрицы БКГ для конкурентного анализа рынка мобильных игр в жанре головоломок. Проведенное исследование позволяет грамотно оценить ситуацию в выбранной сфере и выбрать конкретную нишу под разработку собственного продукта. Использованный метод изучает рынок с различных сторон, благодаря чему можно выделить сильные и слабые стороны конкурентов.

Ключевые слова: рынок, рыночная ниша, доля рынка, конкурент, конкурентный анализ, матрица БКГ, выручка, темп роста.

The relevance of the topic is driven by the intensive development of the market and the need for regular adaptation to current changes and trends. As of 2025, according to analytics data, the leaders in mobile games are representatives of the puzzle genre, namely the popular "Block Blast" and "Royal Match" [1]. As part of developing an original mobile game, this article is part of the marketing analysis necessary for determining a market niche.

The core problem of the research lies in finding benchmarks and references. Competitive analysis is intended, among other things, to identify market leaders and

find those very examples from whose experience effective solutions for one's own project can be derived.

The BCG (Boston Consulting Group) matrix is a tool that allows for the identification of active competitors in the market and their classification along two axes: relative market share and market growth rate. This method helps pinpoint specific applications that can later serve as references and be analyzed for effective development aspects and drawbacks that deter users. Besides providing references for making one's own decisions, competitors can offer insights into the financial state of the market and a specific target niche. At the intersection of the axes, the BCG matrix includes four corresponding zones:

1. Stars – this zone is characteristic of leaders, as it implies high growth rates and a large market share. Interpreting these indicators for the mobile game sphere, one can consider the number of downloads over the reporting period and revenue. Projects in this group are considered to already generate high income and offer prospects for further growth with appropriate investment.

2. Cash Cows – this zone also generates relatively good income, but it is no longer as attractive for investment, as projects in this group do not possess high growth rates. Analysts state that this position is also characteristic of leaders, but those that are already established and have reached their peak.

3. Question Marks (or Problem Children) – this is the zone for projects that require significant investment or restructuring to become highly profitable, as they currently have high growth rates but low profitability indicators.

4. Dogs – this is the zone for emerging or declining projects with no investment appeal, as competitors in this area are characterized by low growth rates and low revenues [2].

After analyzing the mobile puzzle game market, a corresponding BCG matrix was compiled (See page 1).

Within the framework of the analysis, key competitors were identified.

Royal Match is a free-to-play mobile puzzle game. It is an unequivocal market leader, boasting both a high number of downloads and high revenues compared to other applications in the sample. In the game, the user must help the king furnish his castle, which requires completing numerous levels based on a match-3 gameplay mechanic. A distinctive feature of this project is its rich and vibrant visualization, which enhances the game's atmosphere and ambiance. For this research, an important aspect is its monetization model, where players pay for extra attempts and in-game bonuses. Furthermore, the internal tutorial and hint system proved useful for development considerations.

Block Blast is a free-to-play mobile puzzle game featuring a block-falling mechanic. It is also an undeniable leader, surpassing its competitors in audience

reach. This project is notable and useful for development analysis due to its monetization model, where players do not make purchases but periodically watch ads, thereby generating revenue. It features an extremely simple design and a universally understood classic mechanic.

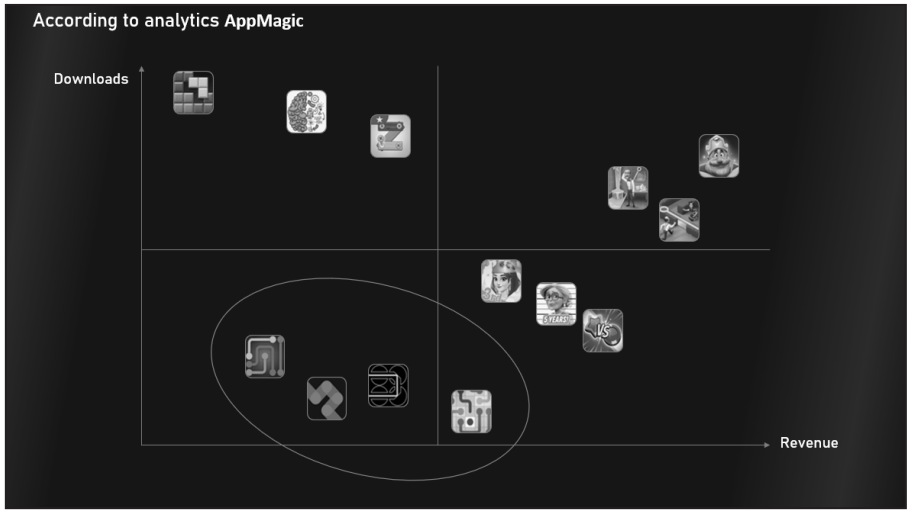


Figure 1. BCG matrix

Source: compiled by the author based on data from AppMagic [1]

One cannot fail to mention projects from the game studio "Playrix," which rightfully entered the Stars zone, being a domestic (Russian) development. A key point here is that the target audience for this game is initially geographically located in Russia, which significantly influences the style of communication with users. The project is monetized similarly through the purchase of level attempts and in-game bonuses.

The group of games circled in the figure represents the closest competitors to our project. This conclusion was drawn based on the similarity of in-game mechanics, where the player needs to trace a path from a starting point to a finish point. A notable feature to consider is their financial position and monetization model.

Laser Puzzle is a free-to-play mobile puzzle game where the player's main task is to guide a light beam from a source to a lamp. Useful aspects here include the music, the attempt system, banner ads, and the purchase of in-game bonuses.

Line & Color Puzzle is a free-to-play mobile puzzle game where the player must establish connections between dots based on their color. Important features here include ads that sometimes play automatically, daily login rewards, and a rating system. Connect the Dots, in turn, is an almost exact clone of this project.

It was precisely through this matrix analysis that direct competitors were identified and a niche was found within which the further development of the project can be planned.

Practical Application and Modeling

Having analyzed the game mechanics of market leaders as well as direct competitors, a decision was made regarding the feasibility of monetization through a similar hybrid free-to-play system, where the game itself is free, but revenue is generated through ads and in-app purchases. Additionally, by studying the current trends in the Stars category, it is planned to incorporate numerous similar bonuses into the game.

Armed with information on the monthly download numbers of competitors, and taking the average daily revenue per user at 12 rubles, a model of the target niche can be calculated. Assuming a capture of 20% of the market leader's total monthly downloads, a financial forecast was modeled, (Seen Figure 2).

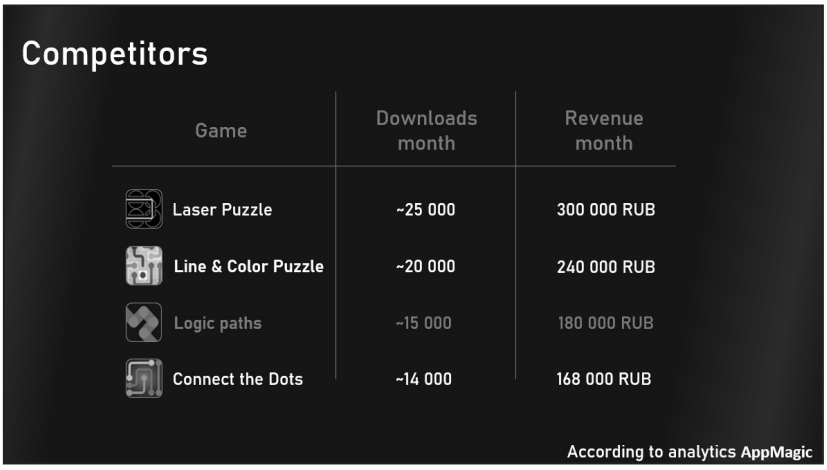


Figure 2. Target niche model

Source: compiled by the author based on data from AppMagic [1].

Based on this information alone, one can roughly estimate the potential market share to be captured and the future development prospects.

Thus, the conducted research, dedicated to the application of the BCG matrix for the competitive analysis of the mobile puzzle game market, provides a comprehensive set of conclusions with both theoretical and significant practical value. The primary goal, which involved assessing the market situation and identifying a promising market niche for developing an original game product, was achieved through the competent application of the chosen analytical tool.

The relevance of the research, driven by the rapid dynamics of the mobile game industry and the need for immediate adaptation to changing trends, was fully confirmed during the analytical work. The mobile game market, particularly the puzzle segment, is characterized not only by high growth rates but also by a vast number of competitors. Under these conditions, relying solely on intuition and copying successful projects from industry giants is a demonstrably losing strategy. Using the BCG matrix, however, allows for the structuring of obtained data (download counts and revenues for the reporting period) and its integration into a sound strategic model.

The key result of the research was the visualization of the competitive landscape. This clarified the four competitive zones, containing the "Stars," "Cash Cows," "Question Marks," and "Dogs." Constructing the matrix helped not merely to highlight prominent market players but also to comprehend their strategic positions. For instance, the industry leaders, Royal Match and Block Blast, clearly point towards current successful game mechanics. Considering the different positions of these two projects, a clear trend emerges: one focuses on simplifying perception to maximize audience reach, while the other innovates with a multitude of in-game monetization features. Identifying specific applications leads to an understanding of which products currently set the standards for quality and player engagement. Analyzing their strengths, such as visual style, game mechanics, and hybrid monetization models combining ads with in-app purchases, provides a benchmark for developing a competitive original product. Conversely, the presence of mature projects from the "Cash Cow" zone in the matrix demonstrates the market saturation ceiling and highlights potential mistakes that could hinder growth.

Of high significance for the practical part of the work is the identification of the "Question Marks" and "Dogs" groups, which include games like Laser Puzzle and Connect the Dots. These projects were classified as direct competitors due to the similarity of their core game mechanics (drawing a line/beam from point to point) with the product being developed. While increasing their growth rate could potentially lead them into a more promising sector, analyzing these specific analogues allowed for the identification of a corresponding target market niche. Examining their financial performance and user engagement models (daily rewards, ratings, nature of ad integration) made it possible not only to assess the capacity of this segment but also to identify its weaknesses. This provides an opportunity to develop a product that avoids the shortcomings of existing solutions and offers users an improved experience.

Thus, the main practical outcome of the work lies in the substantiated choice of a market niche. Using data on the monthly downloads of direct competitors and the

industry-average revenue per user (around 12 rubles), a financial model for the target niche was constructed. Targeting 20% of the market leader's download volume allowed for the creation of a realistic forecast, which will form the basis for business planning and the development of a promotion strategy.

Moreover, the research confirmed the versatility and effectiveness of the BCG matrix as a strategic analysis tool. Despite its apparent simplicity, it allows for solving a complex problem: simultaneously assessing the external environment (market growth rate) and the internal potential of a product relative to competitors (market share). For startups and small development studios that lack the substantial resources for expensive marketing research, this method offers an optimal "cost-to-insight" ratio.

In conclusion, it is worth noting that the conducted competitive analysis using the BCG matrix is not the endpoint of the research but serves as a foundation for further work. The conclusions drawn regarding the preferred monetization model (free-to-play with a hybrid revenue system), the necessary game mechanics, and user acquisition channels require further detailing and testing. The next stages should involve a more in-depth SWOT analysis specifically for the chosen niche, as well as the development and validation of the game concept (MVP) with the target audience. Nevertheless, it is the results of this matrix analysis that have made it possible to shift the development process from the realm of abstract ideas to the plane of concrete, market-oriented tasks, which is the main criterion for the success of the conducted research.

REFERENCES

1. AppMagic // URL: https://appmagic.rocks/top-charts/apps (accessed: 28.03.2026) (in Russian).

2. Biryukova E. R. Matrix Methods for Assessing Enterprise Competitiveness: The BCG Matrix and the Ansoff Matrix / E. R. Biryukova // Management and Marketing: Challenges of the XXI Century: XII All-Russian Student Scientific and Practical Conference, Yekaterinburg, October 21, 2024. – Yekaterinburg: Ural State University of Economics, 2024. – pp. 17-19. – EDN TYWKNF // URL: https://elibrary.ru/item.asp?id=80067236 (accessed: 28.03.2026) (in Russian).

ANALYSIS OF ADVANCED RESEARCH AND PROSPECTIVE PROJECT MANAGEMENT SOLUTIONS FOR KAZAKHSTAN'S EVENT INDUSTRY: CHALLENGES AND OPPORTUNITIES OF DIGITAL TRANSFORMATION

M. M. Shakenova

Research advisor: PhD (Economics) Gaini Mukhanova

Astana, *Astana IT University*, *Kazakhstan*,
shakenova2005@gmail.com

Abstract. The paper analyzes contemporary project management approaches in the context of digital transformation and evaluates their relevance for Kazakhstan's event industry. It identifies key managerial challenges and proposes a governance-oriented conceptual framework integrating hybrid project logic with digitally embedded coordination mechanisms to enhance resilience and effectiveness in emerging markets.

Keywords. project management, event industry, digital transformation, hybrid models, stakeholder management, emerging economies, Kazakhstan.

АНАЛИЗ ПЕРЕДОВЫХ ИССЛЕДОВАНИЙ И ПЕРСПЕКТИВНЫХ РЕШЕНИЙ ПРОЕКТНОГО УПРАВЛЕНИЯ ДЛЯ ИВЕНТ-ИНДУСТРИИ КАЗАХСТАНА: ВЫЗОВЫ И ВОЗМОЖНОСТИ ЦИФРОВОЙ ТРАНСФОРМАЦИИ

М. М. Шакенова

Аннотация: В статье анализируются современные подходы к управлению проектами в условиях цифровой трансформации и оценивается их применимость для ивент-индустрии Казахстана. Определяются ключевые управленческие вызовы, характерные для проектно-ориентированной природы отрасли. В работе предлагается концептуальная модель управления, основанная на принципах управленческой координации, которая интегрирует гибридную логику проектного управления с цифровыми механизмами взаимодействия. Предложенная модель направлена на повышение устойчивости и эффективности управления проектами в условиях развивающихся рынков.

Ключевые слова: управление проектами, ивент-индустрия, цифровая трансформация, гибридные модели управления, управление заинтересованными сторонами, развивающиеся экономики, Казахстан

Introduction

Digital transformation has reshaped business models, communication structures, and decision-making processes. Project-based industries are particularly sensitive to these changes due to their temporary organizational nature and stakeholder complexity. The event industry represents a high-intensity project environment where management efficiency directly affects performance and sustainability.

Project management methodologies have evolved from predictive models to Agile and hybrid approaches, while digital tools increasingly influence coordination and risk management. However, the adaptation of these innovations to event-driven industries in emerging economies remains insufficiently explored. Kazakhstan's event sector operates within conditions of institutional transformation and uneven digital maturity, creating a research gap regarding the contextualization of advanced management frameworks.

The study analyzes contemporary research and evaluates its relevance for the digital transformation of Kazakhstan's event industry.

Literature Review and Theoretical Foundations

Contemporary project management research conceptualizes projects as temporary organizations operating under constraints of time, cost, and scope [8], [10]. Traditional predictive approaches emphasize structured planning, stage-gate control, and performance monitoring, which remain essential for projects with fixed deadlines and contractual obligations. Event projects, characterized by non-transferable launch dates and high coordination intensity, largely correspond to this logic.

The increasing volatility of business environments has stimulated the development of adaptive and Agile methodologies. Agile approaches prioritize iterative development and rapid feedback [3]; however, purely Agile frameworks may be limited in contexts with strict deadlines and formal stakeholder commitments. Hybrid project management models therefore gain relevance by balancing adaptability and structural discipline [4], [12], positioning hybridization as contextual adaptation rather than methodological compromise.

The concept of project success has expanded from time–cost compliance toward a multidimensional construct incorporating strategic alignment and stakeholder satisfaction [11]. Critical success factors depend on governance mechanisms and organizational maturity [7], while integrated monitoring systems enhance transparency and coordination when embedded within coherent management structures [13].

Digital transformation research conceptualizes transformation as systemic organizational change driven by digital technologies and data integration [15]. Digital business strategy literature emphasizes alignment between technological capabilities, processes, and governance mechanisms [2]. Importantly, technological availability alone does not ensure performance improvement; effectiveness depends on integration into governance and project management routines [6], [14]. Consequently, coherent digital transformation strategy and architectural alignment become critical [6].

Event management literature defines events as structured yet temporary value-creating activities with identifiable life cycles [5]. Compared to formal project management standards [8], event frameworks often demonstrate less formalized governance models. Temporary organization theory highlights risks of knowledge discontinuity and coordination breakdown in recurring event portfolios [9]. Organizational design and knowledge management mechanisms therefore become essential for sustaining continuity [9].

Finally, project complexity research identifies interdependencies, uncertainty, and stakeholder multiplicity as central dimensions requiring adaptive management mechanisms [1]. Event projects combine high coordination complexity with fixed time constraints, intensifying managerial pressure.

Identified Research Gap

Although substantial research exists in project management methodologies [3], [4], [8], [9], [10], [12], digital transformation strategy [2], [6], [14], [15], and event studies [5], these streams remain insufficiently integrated at the governance level.

Project management literature offers structured governance mechanisms; however, their adaptation to temporary, deadline-critical event environments remains underdeveloped. Digital transformation research emphasizes technological integration but rarely operationalizes it within project-based temporary organizational settings. Event management studies acknowledge stakeholder complexity, yet governance architectures aligned with hybrid project frameworks remain insufficiently articulated.

As a result, a coherent governance-oriented model integrating hybrid project logic with digitally embedded coordination mechanisms for event-driven industries in emerging economies remains underdeveloped. In Kazakhstan's event sector, characterized by evolving institutional maturity and uneven digital adoption, this fragmentation is particularly evident.

The present study addresses this gap by proposing a context-adapted conceptual architecture that combines managerial discipline, adaptive mechanisms, and digitally structured governance within temporary project environments.

Managerial Challenges in Kazakhstan's Event Industry

Kazakhstan's event industry operates within a developing yet structurally uneven market environment. Business events and exhibitions function as temporary, high-intensity projects requiring coordination among multiple stakeholders. Despite the adoption of CRM systems and digital platforms, digitalization remains fragmented, as tools are often implemented as isolated solutions rather than integrated governance mechanisms. Technological availability alone does not ensure improved performance without structural alignment [6], [14].

Several structural challenges persist. Limited process formalization reduces reproducibility across projects and increases vulnerability during team transitions. Weak knowledge management contributes to repeated operational inefficiencies; lessons learned are insufficiently codified, reflecting risks identified in temporary organization theory [9].

Stakeholder coordination constitutes a critical managerial burden. Coordination difficulties often intensify during final preparation phases when contractual obligations intersect with last-minute adjustments. Given the multidimensional understanding of project success [11], inadequate integration of stakeholder management into formal project structures may affect both operational and reputational outcomes.

Finally, the coexistence of fixed deadlines and environmental uncertainty requires balancing structural discipline with adaptive responsiveness, reinforcing the relevance of hybrid management frameworks [4], [12].

Conceptual Framework for Integrated Project Management

The proposed framework integrates three interdependent layers.

1. The Structural Governance Layer, grounded in traditional project management standards [8], [10], ensures accountability through life-cycle structuring, risk registers, and measurable performance indicators.

2. The Adaptive Hybrid Layer, based on hybrid research [3], [4], [12], introduces iterative coordination mechanisms within defined structural boundaries, enhancing controlled responsiveness.

3. The Digital Integration Layer, anchored in digital transformation theory [2], [6], [14], [15], embeds digital tools into governance architecture and emphasizes transparency, data ownership, and strategic alignment.

The interaction of these layers forms an integrated managerial architecture aimed at increasing resilience and coherence in temporary event projects.

Conclusion

The study suggests that improving effectiveness in event-driven industries requires governance reconfiguration rather than mere technological expansion. Digital transformation becomes meaningful only when integrated into structured and hybrid management systems.

Hybridization is not a methodological trend but a contextual response to deadline-critical and stakeholder-intensive project environments. For emerging economies where digitalization often advances faster than governance maturity, such alignment becomes particularly significant. Future research may empirically examine the robustness of the proposed architecture across varying levels of organizational maturity.

REFERENCES

1. Baccarini D. (1996) The concept of project complexity—A review. International Journal of Project Management, 14 (4), 201–204.
2. Bharadwaj A., El Sawy O. A., Pavlou P. A., Venkatraman N. (2013) Digital business strategy. MIS Quarterly, 37 (2), 471–482.
3. Boehm B., Turner R. (2004) Balancing Agility and Discipline: A Guide for the Perplexed. Boston, MA: Addison-Wesley.
4. Conforto E. C., Salum F., Amaral D. C., da Silva S. L., de Almeida L. F. M. (2016) Can agile project management be adopted by industries other than software development? Project Management Journal, 47 (3), 21–34.
5. Getz D. (2008) Event tourism: Definition, evolution, and research. Tourism Management, 29 (3), 403–428.
6. Hess T., Matt C., Benlian A., Wiesböck F. (2016) Options for formulating a digital transformation strategy. MIS Quarterly Executive, 15 (2), 123–139.
7. Joslin R., Müller R. (2015) A new framework for determining critical success factors in projects. International Journal of Project Management, 33 (6), 1377–1392.
8. Kerzner H. (2017) Project Management: A Systems Approach to Planning, Scheduling, and Controlling. 12th ed. Hoboken, NJ: Wiley.
9. Lundin R. A., Söderholm A. (1995) A theory of the temporary organization. Scandinavian Journal of Management, 11 (4), 437–455.
10. Project Management Institute (2021) A Guide to the Project Management Body of Knowledge (PMBOK® Guide). 7th ed. Newtown Square, PA: PMI.
11. Shenhar A. J., Dvir D., Levy O., Maltz A. C. (2001) Project success: A multidimensional strategic concept. Long Range Planning, 34 (6), 699–725.
12. Špundak, M. (2014) Mixed agile/traditional project management methodology: Reality or illusion? International Journal of Project Management, 32 (5), 939–953.
13. Too, E. G., Weaver, P. (2014) The management of project management. International Journal of Project Management, 32 (8), 1382–1394.

14. Verhoef P. C., Broekhuizen T., Bart Y., et al. (2021) Digital transformation: A multidisciplinary reflection and research agenda. Journal of Business Research, 122, 889–901.

15. Vial G. (2019) Understanding digital transformation: A review and a research agenda. MIS Quarterly, 43 (1), 223–254.

TARGETED ADVERTISING IN SOCIAL NETWORKS AS AN ELEMENT OF OMNICHANNEL MARKETING COMMUNICATIONS IN THE RUSSIAN AUTOMOTIVE MARKET

D. E. Shilingovsky, M. E. Tsoy

Novosibirsk, *Novosibirsk State Technical University*,
den.memos@yandex.ru

Abstract. This study analyzes the role of targeted advertising in omnichannel marketing in the Russian automotive market. The relevance of the study stems from shifting consumer behavior and the need for integrated digital channels amid growing competition. The research, based on literature analysis and a survey of 5 dealers and 153 buyers, reveals that 80% of marketers view targeting as the primary lead source, and 41% of consumers credit social media ads for their purchase decision. Findings emphasize the necessity of integrating CRM data with advertising platforms to ensure communication efficiency.

Keywords: targeted advertising, omnichannel marketing, automotive market, social networks, consumer behavior, CRM integration.

ТАРГЕТИРОВАННАЯ РЕКЛАМА В СОЦСЕТЯХ КАК ЭЛЕМЕНТ ОМНИКАНАЛЬНЫХ МАРКЕТИНГОВЫХ КОММУНИКАЦИЙ НА АВТОМОБИЛЬНОМ РЫНКЕ РОССИИ

Д. Е. Шилинговский, М. Е. Цой

Аннотация. В статье рассматривается роль таргетированной рекламы в социальных медиа в структуре омниканального маркетинга на российском автомобильном рынке. Актуальность исследования обусловлена трансформацией потребительского поведения и необходимостью интеграции цифровых каналов для удержания внимания аудитории в условиях высокой конкуренции и импортозамещения. Цель работы — определить функциональное место таргетинга в воронке продаж дилерских центров. Методологическую базу составили анализ научной литературы по омниканальному маркетингу и авторское анкетирование представителей дилерских центров (n = 45) и покупателей новых автомобилей (n = 300). Результаты демонстрируют, что 80% маркетологов

считают таргет основным источником лидов, а 41% покупателей отмечают влияние рекламы в соцсетях на финальное решение о визите в салон. В заключении обосновывается необходимость интеграции данных CRM и рекламных кабинетов для повышения эффективности коммуникаций.

Ключевые слова: таргетированная реклама, омниканальный маркетинг, автомобильный рынок, социальные сети, потребительское поведение, CRM-интеграция.

The transformation of marketing communications in the digital environment has led to the formation of an omnichannel approach, in which the boundaries between physical and online points of contact with the consumer are blurred. For the Russian automotive market, characterized by a long decision-making cycle and high product cost, this trend acquires particular significance (Kotler et al., 2023). Following the departure of a number of international brands and the increased activity of Chinese manufacturers, the competitive struggle for the consumer has shifted to the digital space. Social networks, particularly VKontakte, as well as video platforms, have become not just communication channels but tools for collecting behavioral data. Targeted advertising allows for audience segmentation with high precision; however, its effectiveness in isolation from other channels (search, aggregators, and offline events) decreases (Osipova, Kozlov, 2024). The problem lies in the absence, among many market players, of an integrated system that unifies data from various sources.

The purpose of this article is to analyze the functional role of targeted advertising on social networks as a connecting element of the omnichannel strategy of dealerships in Russia.

To achieve this goal, the following tasks were set:

1. To study the theoretical aspects of integrating targeting into multi-channel communications.
2. To conduct an empirical study of the perception of targeted advertising by marketers and buyers.
3. To identify barriers and prospects for omnichannel integration in the Russian automotive market.

The study was conducted in two stages. At the first stage, an analysis of secondary data was carried out: scientific publications in the RSCI and Scopus databases, as well as industry reports (Autostat, 2025) for the period 2020–2025. The key categories of analysis were the concepts of "omnichannel," "targeting," "automotive marketing," and "sales funnel."

At the second stage, an applied survey was conducted in the period from December 2025 to February 2026. The study included two target samples:

1. Expert Group (B2B): 5 heads of marketing and sales departments of dealerships representing local players in the city of Novosibirsk.

2. Consumer Group (B2C): 153 respondents who purchased a new car (primarily Chinese and domestic brands in the mass segment) during the specified period. Selection was carried out using random sampling in showrooms at the time of vehicle delivery.

The toolkit included closed and semi-open questions aimed at identifying sources of information, purchase triggers, and evaluating the effectiveness of channels. Data processing was performed using descriptive statistics methods.

In the course of analyzing theoretical sources, it was revealed that omnichannel implies not just the presence of a brand across several channels, but the synchronization of messages and customer data at all stages of the journey. In this model, targeting performs the functions of retargeting and attracting new leads based on look-alike models.

The results of the survey of marketers (Group A) showed the following distribution of responses to the question about priority customer acquisition channels (taking into account end-to-end analytics). Respondents were asked to choose no more than three options.

Table 1 — Evaluation of the effectiveness of acquisition channels

Communication Channel	**Proportion of respondents who rated the channel as one of the most effective, %**
Targeted advertising (VK)	75
Classifieds and aggregators (Auto.ru, Avito, Drom)	55
Contextual advertising (Yandex.Direct)	40
SEO and organic search	25
Outdoor advertising and TV	10

As can be seen from the table, targeted advertising on social networks leads, slightly ahead of specialized automotive platforms. During in-depth interviews, respondents explained that the value of targeting lies in the ability to warm up the audience and collect data for retargeting.

When asked about the degree of channel integration ("Do you consider your marketing system fully omnichannel, i.e., unifying online and offline data in a single CRM?"), only 22% of respondents answered affirmatively. The main barriers cited were the technical complexity of integrating CRM with social network APIs and a lack of qualified analysts.

The results of the survey of buyers (Group B) allowed us to assess the real impact of digital channels.

Table 2 — Behavioral characteristics of buyers on the path to a deal

Parameter	Respondents (%)
Are members of official brand/dealer communities	63
Learned about a special offer (Trade-in, credit) from targeted ads	40
Watched video reviews before the visit	53
Believe that the last trigger for the visit was an ad on social networks	20

The data indicate a high level of audience engagement in social media at the selection stage. Particularly indicative is the 28% figure which suggests that a targeted message can "close" a deal, even if the client was already in a state of deliberation.

The results obtained correlate with global trends in the digitalization of auto retail. The high percentage of marketers (80%) ranking targeting first is explained not so much by the absolute effectiveness of the channel, but by the possibility of relatively precise targeting compared to display advertising. However, the consumer survey data (41% learned about the offer from targeted ads) indicate that advertising on social networks works in conjunction with other channels. A buyer might have seen the car on a classified site, but the motivating discount or special conditions — precisely in the news feed.

The gap between the ambitions of marketers (22% use full omnichannel) and their real technical capabilities confirms the thesis of "fragmented multi-channel" in the Russian automotive business (Kolesnikov, 2024). Most dealers use targeting as an isolated source of traffic, without transferring touchpoint data to the CRM or using it to personalize subsequent communications.

The practical significance of the work lies in substantiating the need for technical integration. Without unifying data from advertising accounts, CRM, and call tracking, targeting remains merely an expensive way to display ads, rather than an element of a seamless customer experience.

REFERENCES

1. Kolesnikov A. V. Marketing v avtomobilnom biznesa Rossii: vyzovy novogo vremeni [Marketing in the Russian Automotive Business: Challenges of the New Time] / A. V. Kolesnikov. — Moscow : AvtoBiznesPress, 2024. — 248 p.

2. Kotler F. Marketing 5.0. Tekhnologii sleduyushchego pokoleniya [Marketing 5.0: Next Generation Technologies] / F. Kotler, S. Kartajaya, H. Setiawan ; translation from English. — Moscow : Eksmo, 2023. — 320 p.

3. Osipova L. B. Omnikanalnyy marketing v roznichnoy torgovle: rossiyskaya praktika [Omnichannel Marketing in Retail: Russian Practice] / L. B. Osipova, I. I. Kozlov // Prakticheskiy marketing [Practical Marketing]. — 2024. — No. 6 (316). — P. 25–32.

4. Ryazanov A. A. Effektivnost targetirovannoy reklamy v sotsialnykh media v period ekonomicheskoy nestabilnosti [Effectiveness of Targeted Advertising in Social Media during Economic Instability] / A. A. Ryazanov // Reklama. Teoriya i praktika [Advertising. Theory and Practice]. — 2025. — No. 1 (103). — P. 14–22.

5. Sovremennye trendy internet-marketinga v avtobiznese [Current Trends in Internet Marketing in the Auto Business] / D. S. Ivanov, E. V. Sokolova, N. Yu. Borisov [et al.] // Vestnik Rossiyskogo ekonomicheskogo universiteta imeni G. V. Plekhanova [Bulletin of the Plekhanov Russian University of Economics]. — 2025. — Vol. 22, No. 1 (127). — P. 112–124.

6. Skrynnikova M. N. Integratsiya CRM i reklamnykh kabinetov sotsialnykh setey kak osnova omnikanalnosti [Integration of CRM and Social Network Advertising Accounts as the Basis for Omnichannel] / M. N. Skrynnikova // Marketing i marketingovye issledovaniya [Marketing and Marketing Research]. — 2024. — No. 4. — P. 290–298.

7. Tsifrovoy marketing v avtobiznese: ot lida do sdelki [Digital Marketing in Auto Business: From Lead to Deal] : practical guide / edited by P. A. Orlov. — Saint Petersburg : Piter, 2025. — 352 p.

8. Automotive Market of Russia: Results of 2025 and Development Prospects [Electronic resource] // Autostat Analytical Agency. — Togliatti, 2025. — URL: https://www.autostat.ru (date of access: 10.03.2026).

GIGACHAT-POWERED AI AGENT DEVELOPMENT: KEY ISSUES AND HIDDEN CHALLENGES

A. E. Sypchenko

Research advisor: E. V. Komf, Can. Sc. (Econ.)

Novosibirsk, *Novosibirsk State Technical University*,
al.sypchenko@internet.ru

Abstract. Developing production-grade AI agents with GigaChat—Sberbank's family of LLMs for Russian-language markets—reveals three critical categories of challenges: technical integration barriers (tool use inconsistencies, streaming reliability), architectural complexities in multi-agent orchestration, and performance gaps compared to frontier models. Hidden challenges include encoding handling deficiencies, object lifetime mismanagement in generated code, and geopolitical

constraints affecting development velocity. Understanding these issues is essential for organizations building robust agentic systems on GigaChat.

Key words. GigaChat, LLM-based agents, Russian-language AI models, technical integration challenges, Technological sovereignty.

РАЗРАБОТКА AI-АГЕНТОВ НА БАЗЕ GIGACHAT: КЛЮЧЕВЫЕ ПРОБЛЕМЫ И СКРЫТЫЕ ВЫЗОВЫ

А. Е. Сыпченко

Аннотация. Разработка AI-агентов промышленного уровня с использованием GigaChat — семейства больших языковых моделей (LLM) от Сбербанка для русскоязычных рынков — выявляет три критических категории проблем: технические барьеры интеграции (несоответствия при вызове функций, надежность потоковой передачи), архитектурные сложности в многоагентной оркестровке и разрывы в производительности по сравнению с передовыми моделями. К скрытым проблемам относятся недостатки обработки кодировок, ошибки управления временем жизни объектов в генерируемом коде и геополитические ограничения, влияющие на скорость разработки. Понимание этих вопросов необходимо организациям, создающим надежные агентные системы на базе GigaChat.

Ключевые слова: GigaChat, LLM-агенты, русскоязычные модели ИИ, технические проблемы интеграции, технологический суверенитет.

Introduction

This article is grounded in practical difficulties encountered while developing an AI assistant for an industrial enterprise. Building agents on GigaChat requires navigating both technical limitations and the strategic advantages of leveraging domestic LLMs in a geopolitically charged environment.

1. Technical Integration Challenges

Function calling inconsistencies. When applications using OpenAI's tool_choice="required" migrate to GigaChat through abstraction layers like LiteLLM, the semantics are not preserved. The model may return free-form text instead of calling functions, breaking agent reliability in workflows requiring guaranteed structured outputs.

Streaming output reliability. Historical analysis reveals tokens delivered in batches rather than progressively—diverging from ChatOpenAI implementations. The root cause appears to be defects in the server-side chunked transfer mechanism,

requiring remediation after release. Defensive programming practices remain necessary.

Template compatibility issues. Community efforts to run GigaChat through llama.cpp encounter persistent template problems stemming from architectural divergence from DeepSeek variants (different layer counts: 26 vs. 27; attention head configurations: 64 vs. 128). These variations complicate integration with inference stacks designed for Western or Chinese architectures.

2. Production Deployment Realities

The tuning paradox. "An agent MVP can be built in a week—but then meticulous tuning is required through prompts and context management to achieve human-comparable accuracy." Traditional development effort curves invert: rapid prototyping masks the substantial work of achieving production-grade reliability.

User experience failures. App Store reviews reveal generic responses to specific queries, circular dialogue patterns where models acknowledge failure but repeat ineffective behaviors, and error sequences that present payment options before demonstrating value—eroding user trust.

Enterprise success patterns. PostgreSQL incident analyzer combining preprocessing pipeline + GigaChat-Max + RAG reduced report generation from 30 minutes to under one minute (a 98% reduction). Success factors include narrow domain scope, preprocessing normalization, retrieval augmentation, human-in-the-loop workflows.

3. Hidden Technical Challenges

UTF-8 encoding deficiencies. When generating C++ code for UTF-8 tokenization, GigaChat produced subtle object lifetime errors:

```
std::string_view current_word = text.substr(begin_pos, pos - begin_pos); // Dangling pointer
```

More sophisticated errors involved storing string_view references to local variables and returning them—classic use-after-free scenarios that escape static analysis. Training data likely lacks sufficient modern C++ examples with encoding awareness.

Architectural opacity. GigaChat models are DeepSeek variants modified for Russian processing. GigaChat3-702B operates as "DeepSeek V3" variant; smaller models adapt DeepSeek-V2-Lite with different layer counts and head configurations. This requires model-specific template fixes and increases testing burden.

Geopolitical constraints. Russia falls short by hundreds of thousands of high-tech researchers compared to global competitors. Only 3,000 AI graduates in 2022

versus 73,000+ in the US (2023). International sanctions, hardware restrictions, and barriers to global collaboration create structural limitations. At the same time, these geopolitical pressures underscore the importance of domestic software: data security and the absence of disconnection risks have become critical factors for Russian businesses seeking technological sovereignty.

4. Benchmark Performance

GigaChat MAX lags behind American models by approximately one year on the MMLU test. It does not appear in the rankings of 170+ LLMs on the English-language LLM Arena. It occupies joint eighth place in the Russian-language LLM Arena, trailing behind variants of Claude, DeepSeek, and ChatGPT.

Domain-specific strengths. A healthcare diagnostic assistant achieved 93% accuracy on clinical cases. Success factors: specialized fine-tuning, constrained workflows, structured evaluation.

5. Business Value for Russian Enterprises

Despite the challenges, deploying GigaChat-powered agents delivers tangible benefits: operational cost reduction (up to 98% in incident documentation), enhanced accuracy in specialized domains (93% in medical diagnostics), and, crucially, technological independence. Russian businesses gain control over sensitive data, eliminate reliance on foreign cloud services, and mitigate sanctions-related risks—advantages that often outweigh the platform's current technical limitations.

6. Recommendations

Architectural patterns: Provider-aware abstraction layers with fallback mechanisms; comprehensive preprocessing pipelines; retrieval-augmented generation; human-in-the-loop workflows for high-stakes applications.

Testing strategies: Static analysis integration for generated code; adversarial edge-case testing; multi-turn dialogue evaluation for extended interactions.

Strategic considerations: Align applications with demonstrated domain strengths (healthcare, enterprise operations); account for geopolitical risk in long-term roadmaps; budget for integration complexity that exceeds initial estimates.

7. Conclusion

GigaChat-powered agents deliver measurable value when appropriately scoped—healthcare assistants achieving 93% accuracy, operational documentation costs reduced by 98%. Success, however, requires a clear-eyed assessment of integration inconsistencies, the tuning paradox, hidden technical deficiencies, and

geopolitical factors. When systematically addressed through sound architecture and rigorous testing, the platform's strengths can be leveraged while its limitations are contained, offering Russian enterprises a viable path toward AI-driven transformation with full data sovereignty.

REFERENCES

1. LiteLLM GitHub Issue #19625: "Add support for tool_choice='required' in GigaChat." January 2026.
2. Hugging Face Discussion: "DevQuasar/ai-sage.GigaChat3-702B-A36B-preview-bf16-GGUF." November 2025.
3. Lenta.ru: "На AI Journey представили решение Giga Agentic RPA на основе GigaChat." November 2025.
4. Devpost: "Codetinel - GigaCHAT - 2" project documentation. November 2024.
5. IT Brief Australia: "GigaChat AI assistant achieves 93% accuracy in medical diagnoses." August 2025.
6. CSDN Blog: "GigaChat 项目中的流式输出问题分析与解决方案." June 2025.
7. Apple App Store: "Gigachat: Chatbot AI Assistant" user ratings and reviews.
8. HSE University Master's Thesis: "Development of an AI Assistant for Analyzing Incidents in PostgreSQL Database Management System in a Large Financial Organization." 2025.
9. PVS-Studio: "Stumbling block for AI: UTF-8." October 2025.
10. Business Insider: "While the US and China compete for AI dominance, Russia's leading model lags behind." February 2025.

KEY CHALLENGES IN THE DIGITAL TRANSFORMATION OF EDUCATION

METAVERSES AS AN EMERGING SPACE FOR IMMERSIVE EDUCATIONAL PRACTICES

A. V. Adarchenko

Research advisor: I. G. Rzun, Cand. Sc. (Phys.-Math.)

Novorossiysk, *Novorossiysk Branch of the Financial University under the Government of the Russian Federation*,
polinaadarchenko@gmail.com

Abstract. The article is dedicated to metaverses as an innovative space for immersive educational practices. It analyzes the integration of VR and AR in education beyond the distance learning format: new models enhance the engagement of remote learners and the inclusion of individuals with disabilities through virtual avatars. The article examines platforms such as Spatial and Frame.io, the BPMN algorithm for interaction, UML for lesson development, and the perspectives of educators and students.

Keywords: metaverses, virtual reality, augmented reality, immersive education, inclusive learning, BPMN, UML.

МЕТАВСЕЛЕННЫЕ КАК НОВОЕ ПРОСТРАНСТВО ДЛЯ ИММЕРСИВНЫХ ОБРАЗОВАТЕЛЬНЫХ ПРАКТИК

А. В. Адарченко

Аннотация. Статья посвящена метавселенной как инновационному пространству для иммерсивных образовательных практик. В ней анализируется интеграция виртуальной реальности и дополненной реальности в образовании за пределами формата дистанционного обучения: новые модели повышают вовлеченность удаленных учащихся и людей с ограниченными возможностями с помощью виртуальных аватаров.

В статье рассматриваются такие платформы, как Spatial и Frame.io, алгоритм взаимодействия BPMN, UML для разработки уроков, а также перспективы преподавателей и учащихся.

Ключевые слова: метавселенные, виртуальная реальность, дополненная реальность, иммерсивное образование, инклюзивное обучение, BPMN, UML.

Modern education is undergoing a radical transformation under the influence of digital technologies, where metaverses form a fundamentally new environment for immersive interaction. While traditional distance learning (Yandex Teleconference, Moodle, and similar platforms) is limited to video broadcasts and static materials, metaverses offer immersive environments where students "immerse themselves" in virtual space through avatars, sensing presence and interacting in real time.

These technologies provide visualization of abstract concepts and modeling of complex processes that are inaccessible to direct observation. VR and AR make it possible to create unique learning environments where abstract concepts become visual, and complex processes are accessible for direct study [1,2]. This approach fundamentally changes the didactic possibilities of the educational process. The advantage of immersive technologies is the ability to create controlled multi-level scenarios with adaptation to the individual needs of students. As well as the development of specific algorithms for teachers aimed at overcoming the cognitive and physical limitations of students.

Virtual and augmented reality technologies are able to reproduce authentic classrooms for classes, include all students and teachers in the process (connecting remotely), place the necessary equipment in the workplace and create a comprehensive learning atmosphere [3,4]. Platforms like Spatial and Frame.io They implement a mixed reality model where digital objects are superimposed on the user's physical environment.

According to the qualitative research "Informant No. 11", immersive technologies increase the efficiency of perception and reproduction of educational material by up to 30% due to emotional involvement and strengthening of neurocognitive connections [5, p. 125]. These empirical data provide the basis for dynamic adaptation of educational scenarios and subsequent optimization of pedagogical techniques in real time.

Virtual avatars in educational metaverses compensate for the limitations of geographical distance by simulating physical presence. On platforms like Spatial and Frame.io Avatars transmit non-verbal communication signals: gestures, gaze direction, postures. This creates an effect of participation in the learning process,

close to face-to-face interaction. Personalization of avatars with adaptive interfaces removes barriers for students with disabilities. The platforms integrate customization tools: the choice of interaction modalities, the adjustment of sensory parameters, and alternative navigation methods. For example, deaf students use avatars with automated sign language translation, while students with cerebral palsy use voice control of environmental elements. Such solutions ensure equal access to educational content without physical restrictions.

The Spatial platform provides the creation of interactive 3D environments for collective learning with support for avatar-oriented interaction and cross-platform access, allowing lectures and group discussions with up to 50 users. Frame.io specializes in collaboration with media content, providing tools for synchronized video viewing and annotation, which is optimal for project activities in creative disciplines.

Both platforms support the personalization of learning: Spatial adapts virtual spaces to pedagogical purposes through the customization of templates, and Frame.io It provides individual work environments with role-based access, which determines their use depending on the specifics of educational tasks.

The use of UML methodology for modeling educational processes in metaverses provides a formalization of interaction between teachers, students and the platform. The UML diagram details the aspects of communication between the teacher, the student and the platform (fig.1).

The UML sequence diagram details the architecture of role models, algorithmizing scenarios of educational interaction. This approach standardizes educational practices, increasing the predictability and reproducibility of pedagogical scenarios in an immersive environment. This is especially true for inclusive educational environments, where interfaces need to be adapted to the needs of students with disabilities. The formalization of structural aspects contributed to the creation of a stable foundation for scaling educational metaverses.

Immersive platforms contribute to the formation of an inclusive educational environment through the use of virtual avatars and adaptive interfaces that provide equal access for remote students and people with disabilities [6, p.94]. However, the implementation of these technologies faces significant technical difficulties, including compatibility issues with existing platforms such as Spatial and Frame.io . Methodological challenges are related to the need to adapt educational methods to the features of virtual spaces, which requires a revision of traditional approaches to pedagogical design.

As a result, the integration of VR/AR into educational metaverses has proven effective in overcoming the limitations of traditional distance learning. Immersive

environments with virtual avatars ensure high student engagement by simulating social presence, which is especially important for remote groups and people with disabilities, helping to level physical and communication barriers.

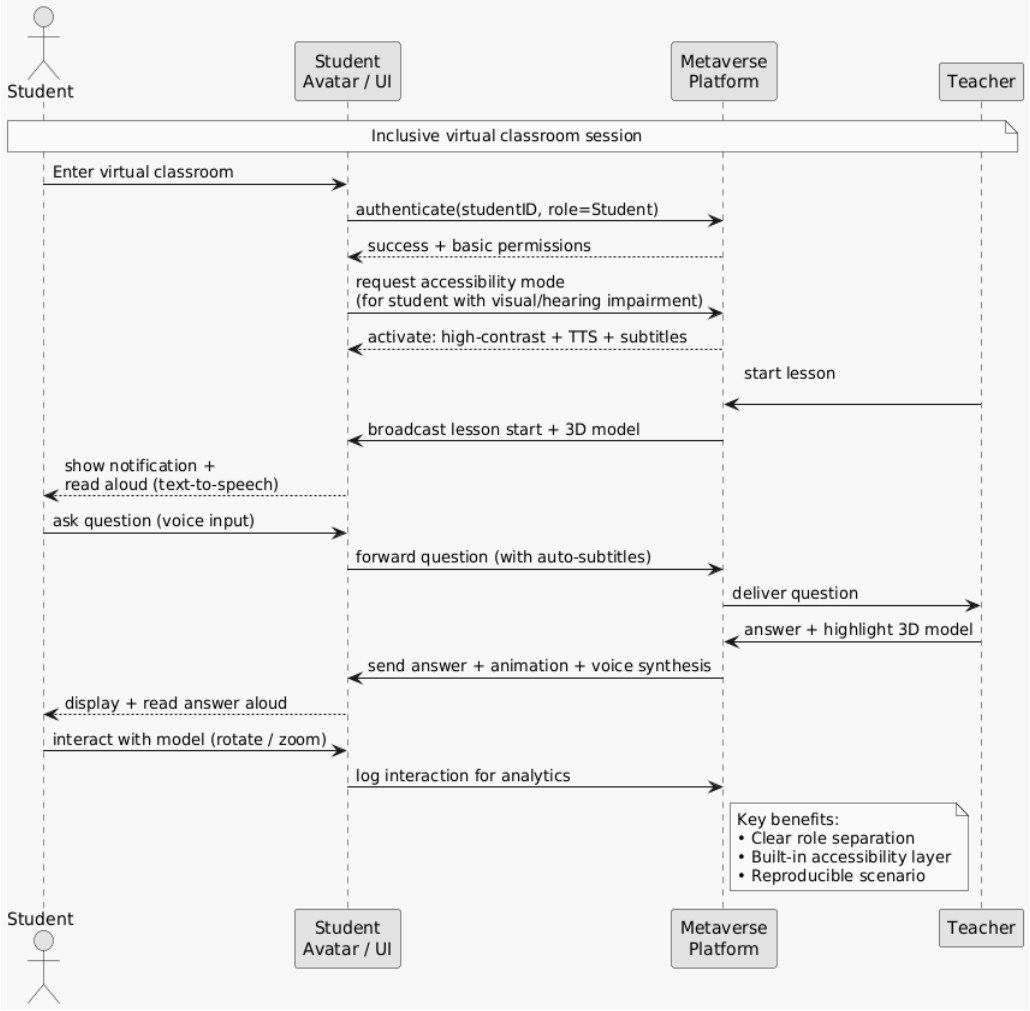


Figure 1. UML diagram of the sequence of educational interaction in the metaverse (https://editor.plantuml.com/)

Analysis of Spatial platforms and Frame.io I have identified their potential to create inclusive spaces where avatars act as a tool for personalizing learning. The algorithms developed on the basis of UML formalize the interaction in the "teacher-student-platform" triad, optimizing content management and feedback, which creates a methodological basis for scaling immersive practices.

The versatility of the proposed models makes it possible to eliminate geographical constraints through adaptive mechanisms, ensuring equal access conditions for students with disabilities through customization of interfaces. Development prospects require refinement of technological platforms (optimization of interfaces, integration of AI for personalization), transformation of pedagogical methods in the framework of blended learning, as well as interdisciplinary research at the intersection of computer science, pedagogical design and psychology of perception.

REFERENCES

1. Davydova D., Kurganov A. A., Lyapunov V. E. et al. (2023) Primenenie immersivnykh tekhnologii v obrazovatel'nom protsesse vuza [Application of immersive technologies in the educational process of a university]. Intellectual Technologies on Transport, 2, 41-49 (in Russian).

2. Sokolovskaya E. V. (2025) Tsifrovye immersivnye sredy: izmenenie vospriiatiia i novye formy sub#ektnosti v sovremennoi kul'ture [Digital immersive environments: changing perception and new forms of subjectivity in modern culture]. Rossiiskie Issledovaniia. Kul'tura i Obshchestvo [Russian Studies. Culture and Society], 3, 101-122 (in Russian).

3. Matveeva V. A., Zaslavskaia O. Iu. (2024) Vozmozhnosti primeneniia immersivnogo obucheniia na osnove abstraktnykh vysokoformalizovannykh matematicheskikh modelei dlia podgotovki budushchikh uchitelei matematiki [Possibilities of applying immersive learning based on abstract highly formalized mathematical models for training future mathematics teachers]. Vestnik Rossiiskogo Universiteta Druzhby Narodov. Seriia: Informatizatsiia Obrazovaniia [Bulletin of the Peoples' Friendship University of Russia. Series: Informatization of Education], 4, 488-500 (in Russian).

4. Razumnova E. A. (2025) Ispol'zovanie virtual'noi i dopolnennoi real'nosti v prepodavanii inzhenernoi grafiki: pedagogicheskii aspekt [Use of virtual and augmented reality in teaching engineering graphics: pedagogical aspect]. Sovremennaia Nauka: Aktual'nye Problemy Teorii i Praktiki. Seriia: Gumanitarnye Nauki [Modern Science: Actual Problems of Theory and Practice. Series: Humanitarian Sciences], 7, 147-150 (in Russian).

5. Ananin D. P., Suvirova, A. Iu. (2024) Immersivnye tekhnologii v obrazovatel'noi praktike rossiiskoi vysshei shkoly [Immersive technologies in the educational practice of Russian higher education]. Vysshee Obrazovanie v Rossii [Higher Education in Russia], 5, 112-135 (in Russian).

6. Makhmudova S. M., Zenkevich I. V. (2020) Inkliuzivnoe obrazovanie v usloviiakh tsifrovizatsii uchebnoi deiatel'nosti [Inclusive education in the context of digitalization of educational activities]. Iazyk i Tekst [Language and Text], 4, 92-98 (in Russian).

7. Koroleva Iu. A. (2023) Tsifrovye navyki podrostkov s ogranichennymi vozmozhnostiami zdorov'ia kak uslovie ikh sotsializatsii [Digital skills of adolescents with

disabilities as a condition for their socialization]. Vestnik Tverskogo Gosudarstvennogo Universiteta. Seriia «Pedagogika i Psikhologiia» [Bulletin of Tver State University. Series "Pedagogy and Psychology"], 3, 130-134 (in Russian).

8. Ovsyannikova A. V. (2025) Tsifrovaia transformatsiia obrazovaniia: kliuchevye draivery, bar'ery i perspektivy razvitiia [Digital transformation of education: key drivers, barriers and development prospects]. Mir Nauki. Pedagogika i Psikhologiia [World of Science. Pedagogy and Psychology], 3, 1-5 (in Russian).

DIGITAL TUTOR IN FOREIGN LANGUAGE EDUCATION FOR FUTURE RAILWAY TRANSPORT ENGINEERS

[1]Ganzorig Gandavaa, [2]E. N. Gvozdeva

[1]Ulaanbaatar, Mongolia, [2]Zabaikal Railway Transport Institute,
gwelena@mail.ru

Abstract. The article examines the problem of individualizing foreign language (FL) instruction in a technical university, given the limited number of classroom hours and varying levels of student proficiency. The aim of the research is to substantiate the methodological effectiveness of using artificial intelligence (AI)-powered chatbots as personal tutors to form adaptive learning path for studying profession-oriented foreign languages for future railway engineers. Based on an analysis of the current capabilities of generative AI, a three-level model for integrating an AI tutor into the educational process is proposed. The model includes diagnostic, procedural, and reflexive stages, focused on developing language skills within the context of the railway industry.

Keywords: artificial intelligence, chatbot, tutor, individual learning path, Language for Specific Purposes (LSP), engineering education, railway transport.

ЦИФРОВОЙ ТЬЮТОР В ИНОЯЗЫЧНОМ ОБРАЗОВАНИИ БУДУЩИХ ИНЖЕНЕРОВ ЖЕЛЕЗНОДОРОЖНОГО ТРАНСПОРТА

Ганзориг Гандаваа, Е. Н. Гвоздева

Аннотация. В статье рассматривается проблема индивидуализации обучения иностранному языку (ИЯ) в техническом вузе в условиях ограниченного количества аудиторных часов и разного уровня подготовки студентов. Цель исследования – обосновать методическую эффективность применения чат-ботов на базе искусственного интеллекта (ИИ) в качестве персональных тьюторов

для формирования адаптивных траекторий изучения профессионально-ориентированного иностранного языка будущими инженерами-железнодорожниками. На основе анализа современных возможностей генеративного ИИ предлагается трехуровневая модель интеграции ИИ-тьютора в образовательный процесс. Модель включает диагностический, процессуальный и рефлексивный этапы, направленные на развитие языковых навыков в контексте железнодорожной отрасли.

Ключевые слова: искусственный интеллект, чат-бот, тьютор, индивидуальная траектория обучения, иностранный язык, инженерное образование, железнодорожный транспорт.

Modern engineering education, particularly the training of specialists for the high-tech and internationalized railway industry, places increased demands on the level of foreign language proficiency. Future engineers must be capable of working with technical documentation, participating in international projects, and interacting with foreign colleagues and equipment manufacturers. However, the traditional system of FL instruction in a non-linguistic university faces several contradictions. The mass nature of instruction does not align with the individual needs of specific students. Furthermore, the limited number of classroom hours contradicts the larger volume of knowledge and skills required for mastery, a situation compounded by the need to master highly specialized terminology alongside general language.

The authors of the article believe that one way out of this situation is the personalization of learning through the construction of individual educational trajectories (IET). This primarily refers to a tutor approach, which is quite difficult to implement fully due to economic and staffing constraints. In this context, artificial intelligence technologies, especially new-generation dialogue systems (chatbots) capable of understanding natural language and generating contextually relevant responses, open up new opportunities for optimizing the process of teaching foreign languages.

The aim of this article is to develop and theoretically substantiate a model for using an AI chatbot in the role of a tutor for forming and supporting an individual trajectory for studying a profession-oriented foreign language by students of railway specialties.

The concept of tutoring implies that an educator accompanies the learner, identifying their interests, resources, analyzing deficits, and designing their individual educational trajectory based on this. The problem of tutoring is actively researched in Russian science: tutoring in the Russian system of education [1; 10], the functioning of a tutor in distance education systems [9], the basics of support in general education [3; 4; 8], the application of tutor technologies for monitoring the

quality of learning in high school students [6], and tutoring from the perspective of the competence-based approach [5; 7].

The key functions of a tutor are: diagnostic, design, implementation, and analytical [2]. The diagnostic function involves identifying the learner's interests, abilities, and information perception characteristics. The design function is expressed in selecting methods and tools to solve the student's problems, and developing a plan for further development considering their wishes, capabilities, and inclinations. The implementation function deals with assistance in defining goals, choosing a learning vector, organizational matters, and support when difficulties arise. The analytical function serves the task of regularly comparing the initial plan with actual results, evaluating the methods and means used to achieve set goals, and adjusting the approach if necessary.

These listed functions and the associated tasks of tutoring in education are also applicable in the higher education system, including in the process of teaching students a foreign language. Moreover, modern AI models are capable of automating or enhancing parts of these functions. AI models offer adaptability, i.e., the ability to analyze input data (user responses, queries, errors) and adjust the complexity, topic, and format of subsequent interactions. They involve contextual understanding and generation, implying the possibility of working within a given subject area (in our case, railway transport), creating dialogues, texts, and exercises simulating professional situations. Constant availability – round-the-clock access for each student – should also be noted, as it creates conditions for forming a language environment.

It is important to remember that an AI tutor does not replace the teacher but becomes a digital assistant, taking over some operations: vocabulary training, practicing grammatical structures in context, supporting dialogue practice, and initial error analysis. This allows the educator to focus on complex methodological tasks: designing scenarios, developing soft skills (e.g., intercultural communication in a professional environment), and in-depth work on the most problematic aspects.

The formation of an individual educational trajectory (IET) depends on the target competencies; therefore, the language profile of a future railway transport engineer can be structured according to the following blocks:

Lexical-terminological: involving knowledge of foreign language terminology in the professional field (e.g., in the areas of track structure, train traction, signaling and interlocking systems, traffic management, logistics, safety);

Genre-communicative: i.e., the ability to work with specific text types (technical data sheets, operating instructions, trouble reports, test protocols, project presentations, business correspondence, etc.);

Situational-role-based: reflecting the ability to communicate in simulated professional situations (communication with a dispatcher, consultation with a technical specialist from a manufacturing company, presenting at an international conference, briefing foreign colleagues).

Consequently, the AI tutor must be "configured" (through prompts and examples) to work specifically with this content, providing students with learning materials relevant to their future profession.

The authors propose a three-level model of an AI tutor for forming an individual trajectory for learning a foreign language by students of a railway university, representing a cyclical process of interaction between the student, the AI tutor, and the teacher.

Level 1. Diagnostic-Design Stage.

Role of AI: Conducting entrance testing not only of the general language level but also of professional orientation. Through a series of questions and tasks (e.g., "Describe the operating principle of a brake system," "Translate a paragraph from a technical manual"), the chatbot identifies strengths and weaknesses, as well as the student's professional interests.

Role of the Teacher: Based on the report from the AI system for the group and their own observations, the teacher approves the key IET goals for each student and sets the overall professional theme.

Result: The outcome of this stage is a formed digital profile of the student, determining the starting point and key vectors of the trajectory.

Level 2. Procedural-Adaptive Stage (*main learning phase*).

Role of AI:

Personalized material delivery: Creating micro-lessons, dialogues, and reading texts on topics relevant to a specific student (e.g., for a power supply specialist – texts about the contact network).

Contextual practice: Practicing grammar using examples from professional vocabulary (e.g., not just the passive voice, but "The faulty component was identified by the diagnostic system").

Dialogue simulation: Role-plays where the bot acts as a colleague, client, or dispatcher (scenarios: discussing repair schedules, clarifying equipment technical specifications).

Intelligent feedback: Commenting on the student's written and oral responses, focusing on errors and offering suggestions for improvement.

Role of the Student: Active interaction with the bot according to the individual plan, completing suggested tasks, initiating dialogues on professional topics of interest.

Role of the Teacher: Monitoring progress via an analytics dashboard (where data on time, topics, and task success is collected), conducting in-person sessions for in-depth work on complex topics, correcting the trajectory as needed.

Level 3. Reflexive-Evaluative Stage.

Role of AI: Conducting formative assessment – short check-up tasks on completed modules; creating a final progress report: vocabulary acquired, grammar topics practiced, activity in dialogues.

Role of the Student and Teacher: Joint analysis of the AI report, reflection on achieved results and difficulties encountered. Based on this analysis, goals for the next learning cycle are set, closing the feedback loop and ensuring the continuous development of the IET.

Implementing this model in a real educational process requires, first and foremost, the development of a library of prompts (instructions for AI) focused on railway topics and pedagogical scenarios. Furthermore, some preparation of students and teachers for effective interaction with AI (prompt engineering for educational purposes) is necessary, as well as integrating the tool not as entertainment but as a mandatory component of the curriculum, with specific tasks allocated.

Undoubtedly, using an AI tutor entails certain risks, such as the possibility of generating inaccurate or false information, especially on complex technical issues. Therefore, it is necessary to perceive the bot as a tool for language practice, not as a source of absolute technical knowledge, and to critically verify information. Digital inequality should also be considered, as there may be varying levels of digital literacy and access to technology.

Conclusion. The integration of AI chatbots in the role of a tutor into the foreign language educational process for future railway engineers represents an effective response to the challenges of individualizing and professionalizing instruction. The proposed three-level model positions AI not as a replacement for the teacher but as a powerful tool for tutor support, taking on tasks of adaptive training, context-dependent practice, and prompt feedback. This allows for the creation of a unique educational environment for each student, as closely aligned as possible with their future professional reality. The individual trajectory formed in this way becomes flexible, relevant, and results-oriented, which ultimately improves the quality of language training for engineering personnel in the modern, globally integrated railway industry. Further research should be directed towards empirical testing of this model's effectiveness and the development of specific methodologies for various engineering specializations.

REFERENCES

1. Gluzman N.A. T'yutorstvo kak sovremennaya model' pedagogicheskoy professii // Problemy sovremennogo pedagogicheskogo obrazovaniya. 2022. №74-2. URL: https://cyberleninka.ru/article/n/tyutorstvo-kak-sovremennaya-model-pedagogicheskoy-professii (data obrashcheniya: 19.02.2026). [Gluzman, N.A. Tutoring as a Modern Model of the Teaching Profession // Problems of Modern Pedagogical Education. 2022. No. 74-2. URL: https://cyberleninka.ru/article/n/tyutorstvo-kak-sovremennaya-model-pedagogicheskoy-professii (date accessed: 19.02.2026).] in Russian

2. Godwin-Jones R. Emerging spaces for language learning: AI bots, ambient intelligence, and the metaverse. Language Learning & Technology. 2023. № 27(2). P. 6–27. URL: https://hdl.handle.net/10125/73501 (date of access: 25.07.2023).

3. Kovaleva T.M. - Otkrytoe obrazovanie i sovremennye t'yutorskie praktiki // T'yutorstvo: kontseptsii, tekhnologii, opyt. Yubileynyy sbornik, posvyashchennyy 10-letiyu t'yutorskikh konferentsiy. 1996-2005.- Tomsk, 2005 [Kovaleva, T.M. - Open Education and Modern Tutoring Practices // Tutoring: Concepts, Technologies, Experience. Anniversary collection dedicated to the 10th anniversary of tutoring conferences. 1996-2005.- Tomsk, 2005] in Russian

4. Kovaleva T.M. Oformlenie novoy professii t'yutora v rossiyskom obrazovanii / T.M. Kovaleva // Voprosy obrazovaniya. - 2011. - №2. - S. 163-180 [Kovaleva, T.M. The Formation of the New Tutor Profession in Russian Education / T.M. Kovaleva // Educational Studies. - 2011. - No. 2. - pp. 163-180.] in Russian

5. Latyshev A.S. Kompetentnostnaya model' t'yutora - razrabotka i realizatsiya v sovremennom rossiyskom universitete / A.S. Latyshev // Vestnik Omskogo universiteta. Seriya «Ekonomika». - 2020. - T. 18. - № 1 - S. 99-110 [Latyshev, A.S. The Tutor's Competence Model - Development and Implementation in a Modern Russian University / A.S. Latyshev // Bulletin of Omsk University. "Economics" Series. - 2020. - Vol. 18. - No. 1 - pp. 99-110] in Russian

6. Lyakh Yu.A. Razvivayushchiy potentsial t'yutorskikh tekhnologiy v sisteme obucheniya starshikh shkol'nikov // Obrazovanie i nauka. 2013. №10. URL: https://cyberleninka.ru/article/n/razvivayuschiy-potentsial-tyutorskih-tehnologiy-v-sisteme-obucheniya-starshih-shkolnikov (data obrashcheniya: 12.02.2026). [Lyakh, Yu.A. The Developmental Potential of Tutor Technologies in the System of Teaching Senior School Students // Education and Science. 2013. No. 10. URL: https://cyberleninka.ru/article/n/razvivayuschiy-potentsial-tyutorskih-tehnologiy-v-sisteme-obucheniya-starshih-shkolnikov (date of access: 12.02.2026)] in Russian

7. Romanov V.A. Nastavnichestvo kak protsess razvitiya kompetentnogo pedagoga / V.A. Romanov // Realizatsiya kompetentnostnogo podkhoda v sisteme professional'nogo obrazovaniya pedagoga: sbornik materialov VII Vserossiyskoy nauchno-prakticheskoy konferentsii. - 2020. - S. 100-110 [Romanov, V.A. Mentoring as a Process of Developing a Competent Teacher / V.A. Romanov // Implementation of the Competence-Based Approach in the System of Professional Teacher Education: collection of materials of the VII All-Russian Scientific and Practical Conference. - 2020. - pp. 100-110] in Russian

8. Stanovlenie t'yutorskoy modeli sovremennogo universiteta v Rossii: kollektivnaya monografiya / [T.M. Kovaleva i dr.]; pod nauch. red. T.M. Kovalevoy. - Tomsk: Izdatel'skiy Dom Tomskogo gosudarstvennogo universiteta, 2019. - 256 s. [The Formation of the Tutor Model of a Modern University in Russia: collective monograph / [T.M. Kovaleva et al.]; scientific editorship by T.M. Kovaleva. - Tomsk: Tomsk State University Publishing House, 2019. - 256 p] in Russian

9. Timokhina T.V. Obuchenie osnovam t'yutorstva v sovremennom sotsial'no-pedagogicheskom obrazovanii / T.V. Timokhina // Sotsial'naya pedagogika. - 2018. - №4. - S. 32-38. [Timokhina, T.V. Teaching the Basics of Tutoring in Modern Socio-Pedagogical Education / T.V. Timokhina // Social Pedagogy. - 2018. - No. 4. - pp. 32-38.] in Russian

10. Verevkina, I.N. T'yutorstvo v sisteme obrazovaniya: opyt Rossii / I.N. Verevkina // Molodoy uchenyy. - 2019. -№ 21 (259). - S. 492-493 [Verevkina, I.N. Tutoring in the Education System: The Experience of Russia / I.N. Verevkina // Young Scientist. - 2019. - No. 21 (259). - pp. 492-493.] in Russian

DIGITALIZATION AND TRANSFORMATION OF EDUCATIONAL STRUCTURES: TECHNOLOGICAL POTENTIAL, PEDAGOGICAL LIMITATIONS, AND MEDICAL AND BIOLOGICAL ASPECTS

[1]L.S. Dragunova, E.V. [2] Dragunova

[1]*Novosibirsk, Novosibirsk State Technical University,*
[2]*Novosibirsk, Novosibirsk, Siberian University of Consumer Cooperatives*

Abstract. The article is devoted to a comprehensive analysis of the digitalization processes in the continuing education system. Based on current statistics from the EdTech market for 2024-2026, the article examines the effectiveness of key technologies (artificial intelligence, VR/AR, LMS, and microlearning) depending on the type of educational activity. Special emphasis is placed on the practical application of digital tools across different types of pedagogical activities, as well as on the medical and biological risks associated with digital transformation.

Keywords: digitalization of higher education, digital technologies, hybrid learning, and digital hygiene.

ЦИФРОВИЗАЦИЯ И ТРАНСФОРМАЦИЯ ОБРАЗОВАТЕЛЬНЫХ СТРУКТУР: ТЕХНОЛОГИЧЕСКИЙ ПОТЕНЦИАЛ, ПЕДАГОГИЧЕСКИЕ ОГРАНИЧЕНИЯ И МЕДИКО-БИОЛОГИЧЕСКИЕ АСПЕКТЫ

Л. С. Драгунова, Е. В. Драгунова

Аннотация: Статья посвящена комплексному анализу процессов цифровизации в системе непрерывного образования. На основе актуальных статистических данных рынка EdTech за 2024–2026 гг. исследуется эффективность ключевых технологий (искусственный интеллект, VR/AR, LMS, микрообучение) в зависимости от типа образовательной активности. Особый акцент сделан на практическом применении цифровых инструментов по видам педагогических активностей и медико-биологических рисках цифровой трансформации.

Ключевые слова: цифровизация высшего образования, цифровые технологии, гибридное обучение, цифровая гигиена.

The current stage of development of the global educational landscape is characterized by an unprecedented pace of digital and information technology adoption. The scale of digital transformation is corroborated by forecast statistics. For example, the global digital education market is projected to reach USD 222.32 billion by 2035, with a compound annual growth rate (CAGR) of 22.38%. Similarly, the LMS-system market is expected to amount to USD 70.83 billion by 2030, with a CAGR of 19.9%. [1, 2].

The relevance of this study stems from the need to objectively assess the effectiveness of the digital tools in use, identify their limitations, and analyze their impact on students' health, which is critical for developing a sustainable educational ecosystem.

An analysis of the technological landscape allows us to identify a set of key digital tools that determine the vector of transformation. Learning Management Systems (LMS) have become the basic infrastructure: in 2024, North America accounted for over 36% of the global LMS market, while institutional implementation in higher education exceeds 95% in a number of regions [3]. They are most effective for administering the educational process, storing materials, and delivering standardized tests.

Artificial intelligence and machine learning represent the next stage of evolution. On Coursera, 40% of top courses are devoted to AI skills, which generated around 3 million enrollments in AI courses in 2024. Studies indicate that AI tools contribute to improved academic performance, motivation, and students' self-efficacy [4].

In the corporate sector, AI is used to forecast skill needs and to match employees with personalized reskilling programs.

The VR market in education is projected to reach approximately USD 65.55 billion by 2032, with a CAGR of 18.2%. VR and AR technologies are most effective in situations where practical skills are required [5 - 7]. In medical schools and engineering faculties, VR simulators allow students to rehearse surgical procedures or work with complex equipment without risk to life. Technology adoption statistics reveal significant differences among segments. In corporate training, microlearning (short modules of 3-10 minutes) demonstrates completion rates of 70-80% versus about 20% for traditional long-form courses and increases knowledge retention by 22-50% [8, 9].

Mobile learning is gaining momentum; however, technology penetration in the academic sector remains uneven. According to PISA 2022, students who use digital devices for learning 1–5 hours per day show better educational results than those who do not use them at all [10].

Despite these obvious benefits, the introduction of digital technologies is associated with a number of significant pedagogical and organizational limitations. The first barrier is digital inequality, manifested both in unequal access to high-speed internet and modern equipment, as well as disparities in digital literacy among teachers and students. According to UNESCO, approximately 2.6 billion people still remain without access to the internet [11].

The second limitation is the constrained development of soft skills in an all-digital environment. The third concern involves knowledge validation and academic integrity: online proctoring technologies cannot always completely eliminate cheating or the use of unauthorized resources, which undermines confidence in distance-learning certificates, particularly in the continuing professional education (CPE). Additionally, persistent information overload and multitasking may increase the risk of cognitive overload, which reduces the depth of learning and processing.

In the context of digital transformation, particular attention should be paid to medico-biological factors and to the impact of technologies on the students' health across different age and gender groups. Increased screen exposure has been associated with a growing prevalence of computer vision syndrome (CVS). A systematic review and meta-analysis of studies reported that the overall CVS prevalence of 69.0%, reaching 76.1% among university students; prevalence was also higher in women than in men (71.4% vs 61.8%) [12].

The musculoskeletal system may also be adversely affected due to prolonged static posture and non-ergonomic workplace setup. Students' psycho-emotional condition is another critical risk area. Digital fatigue, or " zoom fatigue," arises from

the need to maintain sustained attention during videoconferencing. Studies demonstrate that women report higher levels of videoconferencing fatigue than men, which is partly explained by mechanisms of nonverbal communication and self-view on screen [13, 14].

In the digitalization of education, age-related differences must be taken into account. Adolescents appear particularly vulnerable to the development of digital-use addictions, which may present as decreased sleep duration and a shift in bedtime, potentially affecting overall mental health [15].

Adult students in CPE and corporate sector often face reduced adaptability to new interfaces and the need to acquire new skills rapidly. Across all age groups, evening device use may disrupt circadian rhythms and adversely affect sleep quality.

Importantly, the health impact of digitalization is not inevitable; it can be managed through regulation and pedagogical design. Health guidance commonly recommends limiting continuous screen work, alternating it with breaks and physical activity; however, in the context of intensive educational programs, these recommendations are often not followed.

In the corporate sector, leading companies are beginning to implement digital detox policies and mandatory breaks, realizing that employee health is a resource for efficiency. In universities, curricula are increasingly being reconsidered towards blended learning, where online format is used primarily for theoretical knowledge, while in-person class time is devoted to practice and discussion, thereby reduces the overall screen exposure. Technological solutions can serve as health monitoring tool (e.g., posture control apps or eye-exercise reminders) integrated into educational platforms.

In summary, we can say that the digitalization of educational systems is an irreversible and multifaceted process that carries both huge opportunities for access to knowledge and personalization of learning, as well as serious risks for the physical and mental health of participants. The effectiveness of specific technologies directly depends on their pedagogical appropriateness within a given context. Constraints related to the digital divide, a lack of face-to-face interaction, and technical barriers require a comprehensive approach to managing the transformation.

REFERENCES

1. ResearchAndMarkets. (2025). *Digital Education Market Industry Trends and Forecasts Report 2025–2035*. Business Wire. https://www.businesswire.com/news/home/20251013562727/en/

2. Grand View Research. (2024). *Learning Management System* (*LMS*) *Market Size*, *Share & Trends Analysis Report*. https://www.grandviewresearch.com/

3. Research.com. (2026). *51 LMS Statistics*: *2026 Data*, *Trends & Predictions*. https://research.com/education/lms-statistics

4. Systematic Literature Review. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems with Applications*, 254, 124–139. https://doi.org/10.1016/j.eswa.2024.124139

5. Fortune Business Insights. (2024). *Virtual Reality in Education Market Size*, *Share & Industry Analysis*. https://www.fortunebusinessinsights.com/

6. MarketsandMarkets. (2024). *Augmented Reality and Virtual Reality in Education Market by Technology*, *Component*, *Application*, *and Region – Global Forecast to 2029*.

7. Elai.io. (2024). *Microlearning statistics in 2024*. https://elai.io/microlearning-statistics/

8. IMARC Group. (2024). *E-learning Market*: *Global Industry Trends*, *Share*, *Size*, *Growth*, *Opportunity and Forecast 2024–2032*.

9. 7Taps. (2025). *20 Microlearning Statistics to Guide Your Workplace Learning*. https://www.7taps.com/microlearning

10. OECD. (2024). *PISA 2022 Results*: *Using digital resources for learning*. OECD Publishing. https://www.oecd.org/pisa/

11. UNESCO. (2024). *Global Education Monitoring Report 2024*: *Accessibility and effective use of digital technology in education*. Paris: UNESCO. https://www.unesco.org/gem-report/

12. Journal of Optometry. (2023). Prevalence of computer vision syndrome: A systematic review and meta-analysis. *Journal of Optometry*, 16(4), 245–258. https://doi.org/10.1016/j.optom.2023.03.004

13. Faulkner, S. L., & Lull, R. B. (2021). Nonverbal overload: A theoretical argument for the causes of Zoom fatigue. *Technology*, *Mind*, *and Behavior*, 2(1). https://doi.org/10.1037/tmb0000030

14. University of Galway. (2024). *Seeing yourself on Zoom and Teams causes fatigue*. https://www.universityofgalway.ie/

15. World Health Organization. (2024). *Teens, screens and mental health*. WHO Regional Office for Europe. https://www.who.int/europe/news/item/25-09-2024-teens--screens-and-mental-health

SUSTAINABILITY OF WORK CAPACITY OF OLDER EMPLOYEES OF EDUCATIONAL ORGANIZATIONS AS A FACTOR OF SECTORAL STABILITY UNDER DIGITALIZATION AND LABOR SHORTAGE

E. G. Kobeleva, A. A. Borisova

Novosibirsk, *Novosibirsk State Technical University*,
e.g.kobeleva@gmail.com

Abstract. The article examines the sustainability of work capacity among older employees of educational organizations as an economic factor in ensuring sectoral stability under conditions of labor shortage and digitalization. The dependence of

workforce sustainability on the adaptation of working conditions to age-related changes and the growth of cognitive workload is substantiated. Managerial directions aimed at preserving labor potential are proposed.

Keywords: work capacity; labor shortage; digitalization of education; older employees; workforce sustainability; labor market; human capital; personnel management.

УСТОЙЧИВОСТЬ РАБОТОСПОСОБНОСТИ ПОЖИЛЫХ СОТРУДНИКОВ ОБРАЗОВАТЕЛЬНЫХ ОРГАНИЗАЦИЙ КАК ФАКТОР ОТРАСЛЕВОЙ СТАБИЛЬНОСТИ В УСЛОВИЯХ ЦИФРОВИЗАЦИИ И ДЕФИЦИТА КАДРОВ

Е. Г. Кобелева, А. А. Борисова

Аннотация. **В** статье исследуется устойчивость работоспособности пожилых сотрудников образовательных организаций как экономический фактор обеспечения отраслевой стабильности в условиях дефицита кадров и цифровизации. Обоснована зависимость устойчивости трудового потенциала от адаптации условий труда к возрастным изменениям и росту когнитивной нагрузки. Предложены управленческие направления, направленные на сохранение трудового потенциала.

Ключевые слова: работоспособность; дефицит кадров; цифровизация образования; пожилые сотрудники; устойчивость трудового потенциала; рынок труда; человеческий капитал; управление персоналом.

Introduction

The current development of the Russian Federation's education system is occurring amid a structural labor shortage caused by demographic aging. The working-age adult population decreased from 87.8 million in 2010 to 84.7 million by 2023 and is projected to decline further to 80.54 million by 2030. Simultaneously, the number of individuals beyond working age increased from 31.8 million in 2010 to 34.6 million by 2023, accompanied by a decrease in the old-age dependency ratio from 2.68 to 1.96, with a further projected decline to 1.64.

This trend is accompanied by a reduction in the inflow of young professionals into the teaching profession. Under these conditions, the education system exhibits a more pronounced age imbalance than other sectors of the economy. By 2025, the proportion of faculty members over 65 is approaching 27%, while the share of employees under 35 has declined to 13%. From 2017 to 2025, the proportion of young faculty members decreased from 16% to 13%. At the same time, nearly half of

academic staff are aged 50 and older. The average age of faculty exceeds that of the employed population by approximately eight years.

The decline in the economically active population limits the potential for hiring, thereby increasing the importance of preserving the workforce capacity of existing personnel.

Older employees play a particularly significant role in ensuring the stability of educational organizations, as their share in the sector remains high. In a tight labor market, the premature exit of such employees leads to an increased workload for remaining staff, a decline in the quality of educational services, and higher personnel replacement costs. In this context, the sustainability of work capacity among older employees becomes a significant sectoral economic factor.

Digitalization as a Factor Transforming Workload

The digital transformation in education is accompanied by changes in the structure of teachers' professional activities. The increasing use of digital platforms, electronic document management systems, and distance learning formats increases cognitive workload and intensity of information flows.

For older employees, digitalization may serve as an additional factor in professional strain. Age-related changes in sensorimotor and cognitive functions increase sensitivity to work intensification and the complexity of digital interfaces. As a result, there is a risk of reduced sustainability of work capacity, manifested in increased fatigue, decreased productivity, and a higher probability of leaving the profession.

Thus, in the absence of support measures, digitalization may exacerbate workforce instability within educational organizations.

Sustainability of Work Capacity as an Economic Concept

Traditionally, work capacity has been viewed primarily from a physiological or psychophysiological perspective. However, in a labor shortage context, it also constitutes an element of labor supply maintenance and a factor in the stability of the sectoral labor market.

Sustainable work capacity among older employees ensures:

- an extended period of economic activity;
- stabilization of workforce composition;
- reduction of turnover-related costs;
- maintenance of the quality of educational services.

Conversely, a decline in sustained work capacity leads to faster workforce exit. Consequently, work capacity becomes a manageable economic resource upon which the stability of the education system depends.

Organizational and Managerial Approaches for Preserving Work Capacity

In the context of digitalization, maintaining sustainable work capacity requires a shift from reactive support measures to systemic managerial solutions. Priority directions include:

- optimization of the distribution of teaching and administrative workload, taking into account age-related limitations;
- adaptation of the digital environment and interfaces to the capabilities of older employees;
- optimization of work and rest schedules;
- reduction of excessive regulation and information overload;
- development of mentoring programs and initiatives to foster intergenerational interaction.

The implementation of these measures helps reduce functional strain and enhances sustained labor force participation.

Conclusion

Amid labor shortages, the sustainability of work capacity among older employees in educational organizations becomes a factor in sectoral stability. The digitalization of the educational process increases demands on the adaptive capabilities of staff and, in the absence of managerial interventions, may accelerate workforce exit.

The economic rationale for preserving sustainable work capacity is evident in extended working lives, reducing personnel-related costs, and maintaining the quality of educational services. Therefore, the development of organizational and management mechanisms aimed at preserving the work capacity of older employees should be regarded as a strategic priority for the development of the education system under demographic constraints.

ARCHITECTURE AND METHODS OF A RECOMMENDATION SERVICE FOR UNIVERSITY APPLICANTS WHICH MEETS THE REQUIREMENTS OF THE GOSTECH PLATFORM

P. V. Molchanov

Research advisor: D. S. Smirnov, Cand. Sc. (Econ.)

Moscow, National Research Nuclear Univesity Mephi,
elsy1999@yandex.ru

Abstract: This study aims to design the architecture of a recommendation system for selecting educational programs that complies with the regulatory requirements of the Russian Federation, including the regulations of the GosTech unified digital platform. The main goal of the work is to create a methodologically sound solution that provides personalized selection of educational programs in Russian higher education institutions.

Keywords: recommendation service, architecture design, system analysis, collaborative filtering.

АРХИТЕКТУРА И МЕТОДЫ РЕКОМЕНДАТЕЛЬНОГО СЕРВИСА ДЛЯ АБИТУРИЕНТОВ, СООТВЕТСТВУЮЩЕГО ТРЕБОВАНИЯМ ПЛАТФОРМЫ “ГОСТЕХ”

П. В. Молчанов

Аннотация. Данное исследование направлено на проектирование архитектуры рекомендательной системы для выбора образовательных программ, соответствующей нормативно-правовым требованиям Российской Федерации, включая регламенты единой цифровой платформы "ГосТех". Основной целью работы является создание методологически обоснованного решения, обеспечивающего персонализированный подбор образовательных программ в высших учебных заведениях России.

Ключевые слова: рекомендательный сервис, проектирование архитектуры, системный анализ, коллаборативная фильтрация

In the era of digital and information abundance, every product or service has a large number of analogues. It can be very difficult to choose from such a large number of alternatives. Possible ways to solve this problem include consulting with experts, seeking advice from friends, searching for information in literature and on the Internet, and then analyzing the alternatives found. However, all these methods

can be ineffective when there are too many options to choose from. One such situation is choosing an educational program and university to apply to. [9] This is an extremely pressing problem when a student finishes school and chooses a university to attend. In such situations, recommendation systems can come to the rescue.[10] Thanks to various algorithms, they can aggregate information and offer the user the alternative that suits them best. [3] With the global transition to distance learning technologies, their relevance is more evident than ever before. [1, 4, 6]

The recommendation system must comply with Russian Federation Government Resolution No. 2338 dated December 16, 2022 (as amended on April 3, 2024) "On Approval of the Regulations on the Unified Digital Platform of the Russian Federation "GosTech." The system must consider the architectural solutions approved by the interdepartmental working group (clause 18a).

- Use of microservices to ensure flexibility and scalability.
- Ensuring integration with the Unified Identification and Authentication System (ESIA).
- Support for API interfaces for interaction with other GIS.
- As well as methodological recommendations (clause 18b):
- Application of proven machine learning algorithms.
- Use of standard solutions for data processing (in accordance with Federal Law No. 152).
- Ensuring interoperability with the GosTech platform.

The architecture of the recommendation system is designed using c4 notation, which includes the Context, Containers, and Components levels. The resulting diagrams can be seen in Figures 1 and 2.

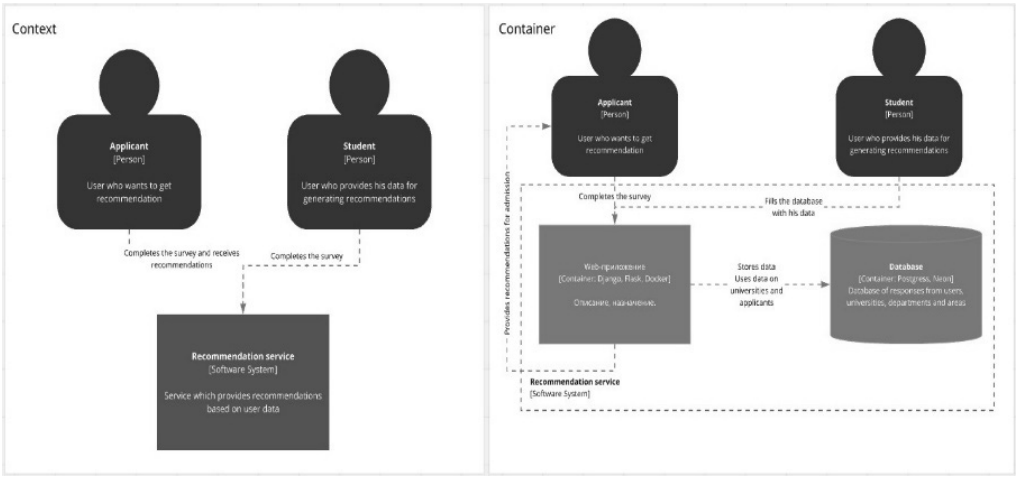


Figure 1. C4-diagram - Context and container of recommendation service

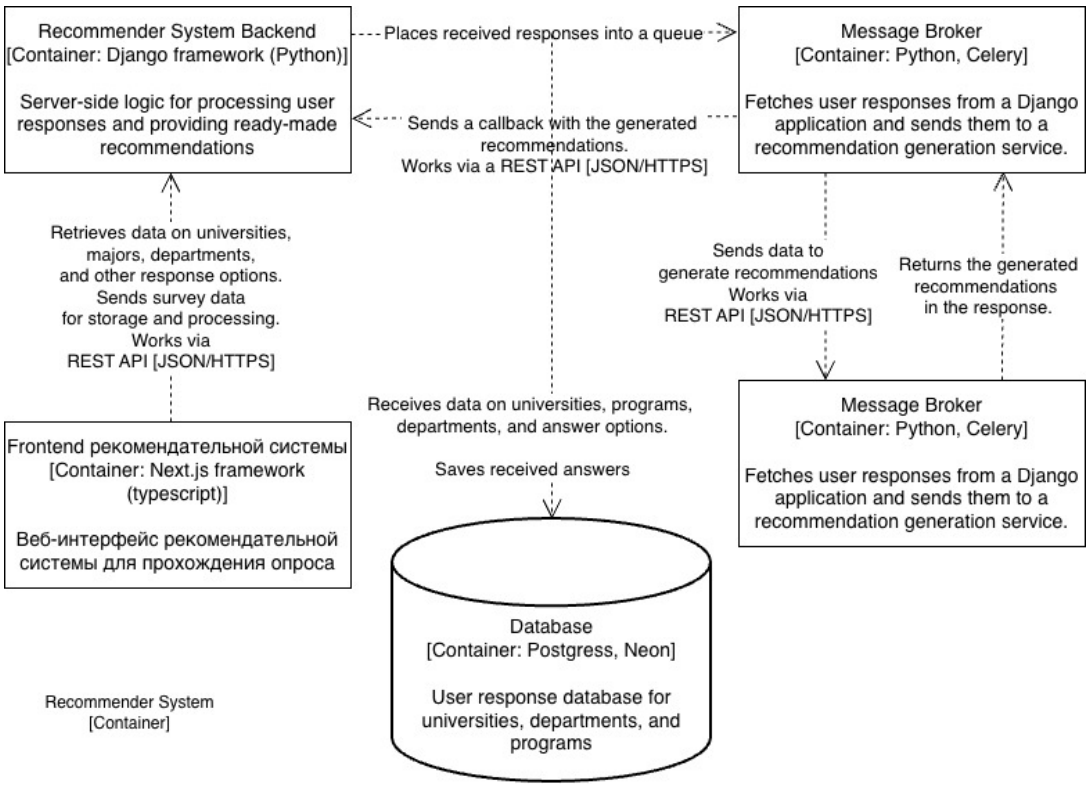


Figure .2 C4 diagram – Components of a recommendation system

The BPMN diagram of the recommendation system is presented in Figure 3.

The system has a microservice architecture that includes a user data processing service, a recommendation generation service, and a queue that implements communication between these services using API interfaces. The system is designed to support integration with various other GIS through REST API. The service supports four recommendation algorithms, each of which is implemented as an independent module:

- CollaborativeFilteringRecommender — implements a user-based collaborative filtering algorithm. The algorithm builds a "user × program" preference matrix and calculates the cosine similarity between user feature vectors to identify similar applicants [3].
- KMeansRecommender — implements the K-means clustering algorithm to segment users based on profile characteristics. The optimal number of clusters is determined automatically using the elbow method and silhouette metric. Recommendations are generated based on the popularity of programs within the user's cluster [5].

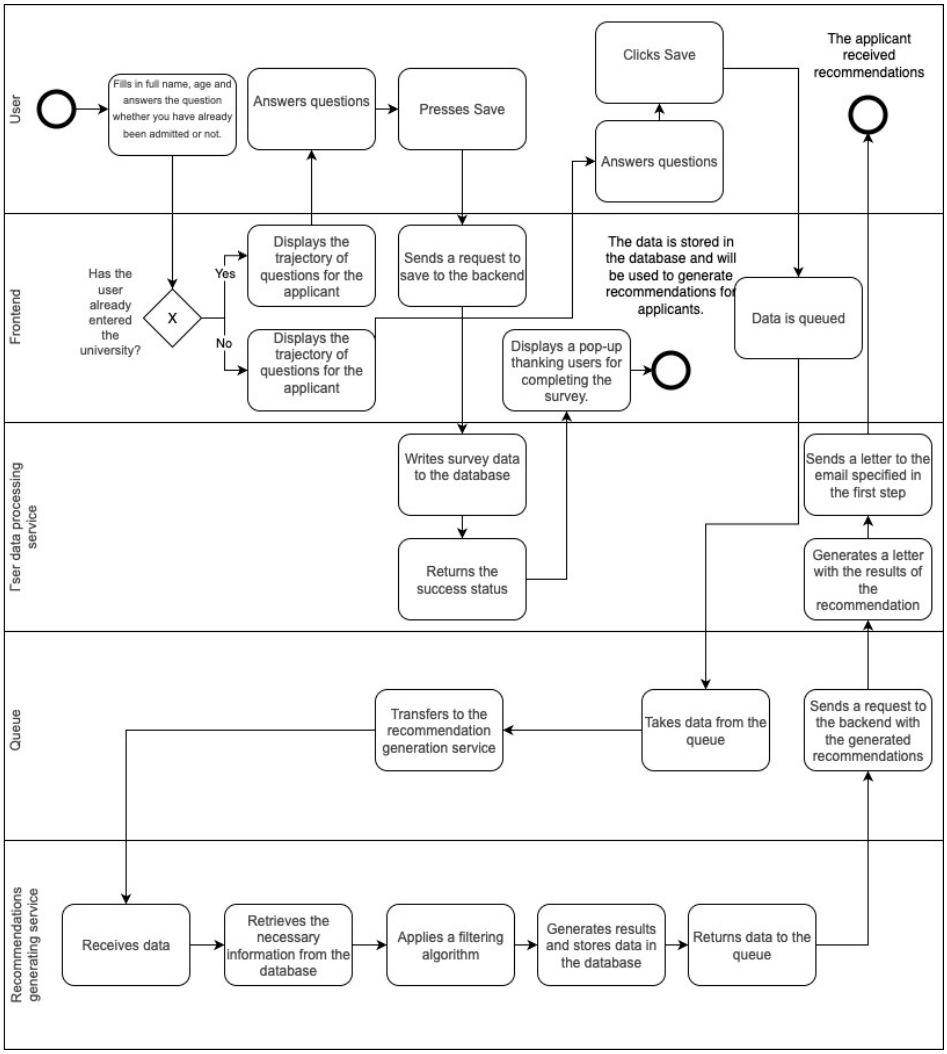


Figure 3. BPMN diagram of the recommendation system

- RandomForestRecommender implements the random forest ensemble method, training a separate regression model for each educational program. Each model is an ensemble of 150 decision trees trained on bootstrap subsamples of data using bagging. The algorithm takes into account nonlinear interactions between user attributes and provides high prediction accuracy [8].
- GNNRecommender implements a graph neural network algorithm to model multi-level relationships in the education system. The algorithm constructs a heterogeneous graph with nodes of the types “user,” “program,” “faculty,” and

"university" and distributes information through a message passing mechanism to generate vector representations of entities [7].

The system provides for the easy integration of an authorization module, which will be implemented through a unified identification and authentication system during further research. The system uses proven algorithms. Data is transferred between system components and stored in the database in an encrypted form. The developed architecture meets modern requirements for security, scalability, and integration into the GosTech ecosystem.

REFERENSES

1. Kedyarova E. A. i dr. Osobennosti psihologicheskoj gotovnosti k EGE u starsheklassnikov //Psihologiya. Psihofiziologiya. – 2021. – T. 14. – №. 2. – S. 38-45. DOI: 10.14529/jpps210204. URL: https://cyberleninka.ru/article/n/osobennosti-psihologicheskoy-gotovnosti-k-ege-u-starsheklassnikov/viewer

2. Ksenofontov V. V. Nejronnye seti //Problemy nauki. – 2020. – №. 11. – S. 59. URL: https://cyberleninka.ru/article/n/neyronnye-seti-1/pdf

3. Mohov A. I., Kislinskij V. G., Aleksejchuk A. S. Razrabotka rekomendatel'noj sistemy na osnove sessij s ispol'zovaniem mnogourovnevoj sistemy otbora kandidatov //Trudy MAI. – 2022. – №. 126. – S. 516-542. DOI: 10.34759/trd-2022-126-20. URL: https://cyberleninka.ru/article/n/razrabotka-rekomendatelnoy-sistemy-na-osnove-sessiy-s-ispolzovaniem-mnogourovnevoy-sistemy-otbora-kandidatov/viewer

4. Molchanov P. V. Rol' Sovremennyh sistem distancionnogo obucheniya // Mezhdunarodnaya molodezhnaya nauchnaya shkola-konferenciya" Cifrovaya transformaciya real'nogo sektora ekonomiki". – 2021. – S. 198-201. URL: https://elibrary.ru/item.asp?id=46817867

5. Molchanov P.V., Smirnov D.S. Formirovanie trebovanij k analiticheskomu i matematicheskomu obespecheniyu rekomendatel'noj sistemy vybora uchebnyh napravlenij dlya abiturientov // Izvestiya vysshih uchebnyh zavedenij. Seriya «Ekonomika, finansy i upravlenie proizvodstvom». – 2025. – № 2(64). DOI: 10.6060//ivecofin.2025642.725 URL: https://ecofin-isuct.ru/article/view/6546

6. Ninichuk M. M., Namiot D. E. Obzor metodov postroeniya rekomendatel'nyh sistem na osnove sessij //International Journal of Open Information Technologies. – 2023. – T. 11. – №. 5. – S. 22-32. URL: https://cyberleninka.ru/article/n/obzor-metodov-postroeniya-rekomendatelnyh-sistem-na-osnove-sessiy/viewer

7. Salman H. A., Kalakech A., Steiti A. Random forest algorithm overview //Babylonian Journal of Machine Learning. – 2024. – T. 2024. – S. 69-79. URL: https://www.researchgate.net/publication/382419308_Random_Forest_Algorithm_Overview

8. Wu B. K. K-means clustering algorithm and Python implementation //2021 IEEE International Conference on Computer Science, Artificial Intelligence and Electronic Engineering (CSAIEE). – IEEE, 2021. – S. 55-59. URL: https://www.researchgate.net/publication/355072137_K-means_clustering_algorithm_and_Python_implementation

9. Zadorozhnyuk Ivan Evdokimovich 75 let MIFI: preemstvennost' obrazovatel'nyh innovacij // Vysshee obrazovanie v Rossii. 2018. №5. URL: https://cyberleninka.ru/article/n/75-let-mifi-preemstvennost-obrazovatelnyh-innovatsiy

10. Chzhibo CH., Afanas'ev G. I. Osnovnye tekhnologii i perspektivy evolyucii personalizirovannyh rekomendatel'nyh sistem //E-Scio. – 2022. – №. 4 (67). – S. 309-320. URL: https://cyberleninka.ru/article/n/osnovnye-tehnologii-i-perspektivy-evolyutsii-personalizirovannyh-rekomendatelnyh-sistem/viewer

ANALYSIS OF STAKEHOLDERS OF NOVOSIBIRSK STATE TECHNICAL UNIVERSITY IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

S. O. Pepelyaeva, E. V. Khomenko

Novosibirsk, *Novosibirsk State Technical University*,
pepelyaeva23245c@gmail.com

Abstract: The article examines the system of interaction between Novosibirsk State Technical University (NSTU) and its stakeholders through the lens of sustainable development. The authors classify stakeholder groups by influence and identify engagement strategies to achieve the goals of the Priority 2030 program. The study employs Mendelow's matrix, a ranking method, and SWOT analysis, and offers practical recommendations for optimizing stakeholder engagement.

Keywords: sustainable development, stakeholders, Mendelow's matrix, university strategy, Priority 2030, SWOT analysis, ranking.

АНАЛИЗ ЗАИНТЕРЕСОВАННЫХ СТОРОН НГТУ В КОНТЕКСТЕ УСТОЙЧИВОГО РАЗВИТИЯ

С. О. Пепеляева, Е. В. Хоменко

Аннотация: В статье рассматривается система взаимодействия Новосибирского государственного технического университета со стейкхолдерами через призму устойчивого развития. Авторы классифицируют группы влияния и определяют стратегии взаимодействия для достижения целей программы «Приоритет 2030». В работе применяются методы матрицы Менделоу, ранжирования и SWOT-анализа, а также предлагаются практические рекомендации по оптимизации взаимодействия со стейкхолдерами.

Ключевые слова: устойчивое развитие, стейкхолдеры, матрица Менделоу, стратегия университета, Приоритет 2030, SWOT-анализ, ранжирование.

In the current context of global transformation in higher education, a university is no longer a closed academic structure but is evolving into an active agent of socio-economic development. The concept of sustainable development in a university's activities implies achieving a dynamic balance between economic growth, social responsibility, and environmental protection. However, practical implementation of this three-part concept is impossible without considering the external and internal environment. A university's sustainability directly depends on how effectively it manages the expectations of multiple stakeholders, whose interests may not only overlap but also conflict [1].

In this context, the stakeholder approach becomes of key importance, based on the idea that an organization's success is determined by the quality of its interaction with its environment. According to Edward Freeman's theory, stakeholders are groups or individuals who can influence the achievement of a university's goals or are affected by its activities. For a technical university like NSTU, this means the need to find a compromise between state objectives, the demands of industrial partners, and the needs of the academic community.

The relationship between sustainable development and stakeholder management is clear: the long-term stability of a university results from harmonizing the interests of all participants in the ecosystem.

To prioritize and conduct strategic analysis of stakeholder engagement, the following tools are applied:

1. Mendelow's matrix — a classification of stakeholders according to their level of influence (power) and degree of interest in the university's activities. This method helps identify priority interaction strategies for each group.

2. Ranking method — a qualitative assessment of each group's contribution to the implementation of the sustainable development strategy on a scale from 1 to 10. This allows the university to prioritize its efforts in stakeholder engagement.

3. SWOT analysis of engagement — identifying the strengths and weaknesses of current communications, as well as opportunities and threats related to the external environment [4].

Next, we conduct a stakeholder analysis for Novosibirsk State Technical University using the three tools described above.

Mendelow's matrix helps allocate university resources to effectively manage the expectations of different groups. Let us construct such a matrix for NSTU (see Table 1).

The matrix enabled prioritizing stakeholders, highlighting students, faculty, staff, and industrial giants as key players requiring maximum engagement to ensure NSTU's sustainable development [2].

Table 1 – Mendelow's Matrix for NSTU

Influence / Interest	*Low Interest*	*High Interest*
High Influence	**Strategy: 'Satisfy'** • Ministry of Education and Science of the Russian Federation (Minobrnauki RF); • Government of Novosibirsk Region; • Federal Service for Supervision in Education and Science (Rosobrnadzor).	**Strategy: 'Key Players'** • Students; • Faculty and staff; • Industrial giants (ODK, NZKhK, SUEK); • Research scientists.
Low Influence	**Strategy: 'Monitor'** • Utility service providers, cleaning companies; • External tenants; • Residents of Leninsky and Kirovsky Districts.	**Strategy: 'Inform'** • Prospective students and their parents; • NSTU Alumni Association.

Next, we conduct a ranking based on the influence of stakeholder groups on achieving the targets of the Priority 2030 program and the campus's environmental and social sustainability (see Table 2).

Table 2 – Ranking Based on the Influence of Stakeholder Groups

Stakeholder Group	Contribution Score (1–10)	Key Role at NSTU
Industrial Partners	9.5	R&D orders, creation of joint laboratories, import substitution.
Faculty and Scientists	9.0	Intellectual capital, development of green technologies and new materials.
Student Community	8.5	Youth entrepreneurship, environmental initiatives, volunteering.
Government Bodies	8.0	Funding of strategic projects, formation of state-mandated tasks.
Alumni	6.5	Expert support, mentoring, sponsorship through the endowment fund.

The ranking confirmed the dominant role of industrial partners and scientists (9.5 and 9.0 points), whose contribution is critical for meeting the knowledge-intensive targets of the Priority 2030 program.

Next, we perform a SWOT analysis of NSTU's engagement with its immediate environment (see Table 3).

Table 3 – SWOT Analysis of NSTU's Stakeholder Engagement

Factors/ Aspects	Positive Aspects	Negative Aspects
External Factors	**Strengths**	**Weaknesses**
	•Strong ties with the Siberian Branch of the Russian Academy of Sciences (SB RAS) •Availability of technological and innovation infrastructure (Technocenter, Design center, laboratories, technology transfer center, startup center, Boiling Point, etc.) •High reputation in certain areas (power electronics, energy, materials science, IT, etc.)	•Complex bureaucratic approval procedures •Uneven media presence of different faculties and departments, resulting in poor promotion •Insufficient involvement of graduates in the university's partner programs
Internal Factors	**Opportunities**	**Threats**
	•Creation of the NSTU station within the SKIF CCP structure •Development of online education for exporting knowledge •Attraction of ESG-related grants	•Brain drain to universities in Moscow, Tomsk, or abroad •Demographic decline and lower quality of prospective students •Shrinking budgets of commercial partner

The analysis showed that to realize opportunities (the Skif project, ESG grants), the university needs to leverage its strong ties with SB RAS while mitigating the threat of "brain drain" by reducing internal bureaucratic barriers [3].

Based on the analyses conducted, we can conclude that NSTU possesses significant potential to achieve sustainable development goals. Using Mendelow's matrix enables the university to focus resources on the most influential stakeholder groups, which is critical for successfully meeting the targets of the Priority 2030 program and strengthening the university's position as a sustainable ecosystem. Future research may focus on quantitatively assessing the effectiveness of the proposed measures and developing a digital platform to monitor stakeholder engagement.

REFERENCES

1. Freeman E. R. Strategic Management: A Stakeholder Approach. Boston, MA: Pitman, 1984.

2. Gorbunov I. A., Petrov N. N. Ustoichivoe razvitie universiteta: modeli i instrumenty [Sustainable Development of a University: Models and Tools] // Universitetskoe upravlenie: praktika i analiz [University Management: Practice and Analysis]. 2021. Vol. 25. No. 3. P. 89–101. (in Russian).

3. Mendelow A. Stakeholder Mapping: A Method for Strategic Planning // Proceedings of the 2nd International Conference on Information Systems. Cambridge, MA, 1991. P. 17–26.

4. Zaitseva N. A., Sokolova, E. V. Primenenie SWOT-analiza dlya otsenki vzaimodeistviya universiteta so stakekholderami [Using SWOT Analysis to Assess University-Stakeholder Engagement] // Vestnik NGTU [Bulletin of NSTU]. 2022. Vol. 14. No. 2. P. 112–125. (in Russian).

STRUCTURAL CHANGES AND PRICE SEGMENTATION IN MOSCOW PRIMARY EDUCATION MARKET

Y. V. Pushkina, O. V. Railian

Moscow, National University of Science and Technology "MISIS",
juliazarubina.91@gmail.com

Abstract. The article analyses the transformation of the primary general education market in Moscow from 2022 to 2025 and the dynamics of demand for private educational institutions. In doing so, it examines structural changes in supply, price differentiation, and demand factors (socio-demographic, institutional, technological). The findings demonstrate that the growth of the private sector is accompanied by increased price segmentation and the development of competitive responses from the public sector.

Keywords: educational services market; primary general education; private schools; Moscow; demand; price differentiation; competition; educational policy.

СТРУКТУРНЫЕ ИЗМЕНЕНИЯ И ЦЕНОВАЯ СЕГМЕНТАЦИЯ РЫНКА НАЧАЛЬНОГО ОБРАЗОВАНИЯ МОСКВЫ

Ю. В. Пушкина, О. В. Райлян

Аннотация. Статья посвящена анализу трансформации рынка начального общего образования города Москвы в 2022–2025 гг. и динамике спроса на частные общеобразовательные организации. Рассмотрены структурные изменения

предложения, ценовая дифференциация и факторы спроса (социально-демографические, институциональные, технологические). Показано, что рост частного сегмента сопровождается усилением ценовой сегментации и развитием конкурентных ответов со стороны государственного сектора.

Ключевые слова: рынок образовательных услуг; начальное общее образование; частные школы; Москва; спрос; ценовая дифференциация; конкуренция; образовательная политика.

The educational services market in Moscow is among the most dynamic and heterogeneous in the Russian Federation. It is characterized by high competition, territorial differentiation in access conditions, and stratification of consumer practices. In 2022–2025, the primary general education segment (grades 1–4) developed under the simultaneous impact of inflationary pressure on costs, changing parental expectations regarding the quality and safety of the educational environment, and institutional and digital transformations of the education system of the city [3, 5].

Private general education institutions implementing primary education programs are a significant element of the education "quasi-market" as far as they operate within state requirements (licensing, compliance with federal norms, educational standards) while competing for consumers through product differentiation, support services, and reputation mechanisms [2]. Consequently, analyzing demand for private schools at the primary level helps identify shifts in parental preferences and assess risks to the accessibility of educational services.

This article examines the trends in the transformation of Moscow's primary general education market from 2022 to 2025 and identifies factors influencing demand for private schools.

The questions raised in this article explore how the dynamics of private primary education in Moscow have changed over the past few years. The article aims to systematize the demand factors for private primary schools, analyze the pricing structure and accessibility of this segment, and examine the competitive interaction between the public and private sectors.

To answer these questions, it is important to note that there are now many schooling options, such as full-time education, part-time education, and homeschooling. Despite the variety of schools and formats, all educational institutions must comply with the Law on Education of the Russian Federation when implementing their programs. It is also necessary to understand key documents such as the Law on Education and regulatory acts governing educational activities in the Russian Federation [3, 5]. Moreover, it is important to monitor scientific and analytical publications on private general education in Russia and on educational

policy outcomes [1, 2], as well as follow mass monitoring and sociological studies reflecting household attitudes and educational choice practices (RLMS-HSE, Russian Public Opinion Research Center) [4, 6].

Based on a range of public and departmental sources, the number of private educational institutions offering primary general education programs in Moscow increased by approximately 18–23 % from 2022 to 2025. This growth was uneven, combining post-pandemic demand recovery with subsequent growth constraints due to rising costs.

Table 1 – Assessment of the dynamics of private primary school supply in Moscow (2022–2025)

Period	Trend	Key factor interpretation
2022	Moderate growth (≈ +5 %)	Demand recovery after the pandemic
2023	Acceleration (≈ +9 %)	Migration processes; growing demand for flexibility and services
2024–2025	Stabilisation (≈ +7 %)	Market saturation; rising resource cost

So, what are the key factors that have driven the growth in private primary education providers?

The first factor is geographical. In recent years, Moscow has seen active growth in housing stock, including the development of former industrial zones and New Moscow territories. As a result, new private projects are concentrated in areas of active residential development and relatively high purchasing power (New Moscow, Western Administrative Area, South-Western Administrative Area). This indicates that potential buyers place considerable emphasis on infrastructure when purchasing real estate, particularly regarding the availability of educational institutions or centers. Notably, demand is growing for institutions offering "gentle education" concepts and individualized approaches at the primary level.

In this context, it is also important to highlight the socio-demographic factor. Over the past four years, family migration has increased, raising demand for adaptation practices that preserve the psychological well-being of children and parents. There is also a significant focus on demographic stability. In 2020, the total fertility rate was 1,473, which was below 2019 levels and the national average. Natural increase gave way to decline, with a birth rate of 9,8‰. In 2021, the rate rose to 1,597, exceeding national figures. However, during the pandemic, natural decline increased to 3,3‰. In 2022–2023, low birth rates persisted, driven by a shift toward

individual values and delayed childbearing. Consequently, many parents have become more conscious of the role of "parent" in terms of pedagogical and psychological aspects of child-rearing, increasing the importance of psychological well-being and the educational environment as selection criteria [6].

Thus, it is possible to identify geographic and academic-pedagogical factors, socio-demographic and technological components as drivers of demand for private schools [2, 6].

Academic-pedagogical factors include multiple elements. The primary element to consider is the individualization of learning and reduced class sizes. Most public schools have high student densities. In Moscow, the average class size in public primary schools is typically 25–30 students; in some areas/schools (especially new ones), it is even higher. In private schools, the typical range is much lower — about 10–15 students. With around 30 students per class, it is extremely difficult for teachers to implement individualized and personalized learning technologies and to guarantee academic quality and psychological comfort for each pupil.

Furthermore, there is the variability of programs and approaches, including the use of authoring techniques. While public schools are strictly regulated by the Department of Education in their adherence to Federal State Educational Standards (FSES), parents frequently request specialized or adapted programs that are difficult to implement within the public-school framework.

Continuity of the educational pathway within a single institution can be highlighted as the element which reduces family transaction costs (adaptation, group changes, logistics). However, private institutions sometimes cannot offer a complete educational pathway unlike public schools.

The next component influencing the rise in demand for private organizations involves technological and organizational factors. Several years post-pandemic, the world has rapidly adapted to structural changes, specifically the prevalence of online formats and remote work. Notably, the educational sector has normalized hybrid practices and digital integration into the learning process. Furthermore, there is steady growth and proliferation of EdTech solutions and STEM components, which serve as tools for school product differentiation and marketing positioning.

Thus, the competitive advantage of private primary schools often stems not from declared academic results but from characteristics of the educational environment (safety, psychological climate, manageability of "school–family" communications) [2].

Currently, competition in the education market is intense. The average tuition fee at private primary schools in Moscow has increased by approximately 28–35% from 2022 to 2025. This price inflation correlates with rising costs for personnel, facility leasing and maintenance, security, digital infrastructure, and extracurricular activities.

Table 2 – Price segments of Private Primary Education in Moscow (estimated, 2022–2025)

Segment	Cost, RUB/month	Typical characteristics
Lower	25,000–45,000	Basic curriculum, limited additional services
Middle	50,000–90,000	Enhanced infrastructure, languages, extracurricular activities
Premium	over 100,000	Small groups, extended support, international components

Rising prices increase the risk of reduced accessibility for certain families, prompting a shift toward alternative strategies: public school with supplementary classes, homeschooling with partial paid support, distance learning, or mixed formats. Public schools closely monitor private sector developments and quickly respond to modern parental demands, as seen in the rapid digitalization of public schools and expansion of infrastructure and curricular opportunities [3]. Meanwhile, the private education market retains advantages in managerial agility and intensity of individual student support, which is especially important at the primary school age [2, 6].

Conclusion. The analysis of the transformation within Moscow's primary general education market from 2022 to 2025 confirms a steady expansion of the private sector, occurring alongside an increasingly complex internal structure. The growth in the supply of private educational organizations is characterized not only by a rising number of market participants but also by the emergence of distinct product and price differentiation. Within this framework, schools compete through service packages, personalized educational trajectories, diverse support formats, and symbolic attributes such as reputation, core values, and the "quality of the environment." Concurrently, a significant upward trend in tuition fees has been identified.

The competitive landscape in Moscow during the 2022–2025 period is further defined by the revitalization of the public sector. State schools are enhancing their appeal through infrastructure development and the digitalization of educational processes, including the expansion of digital services and management tools. Nevertheless, comparative analysis indicates that, while operating within a similar regulatory framework, private schools maintain a competitive edge in personalization, intensive student support, and organizational flexibility. These factors sustain robust demand from families seeking individualized educational pathways and a heightened focus on the educational environment.

REFERENCES

1. Froumin I., & Kouzminov, Ya. (2022). Education Policy in Russia: Reforms and Outcomes. HSE Publishing House. 352 p.
2. Mertsalova T. A., & Kosaretsky S. G. (2023). Chastnoe obshchee obrazovanie v Rossii: mezhdu rynkom i gosudarstvom [Private general education in Russia: Between the market and the state]. NRU HSE Publishing House. 48 p. (in Russian)
3. Moscow City Government. (2022). Gosudarstvennaya programma goroda Moskvy "Razvitiye obrazovaniya goroda Moskvy («Stolichnoye obrazovaniye»)" [State Program of Moscow City "Development of Education in Moscow ("Metropolitan Education")] (As amended on March 29, 2022, N 490-PP). (in Russian)
4. NRU HSE. (2024). Rossiyskiy monitoring ekonomicheskogo polozheniya i zdorov'ya naseleniya NIU VSHE (RLMS-HSE). Volna 2024 [Russia Longitudinal Monitoring Survey of Russia, RLMS-HSE: Wave 2024] (Data set). National Research University Higher School of Economics. (in Russian)
5. Russian Federation. (2012). Federal'nyy zakon ot 29.12.2012 No. 273-FZ "Ob obrazovanii v Rossiyskoy Federatsii" [Federal Law No. 273-FZ of December 29, 2012 "On Education in the Russian Federation"] (as amended in 2024). Official Internet Portal of Legal Information. (in Russian)
6. Russian Public Opinion Research Center. (2024). Otnoshenie rossiyan k chastnomu obrazovaniyu: dinamika 2020–2024: analiticheskiy doklad [Russians' attitudes toward private education: Dynamics 2020–2024: Analytical report]. Russian Public Opinion Research Center. 32 p.(in Russian)

ANALYSIS OF THREATS TO THE CRIMINOLOGICAL SECURITY OF THE DIGITAL EDUCATIONAL ENVIRONMENT AT THE PRESENT STAGE

E. Z. Sidorova

Irkutsk, East Siberian Institute of the Ministry of Internal Affairs of Russia,
ketrik6@mail.ru

Abstract. The article is devoted to the study of the digital educational environment as an independent object of criminological security. The author analyzes and systematizes modern criminal and criminogenic threats that have a destructive effect on the environment under consideration at the technological, informational, psychological, and value-semantic levels. The main conclusion is that ensuring protection requires the abandonment of fragmented technical measures in favor of developing a holistic conceptual model of security, including regulatory, organizational, technical, pedagogical and value-oriented components.

Keywords: criminological security of education, criminal threats, educational sovereignty, national security, digitalization of education.

АНАЛИЗ УГРОЗ КРИМИНОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ ЦИФРОВОЙ ОБРАЗОВАТЕЛЬНОЙ СРЕДЫ НА СОВРЕМЕННОМ ЭТАПЕ

Е. З. Сидорова

Аннотация. Статья посвящена исследованию цифровой образовательной среды в качестве самостоятельного объекта криминологической безопасности. Автором проведен анализ и предложена систематизация современных криминальных и криминогенных угроз, оказывающих деструктивное воздействие на рассматриваемую среду на технологическом, информационно-психологическом и ценностно-смысловом уровнях. В качестве основного вывода обосновывается положение о том, что обеспечение защиты требует отказа от фрагментарных технических мер в пользу разработки целостной концептуальной модели безопасности, включающей нормативно-правовой, организационно-технический, педагогический и ценностно-ориентационный компоненты.

Ключевые слова: криминологическая безопасность образования, криминальные угрозы, образовательный суверенитет, национальная безопасность, цифровизация образования.

The digital transformation of education, accelerated by the global challenges of recent years, has led to the formation of a hybrid digital educational environment. The digital educational environment is the result of combining traditional and distance learning relationships that have emerged due to the development and accessibility of various technological platforms, services, and digital data. Having become an integral element of the Russian education system, the digital educational environment has become not only a didactic tool, but also a strategically significant object requiring comprehensive criminological protection against criminal threats. Criminological security of the digital educational environment can be understood as the state of protection of objects, subjects of the educational environment and educational relations arising between participants in these relations in the digital space from criminal and other unlawful encroachments, guaranteeing the preservation of national educational and educational priorities, values and interests.

Based on the proposed definition, it can be concluded that the digital educational environment should be considered as an object of criminological security of the education system.

The digital educational environment is a complex system element of the education sector, including:

1) technical and technological infrastructure (servers, networks, platforms, devices);

2) information and educational content;

3) subjects of educational relations (students, teachers, administrators of educational organizations, parents of underage students, and others);

4) digital personal data and other information about participants in educational relations.

It is this complexity that makes it vulnerable to a variety of criminal manifestations. Cyber threats are not only of a direct criminal nature (for example, hacking into digital repositories of personal data about underage students; theft of information about the work of an educational organization), but also of an indirect criminogenic nature, creating conditions for deviant behavior and the formation of antisocial attitudes (for example, cyberbullying of one of the students in a particular social network, which may further to provoke such a student to commit an act of school shooting). Thus, the digital educational environment acts simultaneously as an object of criminological protection and as an environment capable of generating new forms of illegal activity in the field of education.

Since criminal threats that encroach on the criminological security of the digital educational environment are systemic and multilevel in nature, while simultaneously affecting its various components, it is possible to identify a multilevel system of such threats:

1. The technological level of threats to the criminological security of the digital educational environment. At this level, traditional, but no less dangerous cyber threats are manifested:

– attacks on the availability of education, for example, DDoS attacks on educational platforms and portals (these are online attacks on the digital system of an educational organization, in which attackers send a huge number of requests), paralyzing the educational process during certain periods, for example, to disrupt a training session or conduct an admission campaign for admission to an educational organization;

– attacks on the confidentiality of information about participants in educational relations and the integrity of the educational system. We are talking about cybercrimes related to the theft, destruction or substitution of data. Compromising the arrays of personal data (including biometric data) of students and teachers, as well as unauthorized access to the results of intellectual activity (unique methods, courses, research) is particularly dangerous;

– the introduction of malicious software. In some cases, the method of influencing educational organizations is the use of encryption viruses, spyware, botnets and other means to carry out attacks on the infrastructure of educational organizations or use its resources for illegal purposes.

2. Information and psychological level. This threat level is aimed directly at the personality of the participants in educational relations:

– cyberbullying and cyber-trolling. These are systematic insults to participants in educational relations, threats against them, and the dissemination of information discrediting their honor and dignity in the digital space, leading to psychological trauma, desocialization, and in extreme cases, suicidal consequences;

– phishing and social engineering. We are talking about manipulative techniques aimed, among other things, at children, adolescents and teachers in order to fraudulently obtain confidential data, involve in illegal activities or destructive online communities;

– propaganda of deviant and suicidal behavior. In some cases, information is disseminated in digital educational and related communication spaces (chat rooms, social networks) aimed at encouraging schoolchildren and students to use drugs, violence, participate in extremist groups or commit suicide (the so-called "death groups").

3. The value-semantic (ideological) level. This is the most latent and extremely dangerous threat level, encroaching on the fundamental nature of the country's educational sovereignty:

– ideological and value impact on participants in educational relations. We are talking about the purposeful dissemination through educational content (the content of individual textbooks or educational programs), mass culture and the media space integrated into the digital educational environment of ideologies alien to traditional Russian values (the cult of consumption, radical individualism, devaluation of moral norms, falsification of the country's history). Such actions are aimed precisely at blurring the cultural and moral Russian traditional identity of the younger generation.;

– substitution of the educational paradigm. This type of threat can manifest itself with the complete digitalization of the educational environment and the abandonment of the traditional education format, where a digital tool replaces a living teacher-mentor; with the abandonment of the educational component of educational programs; with the complete transition to providing only paid digital educational services and the formation of knowledge among students only on a paid basis (full commercialization of education). Experts emphasize that in such cases, "inequality in educational opportunities may increase: good fundamental education is expensive "human", for others it is cheap distance education, online" [3, p. 18]. That is why Russian legal scholars consider it necessary to overcome the problem of digital inequality [1, p. 736].

The vulnerability of the digital educational environment is generated both by technical imperfections in this area of public relations and by socio-psychological risks, which include:

1) external factors such as the activities of transnational cybercrime groups, the actions of foreign hackers and intelligence agencies, as well as ideological pressure from a number of foreign digital platforms and manufacturers of digital products;

2) Internal factors such as digital inequality and low digital literacy. A significant part of the participants in educational relations, especially representatives of the teaching community and the parent community, do not yet have sufficient cyber hygiene and media security skills to effectively counter criminal threats that manifest themselves in the digital educational space. The deviant behavior of the participants in educational relations themselves should also be considered as an internal factor. We are talking about the so-called intra-environmental risks created by students themselves, including cyberbullying, plagiarism in the digital space, leading to copyright infringement, the distribution of prohibited content among schoolchildren and students, and others. It should also be noted that the regulatory framework is lagging behind the dynamics of technological change, insufficient funding for cybersecurity measures, and the lack of uniform standards of protection for all participants in the digital educational environment.

Thus, the analysis suggests that threats to the criminological security of the digital educational environment are a complex phenomenon that combines technical cyber threats, psychological manipulation, and attempts at ideological interference in the educational environment. The key conclusion is that both direct, visible attacks and latent threats to the value-semantic level pose a great danger to digital education, which can negatively affect the level of protection of the national educational and cultural sovereignty of the country.

In this regard, it can be reasonably argued that the protection of the digital educational environment cannot be limited solely by technical measures (for example, the installation of antiviruses and firewalls; a firewall is a software and hardware complex designed to check and filter network traffic [4, p. 50]; it allows you to control the flow of data passing through the network, and make decisions about allowing or blocking connections based on predefined rules; a firewall is a kind of "shield" or "filter" that ensures the security of data transmission). As it is rightly noted in the literature, it is a systematic approach to ensuring the safety of the educational environment that is required [2, p. 187]. A comprehensive criminological security model for the educational environment, including digital, should include:

1) the regulatory component, which implies the improvement of legislation in the field of criminological protection of the education system, in particular, ensuring the

protection of personal information belonging to participants in educational relations and stored in digital databases from the so-called "leakage" and loss; ensuring the cybersecurity of educational organizations; more detailed regulation of relations related to the use of digital educational content;

2) the organizational and technical component, presented in the form of the introduction of cybersecurity standards for participants in educational relations, ensuring digital sovereignty through the use of domestic software and domestic digital educational platforms;

3) the pedagogical and educational component, which involves the integration of provisions on digital and media literacy, cyber hygiene, and the basics of legal culture in the digital environment into educational programs, while a key role is given to the training and retraining of teachers in this field.;

4) value-oriented component, which implies the formation of students' critical thinking, value immunity to destructive content distributed in the information and telecommunications environment, and the education of responsible digital citizenship.

Only such a systematic interdisciplinary approach, considering the digital educational environment as a space for shaping the future of the nation, will ensure its criminological security, protect the rights of individuals involved in educational relations and strengthen the national educational sovereignty of the Russian Federation.

REFERENCES

1. Begishev I. R., Zharova A. K., Zaloilo M. V., Filipova I. A., Shutova A. A. (2024) Tekhnologicheskie transformacii: rost vozmozhnostej i pravovoj otvet na voznikayushchie riski [Technological transformation: growing opportunities and legal response to emerging risks]. *Journal of Digital Technologies and Law*, 2 (4), 735-740. (in Russian).

2. Sidorova E. Z. (2025). Cifrovaya, antiekstremistskaya i inye vidy kriminologicheskoj bezopasnosti obrazovatel'noj sredy [Digital, anti-extremist and other types of criminological security of the educational environment]. *Vestnik Vostochno-Sibirskogo instituta MVD Rossii* [Bulletin of the East Siberian Institute of the Ministry of Internal Affairs of Russia], 4 (115), 181-189. (in Russian).

3. Starichenko B. E. (2020) Cifrovizaciya obrazovaniya: realii i problemy [Digitalization of education: realities and challenges]. *Pedagogicheskoe obrazovanie v Rossii* [Teacher education in Russia], 4, 16-26. (in Russian).

4. Suprunov S. (2008) O pol'ze fajervolov [About the benefits of firewalls]. *Sistemnyj administrator* [System Administrator], 3(64), 50–52. (in Russian).

INTEGRATION OF THE MEMORY MODULE INTO AN APPLICATION FOR THE DEVELOPMENT OF HUMAN COGNITIVE PROCESSES

A. P. Stupnikova-Dolbnya, D. I. Stupnikov-Dolbnya

Research advisor: E. S. Kagan, Cand. Sc. (Engineering)

Kemerovo, Kemerovo State University,
dolbnya.ap@rambler.ru

Abstract: The article argues for the relevance of integrating a Memory module into an application designed to develop human cognitive processes in the context of the digital transformation of education. The module, based on the rules of the homonymous board game, is aimed at training memory, attention, and thinking. The paper outlines the functional requirements for development, including adjustable preview time, number of card pairs, types of images (shapes, numbers, letters), level progression mode, and parameter saving. The module's versatility is highlighted for use by schoolchildren, the elderly, and patients with cognitive impairments.

Keywords: Cognitive processes, digital transformation, education, memory, attention, development, integration.

ИНТЕГРАЦИЯ МОДУЛЯ MEMORY В ПРИЛОЖЕНИЕ РАЗВИТИЕ КОГНИТИВНЫХ ПРОЦЕССОВ ЧЕЛОВЕКА

А. П. Супникова-Долбня, Д. И. Ступников-Долбня

Аннотация: В статье обосновывается актуальность интеграции модуля «Memory» в приложение для развития когнитивных процессов человека в условиях цифровой трансформации образования. Модуль, основанный на правилах одноименной настольной игры, направлен на тренировку памяти, внимания и мышления. Описаны функциональные требования к разработке, включающие настройку времени предпросмотра, количества пар карточек, типов изображений (фигуры, цифры, буквы), режима перехода между уровнями и сохранения параметров. Подчеркивается универсальность модуля для использования школьниками, пожилыми людьми и пациентами с когнитивными нарушениями.

Ключевые слова: Когнитивные процессы, цифровая трансформация, образование, память, внимание, развитие, интеграция.

Currently, the processes of digital transformation of the economy place high demands on specialists in various fields. The large amount of information that representatives of various professions face, creates new challenges that directly affect human cognitive processes. Digital transformation also affects educational processes.

Digital transformation also affects educational processes. One of the ways aimed at developing a student's cognitive abilities is the development of processes such as memory and concentration. However, it is very important that students can train these processes at any time convenient for them. According to a number of scientists, the board game "Memory" is aimed at developing visual perception, visual memory, logical and spatial thinking, and also trains perseverance and observation [5], [6]. Therefore, the integration of the "Memory" module into the application for the development of human cognitive processes is an urgent task [1], [3-4].

On the one hand, this module can be used to develop students' cognitive processes, on the other hand, it can be useful and interesting for elderly people whose cognitive abilities are beginning to decline, as well as for people with cognitive disorders that may occur after various surgical interventions.

Purpose: Integration of the Memory module into the application for the development of human cognitive processes.

To develop the module, consider the rules of the board game "Memory":

A number of pictures are laid out on the table, consisting of numbers, shapes or letters to choose from, which turn over after a certain period of time. The player needs to memorize their location in order to further accurately reproduce their position. If the location of a particular picture is selected correctly, then a point is counted, but if the location of the picture is violated, then all the cards on the table are turned over, even if some have already been counted, everything is reset. Thus, the game helps to develop memory and concentration, compare objects, identify similarities and differences between them, generalize and classify objects according to given characteristics, and also develops logical and spatial thinking [1-4].

The following requirements are formulated for the practical implementation of the module.

1. There must be a choice option in the module settings.:

1) Card preview is the time allowed for memorizing pictures (must be specified in milliseconds);

2) the number of pairs of cards for the initial difficulty level (from 2 pairs to 50 pairs);

3) types of images on the cards (geometric shapes, numbers, letters).

2. The transition to the next level must be set in the module settings. If this mode is selected, the program will automatically move to the next level, that is, add another pair of memory cards. If this mode is not selected, the program will reproduce only the specified mode difficulty, that is, there will be no level complication.

3. The module terminates at the user's request, that is, it stops manually.

4. The module settings must be saved until the user makes the following changes.

In Fig. 1, The interface of the main menu of the program is presented.

The user selects the "Memory" module. Figure 2 shows the module settings window with a selection of parameters such as: the number of pairs of cards for the

initial level; card preview time (in milliseconds), and the option to select the transition to the next level.



Figure 1. The interface of the main menu of the program

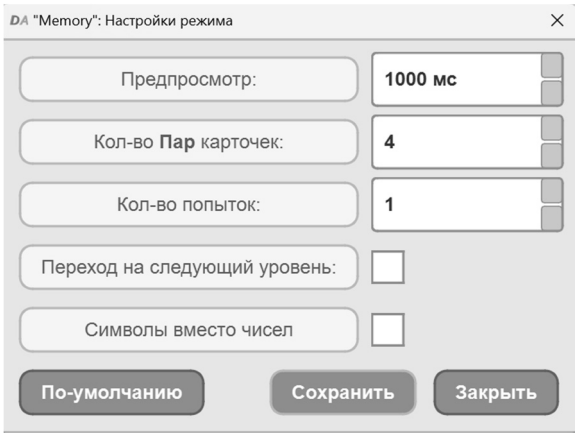


Figure 2. The "Memory" module settings window

After launching the module, using the "Start!" button, image cards are displayed for the time indicated above, giving the user time to memorize their location (Fig. 3).

Figure 4 shows an example of passing a level.

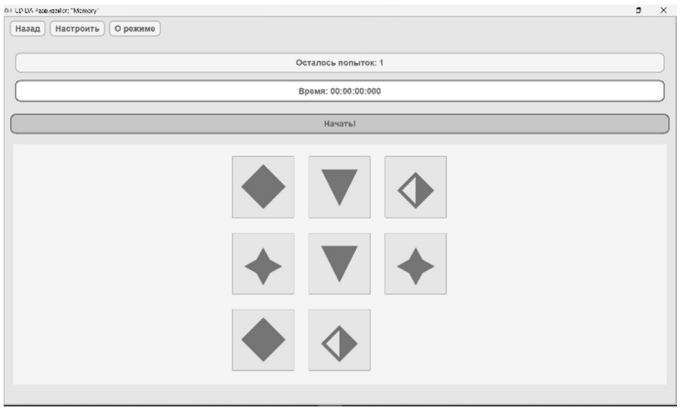


Figure 3. The main window of the "Memory" module

Thus, another module has been implemented in the program for the formation and development of human cognitive processes. However, work on additional modules continues. In the future, it is planned to add techniques to the program

aimed at developing cognitive functions such as concentration and logic, which will significantly enhance the functionality of the program and expand the target audience [7].

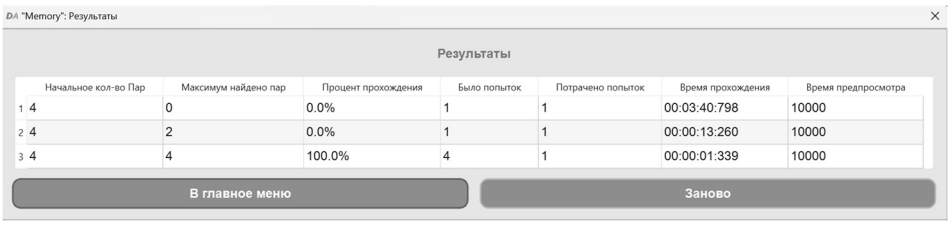


Figure 4. The output window of the "Memory" module

REFERENCES

1. Beloshitskaya A.V., Plotnikova T.V. Didakticheskaya igra kak metod razvitiya proizvol'noj pamyati detej starshego doshkol'nogo vozrasta [Didactic Game as a Method of Developing Voluntary Memory in Older Preschool Children]. Sovremennoe doshkol'noe obrazovanie. 2021, no. 5 (107), pp. 38–47. Available at: https://cyberleninka.ru/article/n/didakticheskaya-igra-kak-metod-razvitiya-proizvolnoy-pamyati-detey-starshego-doshkolnogo-vozrasta (accessed 20.05.2024). (In Russian)

2. Chistovskaya O.V. Nauchnoe obosnovanie effektivnosti mobil'nykh igr i komp'yuternykh programm dlya trenirovki pamyati [Scientific Substantiation of the Effectiveness of Mobile Games and Computer Programs for Memory Training]. Molodoj uchenyj. 2023, no. 7 (454), pp. 12-15. Available at: https://moluch.ru/archive/454/100166/ (In Russian)

3. Didakticheskaya igra "Najdi paru" [Didactic Game "Find a Pair"]. Available at: https://infourok.ru/didakticheskaya-igra-najdi-paru-4317440.html (accessed 20.05.2024). (In Russian)

4. Didakticheskaya igra "Najdi paru" [Didactic Game "Find a Pair"]. Sotsial'naya set' rabotnikov obrazovaniya "Nasha set'". Available at: https://nsportal.ru/detskiy-sad/razvitie-rechi/2016/09/10/didakticheskaya-igra-naydi-paru (accessed 20.05.2024). (In Russian)

5. Gol'dfel'd I.L., Kuz'mina O.G. Razvitie pamyati u starshikh doshkol'nikov [Memory Development in Older Preschoolers]. Vospitatel' doshk. obrazovat. uchrezhdeniya. 2012, no. 11, pp. 118-123. (In Russian)

6. Tarasenko N.A. Memori ili najdi paru : didakticheskaya igra dlya detej doshkol'nogo vozrasta [Memory or Find a Pair: A Didactic Game for Preschool Children]. MBDOU "Detskij sad № 273" g. Chelyabinska. Available at: https://mbdou-273.ru/wp-content/uploads/2023/04/06.03.2023g.-Memori-ili-najdi-paru.pdf (accessed 20.05.2024). (In Russian)

7. Available at: https://elibrary.ru/item.asp?id=45720800 (accessed 20.05.2024). (In Russian)

ЭКОНОМИКА, МЕНЕДЖМЕНТ
И ТЕХНОЛОГИИ В ЦИФРОВУЮ ЭПОХУ

ВЫЗОВЫ, РЕШЕНИЯ И ПЕРСПЕКТИВЫ

МАТЕРИАЛЫ
Всероссийской научно-практической конференции
с международным участием

Новосибирск, Россия, 16–21 марта 2026 г.

ECONOMICS, MANAGEMENT
AND TECHNOLOGIES IN THE DIGITAL ERA

CHALLENGES, SOLUTIONS AND FUTURE OUTLOOK

PROCEEDINGS VOLUME
of the International Research-to-Practice Conference

Novosibirsk, Russia, March 16–21, 2026

Составители: *В. Л. Каракчиева, Е. Г. Логинова*

Выпускающий редактор *И.П. Брованова*
Дизайн обложки *А.В. Ладыжская*
Компьютерная верстка *Л.А. Веселовская*

Налоговая льгота – Общероссийский классификатор продукции
Издание соответствует коду 95 3000 ОК 005-93 (ОКП)

Подписано в печать 07.09.2026. Формат 70 × 100 1/16. Бумага офсетная. Тираж 12 экз.
Уч.-изд. л. 43,53. Печ. л. 33,75. Изд. № 99. Заказ № 169. Цена договорная

Отпечатано в типографии
Новосибирского государственного технического университета
630073, г. Новосибирск, пр. К. Маркса, 20