Saint Petersburg 2025

volume 4 issue 3

An international journal

TECHNO ECONOMICS

TECHNO ECONOMICS

An international journal

EDITORS OFFICE PUBLISHER
Executive Secretary: *Olga Voronova*
Development Manager: *Anastasia Levina*
Layout designer: *Dayana Gugutishvili*

PUBLISHER
Peter the Great St. Petersburg Polytechnic University
Corresponding address: 29 Polytechnicheskaya st.,
Saint-Petersburg, 195251, Russia

CONTACTS
Email: *technoeconomics @spbstu.ru*
Web: *https://technoeconomics.spbstu.ru/en*

Saint Petersburg
2024

CONTENTS

Technoeconomics. 2025, Vol. 4, No. 3 (14). Pp. 4–14.
Техноэкономика. 2025, Том 4, № 3 (14). С. 4–14.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.1

BUSINESS OPTIMIZATION IN E-COMMERCE: LEVERAGING DATA ANALYTICS FOR IMPROVED DECISION-MAKING AND PERFORMANCE ENHANCEMENT

Peter Okunlola[1], Anastasia Levina[2] ✉

[1] Rimt University, Mandi Gobindgarh, Punjab, India;
[2] Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia

✉ alyovina@gmail.com

Abstract. In today's data-driven business environment, e-commerce platforms are increasingly leveraging data analytics to enhance operational efficiency, improve decision-making, and gain a competitive edge. This research examines how analytics is transforming core e-commerce functions, including inventory management, supply chain and logistics, personalization, marketing campaign optimization, and pricing strategy. By enabling real-time demand forecasting, route planning, and customer behaviour analysis, data analytics empowers businesses to deliver products more efficiently and tailor experiences for individual users. The paper presents case studies from leading platforms like Amazon, eBay, Shopify, and Flipkart to demonstrate how data-driven decision-making leads to measurable performance improvements and competitive success. These examples highlight the strategic importance of embedding analytics into e-commerce ecosystems as a foundation for business optimization, innovation, and long-term growth.

Keywords: business optimization, e-commerce, data analytics, decision-making, performance enhancement, business intelligence, digital transformation

Citation: Okunlola P., Levina A. Business optimization in e-commerce: leveraging data analytics for improved decision-making and performance enhancement. Technoeconomics. 2025. 4. 3 (14). 4–14. DOI: https://doi.org/10.57809/2025.4.3.14.1

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.1

ОПТИМИЗАЦИЯ БИЗНЕСА В ЭЛЕКТРОННОЙ КОММЕРЦИИ: ПРИМЕНЕНИЕ ИНСТРУМЕНТОВ АНАЛИТИКИ ДАННЫХ В ЦЕЛЯХ УЛУЧШЕНИЯ ПРОЦЕССА ПРИНЯТИЯ РЕШЕНИЙ И ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ПРЕДПРИЯТИЯ

Петер Окунлола[1], Анастасия Левина[2] ✉

[1] Университет РИМТ, Манди Гобиндгарх, Пенджаб, Индия;
[2] Санкт-Петербургский политехнический университет Петра Великого, Санкт-Петербург, Россия

✉ alyovina@gmail.com

Аннотация. В современной бизнес среде, ориентированной на большие данные, платформы электронной торговли все чаще используют аналитику данных для повышения операционной эффективности, улучшения процесса принятия решений и извлечения ощутимых конкурентных преимуществ. Данное исследование посвящено аналитике данных с точки зрения трансформирмации ключевые функции электронной коммерции, включая управление запасами, цепочки поставок, логистику, персонализацию, а также оптимизацию маркетинговых кампаний и стратегии ценообразования. Благодаря возможностям прогнозирования спроса в режиме реального времени, планированию маршрутов и анализу поведения клиентов, аналитика данных позволяет предприятиям доставлять товары более эффективно, а также в существенной мере персонализировать пользовательский опыт. В исследовании представлен анализ ведущих платформ, таких как Amazon, eBay, Shopify и Flipkart, демонстрирующий, как принятие решений на основе данных приводит к измеримым улучшениям в показателях и способствует росту конкурентоспособности. Данные примеры подчеркивают стратегическое значение внедрения аналитики данных в экосистемы электронной коммерции как основы для общей оптимизации бизнеса, инноваций и долгосрочного роста.

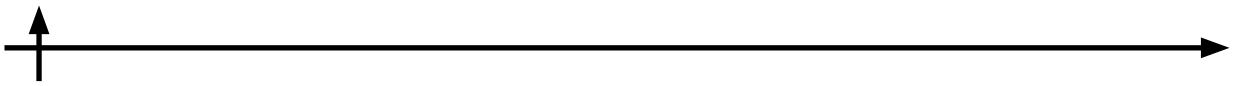
Ключевые слова: оптимизация бизнеса, электронная коммерция, аналитика данных, принятие решений, повышение эффективности, BI-системы, цифровая трансформация

Для цитирования: Окунлола П., Левина А. Оптимизация бизнеса в электронной коммерции: применение инструментов аналитики данных в целях улучшения процесса принятия решений и повышения эффективности предприятия // Техноэкономика. 2025. Т. 4, № 3 (14). С. 4–14. DOI: https://doi.org/10.57809/2025.4.3.14.1

Introduction

The rapid evolution of e-commerce has revolutionized the way consumers interact with businesses, creating a highly competitive digital marketplace driven by convenience, personalization, and real-time access to global products and services. Consumers today can purchase everything from books to groceries with a few clicks, bypassing traditional physical retail models. This exponential shift toward online shopping has reshaped consumer expectations and introduced intense market competition, rapid trend cycles, and pressure for operational excellence. To thrive in this fast-paced environment, e-commerce platforms must adopt intelligent systems capable of making accurate, timely, and scalable decisions.

At the heart of this transformation lies data, massive volumes of it generated continuously through customer browsing behaviour, purchase histories, feedback, clicks, search queries, and



social interactions. When effectively harnessed, this data becomes a valuable asset, offering insights that can guide business strategy, streamline operations, and deliver highly personalized customer experiences. However, the sheer scale and complexity of such data pose significant analytical challenges that traditional decision-making models are ill-equipped to handle. This is where data analytics provides the necessary tools, methodologies, and technologies to transform raw data into actionable business intelligence.

The importance of analytics for e-commerce has been widely acknowledged in previous research. Almtiri, Miah, and Noman (Almtiri, 2022) emphasize that small and medium-sized enterprises increasingly rely on decision support systems and ICT adoption to enhance competitiveness, yet they face persistent barriers such as limited resources, software adaptation difficulties, and a shortage of managerial expertise. Their findings highlight the importance of analytics but also point to the structural disadvantages that SMEs encounter compared to large corporations. Similarly, Pande et al. (Pande, 2023) examine how big data analytics can be applied in e-commerce to understand customer behaviour, predict preferences, optimize pricing, and enhance marketing effectiveness. While their work demonstrates the power of predictive modelling and machine learning for personalization, it also draws attention to unresolved challenges, including data privacy concerns, regulatory pressures such as GDPR, and the difficulty of scaling advanced analytical systems across businesses of different sizes.

Despite these contributions, several gaps in the literature remain. Much of the existing research focuses on either SMEs or on general applications of big data analytics, leaving limited insights into comparative, function-specific implementations across major e-commerce platforms (Abidemi, 2024). Ethical considerations and governance frameworks also remain underexplored, even though consumer trust increasingly depends on transparency and responsible data use. Furthermore, few studies provide multi-case comparative perspectives that analyze how different platforms adopt analytics according to their scale, strategic orientation, or technological capabilities.

This research addresses these gaps by investigating the role of data analytics in optimizing decision-making and enhancing performance within e-commerce. It seeks to examine six core functional areas where analytics exerts the most significant influence, namely inventory management, supply chain and logistics, personalization and customer experience, marketing campaign optimization, pricing strategy, and platform-level integration through case studies of Amazon, eBay, Shopify, and Flipkart. In doing so, the study sets out to analyze how data analytics supports inventory and supply chain efficiency, evaluate its role in driving personalization and marketing effectiveness, investigate its contribution to dynamic pricing, and compare how leading platforms implement these practices in distinctive ways.

The aim of the research is to demonstrate that data analytics is not merely a supportive tool but a central pillar of strategic agility and operational sustainability in the digital economy. By combining insights from literature with empirical case analysis, the study contributes to the ongoing discourse on digital transformation and provides recommendations for scalable, ethical, and impactful integration of analytics in e-commerce.

Materials and Methods

Research Design

This study adopts a qualitative, case study-based research design aimed at exploring how leading e-commerce companies leverage data analytics to optimize business functions and improve decision-making. The qualitative approach enables a deep exploration of organizational practices, technologies, and outcomes related to data analytics adoption. The case study method is particularly suitable for understanding complex, real-world applications of data-driven strat-

egies within their specific business contexts. By examining multiple case examples of Amazon, eBay, Shopify, and Flipkart, the research draws comparative insights across varying organizational models, technological infrastructures, and market environments.

Data Collection Method

Data for this research were collected through documentary analysis of secondary sources. These include academic literature, company white papers, industry reports, media interviews, and technology documentation. Particular emphasis was placed on collecting descriptive and strategic information regarding how each platform applies data analytics in core operational areas such as inventory management, customer personalization, logistics, and marketing.

The four selected case studies Amazon, eBay, Shopify, and Flipkart were chosen for their prominence in the global and regional e-commerce markets, as well as their diverse use of analytics across both customer-facing and internal operations. Each case was systematically analyzed using a structured framework to extract relevant insights on analytics strategy, implementation, tools used, and measurable outcomes.

Sources of Data

Data were drawn from a combination of credible sources, including:

— Peer-reviewed academic journal articles and conference proceedings
— Business technology publications (McKinsey, Forbes Technology Council)
— Company-authored materials (Amazon and eBay analytics documentation)
— Market intelligence reports (Statista, Gartner, Accenture)
— Case studies provided in publicly available business analytics and e-commerce literature

These sources provided both qualitative narrative accounts and quantitative performance indicators (sales uplift from recommendation engines, infrastructure savings, and customer engagement metrics), which were cross-referenced to ensure reliability and consistency.

Results and Discussion

Case Study: Amazon

Amazon exemplifies the effective use of advanced data analytics and AI to gain a competitive edge in e-commerce. The company collects and analyzes massive volumes of structured and unstructured data from user interactions, including clicks, searches, purchases, reviews, and device usage, to extract insights into customer behaviour and preferences. Central to Amazon's strategy is its AI-powered recommendation system, which applies predictive analytics and machine learning algorithms, such as collaborative filtering and deep learning models, to suggest products tailored to individual users (Liu, 2022, 2024; Wang, 2024). This system is estimated to drive approximately 35 percent of total sales, demonstrating the direct impact of data analytics on business outcomes.

In addition to personalized recommendations, Amazon employs real-time analytics to optimize marketing campaigns, dynamic pricing, and inventory forecasting. Advanced customer segmentation enables the identification of emerging trends, accurate demand prediction, and targeted promotions for distinct user groups (Govindarajan, 2024). Amazon also applies AI in search and discovery, voice commerce through Alexa, operational analytics in supply chain management, and retail analytics in Amazon Go stores. These integrated functions enhance efficiency, scalability, and customer engagement, feeding into Amazon's Flywheel model, where improvements in experience generate more data for continuous refinement (Zhuang, 2021; Huang, 2020).

These findings align with Pande et al. (Pande, 2023; Hasan, 2024), who emphasize that big data analytics in e-commerce improves personalization, operational performance, and customer engagement. Similarly, the role of predictive analytics in Amazon's inventory and marketing

strategies reflects principles identified by Almtiri et al. (Almtiri, 2022) regarding the importance of decision support systems for scalable business optimization.

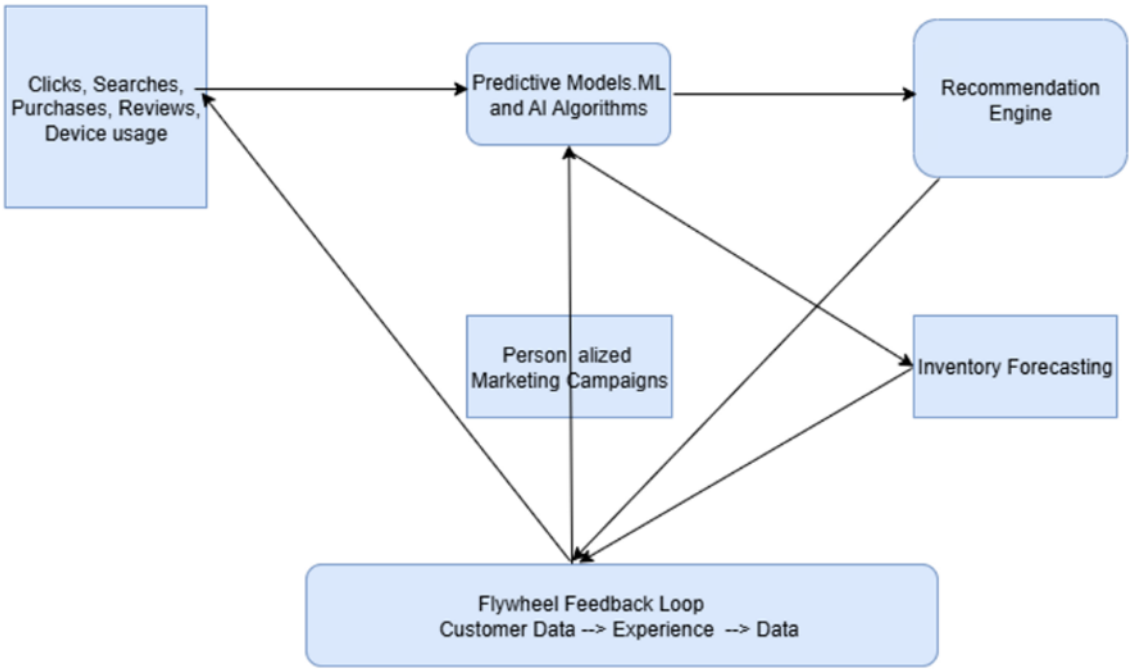


Fig. 1. Amazon analytics flow.

Case Study: eBay

eBay demonstrates a distinct approach, focusing on behavioural analytics and infrastructure optimization rather than inventory management. Processing over 50 terabytes of machine-generated data daily and managing more than 100 petabytes of historical data, eBay gains insights into user preferences, behaviour patterns, and search interactions. The platform replicates the personalized attention of local shops on a global scale through predictive modelling, real-time A/B testing, and sentiment analysis (Rimon, 2024; Shah, 2022).

Unlike Amazon, eBay's analytics strategy prioritizes the management of unstructured customer journey data. The company employs a three-tiered system consisting of Teradata Enterprise Data Warehouse for transactional queries, Singularity for scalable unstructured data analytics, and Hadoop clusters for large-scale ad hoc processing. This architecture enables efficient real-time decision-making and supports infrastructure optimization. For example, minute-by-minute server data analysis revealed underutilized resources, allowing eBay to repurpose servers and save millions in capital expenditures (Benjamin, 2024; Adebanji, 2025).

The focus on behavioural analytics and IT efficiency illustrates the diversity of analytics applications in e-commerce. It confirms Pande et al.'s observation that predictive models can enhance both customer-facing services and internal operations while highlighting the need for robust technical infrastructure, particularly for platforms without inventory control.

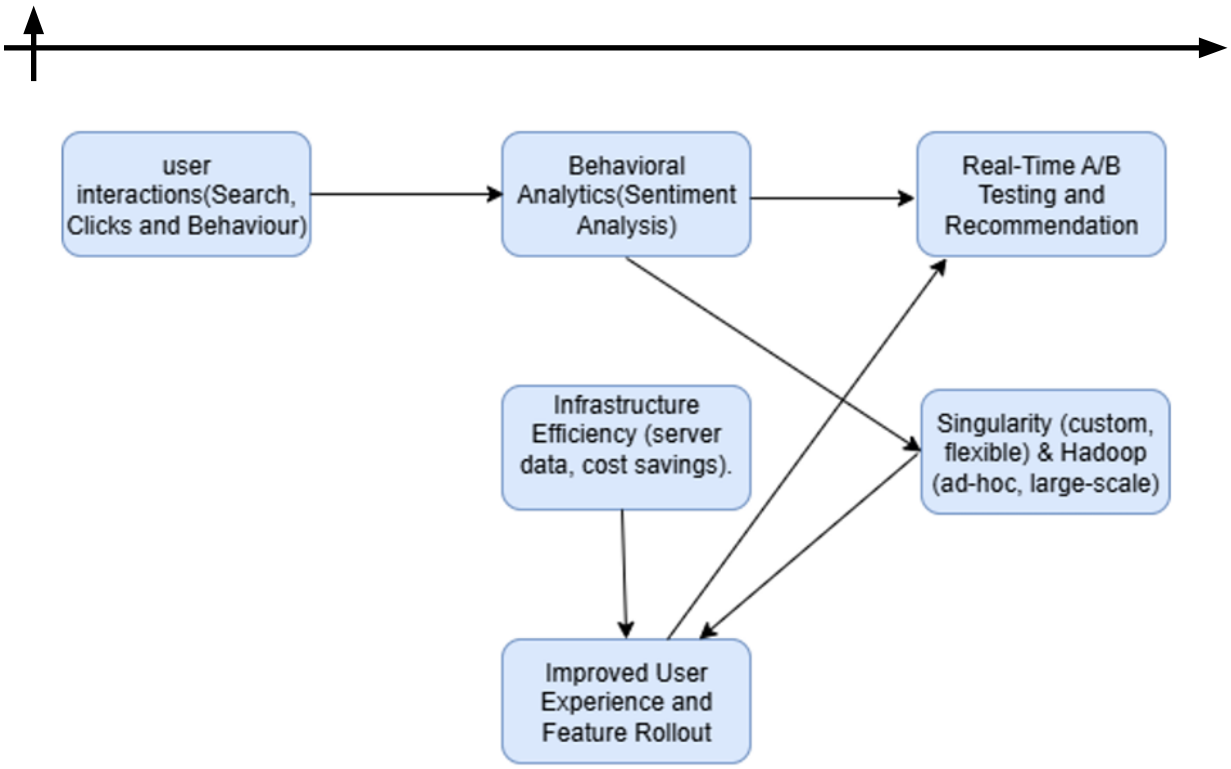


Fig. 2. eBay analytics flow.

Case Study: Shopify

Shopify provides a platform-centric approach, empowering small businesses to leverage analytics for growth and personalization. Through Shopify Analytics, merchants access insights into sales performance, customer behaviour, traffic sources, and marketing effectiveness. Real-time dashboards allow store owners to monitor conversion rates, cart abandonment, and customer demographics, supporting informed decisions on marketing spend, inventory management, and customer experience.

By analyzing customer behaviour, Shopify enables personalized marketing and product recommendations. Integration with third-party applications enhances reporting capabilities, allowing small businesses to apply AI-driven insights without the resources of larger corporations. Shopify also supports multi-channel retail strategies, providing comprehensive visibility across online and offline sales touchpoints.

This approach demonstrates the practical application of big data analytics for SMEs, addressing gaps identified by Almtiri et al. regarding scalability and resource constraints in smaller enterprises (Deng; Urhan, 2022). Shopify's model confirms that accessible analytics tools can democratize data-driven decision-making, a theme less explored in prior literature (Jakkula, 2023; Zeng, 2021).

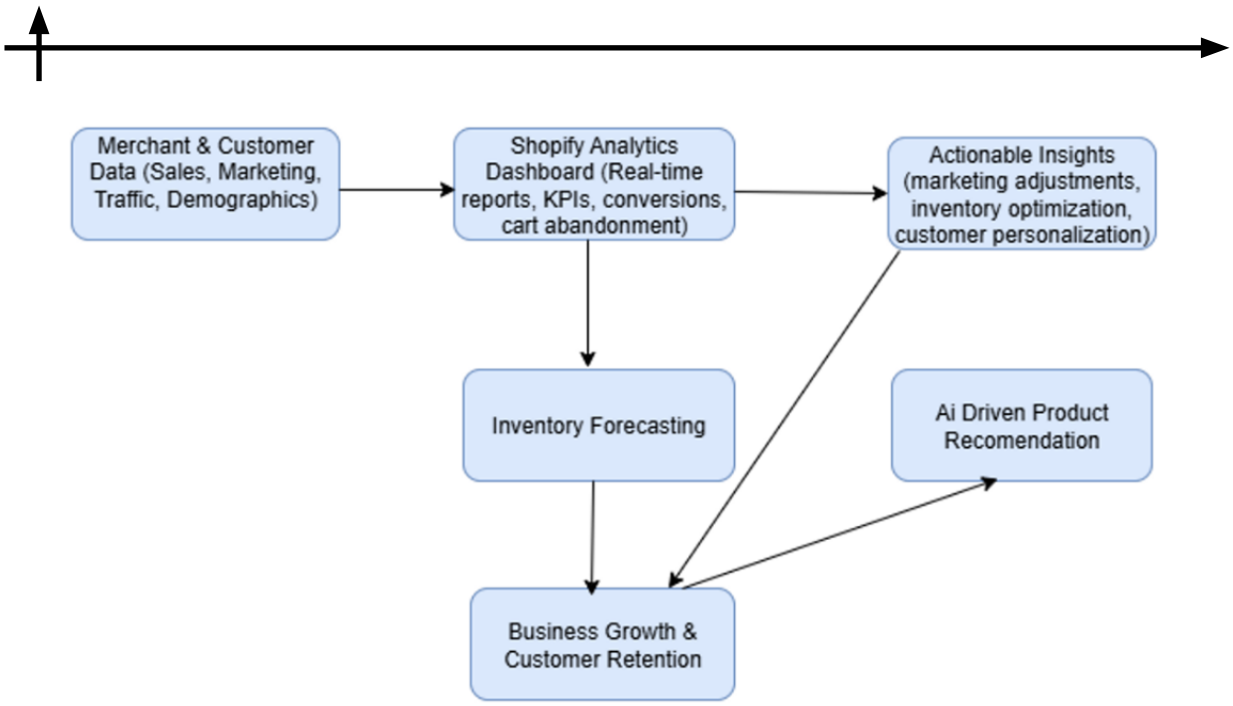


Fig. 3. Shopify analytics flow.

Case Study: Flipkart

Flipkart leverages predictive analytics to optimize inventory, supply chain operations, and personalized marketing within the Indian e-commerce market. Historical sales, seasonal trends, and customer behaviour data allow Flipkart to forecast demand accurately, reducing overstocking and stockouts while enhancing logistics efficiency. Machine learning algorithms facilitate targeted marketing campaigns and customer segmentation, increasing engagement and conversion rates (Jain, 2025; Fu, 2023).

Data science also underpins Flipkart's real-time supply chain monitoring, enabling the identification of bottlenecks, forecasting of delays, and streamlining of delivery processes. Customer behaviour analytics predicts churn risk and purchase likelihood, supporting proactive retention strategies. Flipkart's implementation highlights the applicability of analytics in emerging markets, demonstrating that predictive modelling can drive operational efficiency and competitive advantage even in complex market environments.

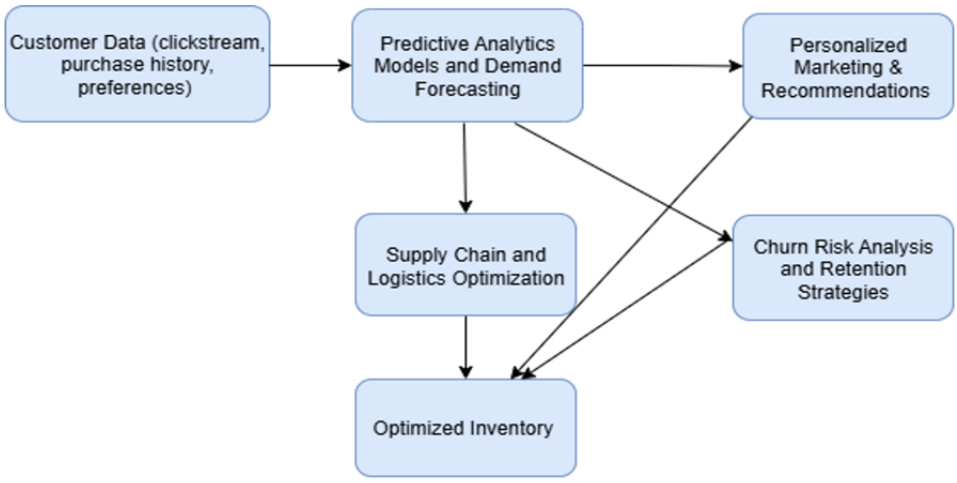


Fig. 4. Flipkart analytics flow.

Cross-Case Comparison

The following table summarizes the key use of analytics and unique focus across the four platforms.

Table 1. Key use of analytics and unique focus across the four platforms.

Platform	Key Use of Analytics	Unique Focus
Amazon	Personalization, logistics, pricing	End-to-end AI-driven optimization
eBay	Customer journey, UX, infrastructure	Behavior-based platform refinement
Shopify	Marketing, inventory, UX	Empowering small businesses
Flipkart	Inventory, supply chain, marketing	Predictive modeling for local markets

Analysis of these cases reveals that analytics has shifted decision-making from intuition to evidence-based practices, enabling faster, smarter, and more scalable actions (Mashtakov et al., 2023). Amazon integrates analytics across its entire business model, eBay emphasizes behavioural insights and infrastructure efficiency, Shopify democratizes analytics for SMEs, and Flipkart leverages predictive modelling for demand and logistics in emerging markets. These findings align with Pande et al. and Almtiri et al., confirming that data analytics enhances efficiency, personalization, and competitiveness, while highlighting the importance of scalability, accessibility, and ethical data governance.

Strategically, the results suggest that e-commerce businesses must integrate analytics as a central component of operations and growth strategy, rather than merely as a supportive tool. The practical applications demonstrated by these platforms offer insights for other firms seeking to leverage data-driven decision-making to optimize customer experience, operational efficiency, and strategic agility.

Conclusion

This research has explored how data analytics plays a critical role in optimizing key e-commerce functions such as inventory management, logistics, personalization, marketing, and pricing. Case studies of Amazon, eBay, Shopify, and Flipkart reveal that analytics has transformed business decision-making—from reactive and intuition-based to proactive, data-driven strategies.

Each company demonstrates a unique application of analytics based on its business model: Amazon integrates AI and predictive analytics across all operations; eBay focuses on customer behaviour analytics and infrastructure optimization; Shopify empowers small businesses through accessible dashboards; and Flipkart applies data science to improve supply chain and marketing performance.

The findings confirm that data analytics enhances both operational efficiency and customer experience, contributing to increased competitiveness in a crowded digital marketplace.

REFERENCES

Abidemi A., Abayomi P. 2023. Big Data analytics in e-commerce marketing and measuring its effectiveness. doi:10.13140/RG.2.2.29185.22881

Adebanji S., Balogun E., Kolade O. 2025. The role of business analytics in enhancing revenue optimization and competitive advantage in e-commerce. Gulf Journal of Advance Business Research 3 (3), 952-963. doi:10.51594/gjabr.v3i3.121

Almtiri Z., Miah S., Noman N. 2022. Impact of business analytics and decision support

systems on E-commerce in SMEs. Springer Nature Singapore, 344-361. doi:10.48550/arXiv.2212.00016

Benjamin L., Amajuoyi P., Adeusi K. 2024. Leveraging data analytics for informed product development from conception to launch. GSC Advanced Research and Reviews 19 (2), 230-248. doi:10.30574/gscarr.2024.19.2.0180

Deng C., Zhang J., Wu R. 2023. Application and future of data analytics in retail e-commerce. Proceedings of ICEDBC 225, 471. doi:10.2991/978-94-6463-036-7_7

Fu. X. 2023. The promoting role of business environment optimization on the development of cross-border e-commerce. Information Systems and Economics 4 (8). doi:10.23977/infse.2023.040818

Govindarajan S., Balaji A. 2024. Leveraging data analytics for product decision-making.

Hasan M., Daryanto Y., Triki Ch., Elomri A. 2024. An inventory model of e-marketplace with a promotional program. Journal of Modelling in Management 19 (3), 787-808. doi:10.1108/jm2-01-2023-0011

Huang Ch. 2020. The study of business model for cross-border e-commerce. Management Studies 8 (1), doi:10.17265/2328-2185/2020.01.004

Jain A. 2025. The role of predictive analytics in e-commerce conversion rate optimization. Journal of Computer Science and Technology Studies 7 (2), 114-121. doi:10.32996/jcsts.2023.5.4.25

Jakkula A. 2023. Predictive analytics in e-commerce: maximizing business outcomes. J. Mark. Supply Chain. Manag 2, 1-3. doi:10.47363/JMSCM/2023(2)158

Liu J. 2022. Research on the effectiveness of customers to business to customers business model on consumers' willingness to use e-commerce platform. BCP Business & Management 31, 1-12. doi:10.54691/bcpbm.v31i.2530

Liu P. 2024. Optimizing e-commerce operational efficiency and customer experience through data analytics and technological innovation. Advances in Economics, Management and Political Sciences. doi:10.54254/2754-1169/100/20241121

Mashtakov M.M., Shirokova S.V., Bolsunovskaya M.V. 2023. Application of RPA technology in management and decision-making processes. Technoeconomics 2, 1 (4), 29–40. DOI: https://doi.org/10.57809/2023.2.1.4.3

Pande P., Adokshaja K. 2025. Big Data analytics in e-commerce driving business decisions through customer behavior insights. ITM Web of Conferences 76, 05001. doi:10.1051/itmconf/20257605001

Rimon S., Tamim H. 2024. Leveraging artificial intelligence in business analytics for informed strategic decision-making: enhancing operational efficiency, market insights, and competitive advantage. Journal of Artificial Intelligence General science (JAIGS) 6 (1), 600-624. doi:10.60087/jaigs.v6i1.278

Shah W. 2021. AI and Big Data integration for intelligent supply chain optimization: boosting efficiency in ecommerce operations. Open Access Library Journal 12 (7). doi:10.13140/RG.2.2.12825.22888

Urhan C. 2023. Leveraging data analytics for improved business process efficiency. OSF Preprints, 1-9. doi:10.31219/osf.io/r8q6x

Wang L., Pertheban T., Li T., Zhao L. 2024. Application of business intelligence based on big data in E-commerce data evaluation. Heliyon 10 (21). doi:10.1016/j.heliyon.2024.e38768

Zeng A., Yu H., He H. 2021. Enhancing e-commerce recommender system adaptability with online deep controllable learning-to-rank. Proceedings of the AAAI Conference on Artificial Intelligence 35 (17), 15214-15222. doi:10.1609/aaai.v35i17.17785

Zhuang W. 2021. The influence of Big Data Analytics on e-commerce: case study of the US and China. Wireless Communications and Mobile Computing 1, 2888673. doi:10.1155/2021/2888673

СПИСОК ИСТОЧНИКОВ

Abidemi A., Abayomi P. 2023. Big Data analytics in e-commerce marketing and measuring its effectiveness. doi:10.13140/RG.2.2.29185.22881

Adebanji S., Balogun E., Kolade O. 2025. The role of business analytics in enhancing reve-

nue optimization and competitive advantage in e-commerce. Gulf Journal of Advance Business Research 3 (3), 952-963. doi:10.51594/gjabr.v3i3.121

Almtiri Z., Miah S., Noman N. 2022. Impact of business analytics and decision support systems on E-commerce in SMEs. Springer Nature Singapore, 344-361. doi:10.48550/arXiv.2212.00016

Benjamin L., Amajuoyi P., Adeusi K. 2024. Leveraging data analytics for informed product development from conception to launch. GSC Advanced Research and Reviews 19 (2), 230-248. doi:10.30574/gscarr.2024.19.2.0180

Deng C., Zhang J., Wu R. 2023. Application and future of data analytics in retail e-commerce. Proceedings of ICEDBC 225, 471. doi:10.2991/978-94-6463-036-7_7

Fu. X. 2023. The promoting role of business environment optimization on the development of cross-border e-commerce. Information Systems and Economics 4 (8). doi:10.23977/infse.2023.040818

Govindarajan S., Balaji A. 2024. Leveraging data analytics for product decision-making.

Hasan M., Daryanto Y., Triki Ch., Elomri A. 2024. An inventory model of e-marketplace with a promotional program. Journal of Modelling in Management 19 (3), 787-808. doi:10.1108/jm2-01-2023-0011

Huang Ch. 2020. The study of business model for cross-border e-commerce. Management Studies 8 (1), doi:10.17265/2328-2185/2020.01.004

Jain A. 2025. The role of predictive analytics in e-commerce conversion rate optimization. Journal of Computer Science and Technology Studies 7 (2), 114-121. doi:10.32996/jcsts.2023.5.4.25

Jakkula A. 2023. Predictive analytics in e-commerce: maximizing business outcomes. J. Mark. Supply Chain. Manag 2, 1-3. doi:10.47363/JMSCM/2023(2)158

Liu J. 2022. Research on the effectiveness of customers to business to customers business model on consumers' willingness to use e-commerce platform. BCP Business & Management 31, 1-12. doi:10.54691/bcpbm.v31i.2530

Liu P. 2024. Optimizing e-commerce operational efficiency and customer experience through data analytics and technological innovation. Advances in Economics, Management and Political Sciences. doi:10.54254/2754-1169/100/20241121

Mashtakov M.M., Shirokova S.V., Bolsunovskaya M.V. 2023. Application of RPA technology in management and decision-making processes. Technoeconomics 2, 1 (4), 29–40. DOI: https://doi.org/10.57809/2023.2.1.4.3

Pande P., Adokshaja K. 2025. Big Data analytics in e-commerce driving business decisions through customer behavior insights. ITM Web of Conferences 76, 05001. doi:10.1051/itmconf/20257605001

Rimon S., Tamim H. 2024. Leveraging artificial intelligence in business analytics for informed strategic decision-making: enhancing operational efficiency, market insights, and competitive advantage. Journal of Artificial Intelligence General science (JAIGS) 6 (1), 600-624. doi:10.60087/jaigs.v6i1.278

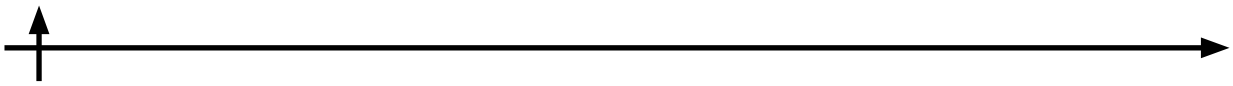
Shah W. 2021. AI and Big Data integration for intelligent supply chain optimization: boosting efficiency in ecommerce operations. Open Access Library Journal 12 (7). doi:10.13140/RG.2.2.12825.22888

Urhan C. 2023. Leveraging data analytics for improved business process efficiency. OSF Preprints, 1-9. doi:10.31219/osf.io/r8q6x

Wang L., Pertheban T., Li T., Zhao L. 2024. Application of business intelligence based on big data in E-commerce data evaluation. Heliyon 10 (21). doi:10.1016/j.heliyon.2024.e38768

Zeng A., Yu H., He H. 2021. Enhancing e-commerce recommender system adaptability with online deep controllable learning-to-rank. Proceedings of the AAAI Conference on Artificial Intelligence 35 (17), 15214-15222. doi:10.1609/aaai.v35i17.17785

Zhuang W. 2021. The influence of Big Data Analytics on e-commerce: case study of the US and China. Wireless Communications and Mobile Computing 1, 2888673. doi:10.1155/2021/2888673



INFORMATION ABOUT AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

OKUNLOLA Peter M. – student.
E-mail: okunlola_pm@spbstu.ru
ОКУНЛОЛА Петер Майова – студент.
E-mail: okunlola_pm@spbstu.ru

LEVINA Anastasia I. – Professor, Doctor of Economic Sciences
E-mail: alyovina@gmail.com
ЛЁВИНА Анастасия Ивановна – профессор, д.э.н.
E-mail: alyovina@gmail.com
ORCID: https://orcid.org/0000-0002-4822-6768

Статья поступила в редакцию 12.08.2025; одобрена после рецензирования 18.08.2025; принята к публикации 21.08.2025.

The article was submitted 12.08.2025; approved after reviewing 18.08.2025; accepted for publication 21.08.2025.

Technoeconomics. 2025, Vol. 4, No. 3 (14). Pp. 15–25.
Техноэкономика. 2025, Том 4, № 3 (14). С. 15–25.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.2

MULTI-AGENT SYSTEM AS A TOOL FOR TRANSPORT LOGISTICS PLANNING: TECHNICAL STATUS OF VEHICLES IN THE RUSSIAN FEDERATION

Lev Gudkovskiy ✉

Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia

✉ gudkovskij.lg@edu.spbstu.ru

Abstract. This article examines the importance of transport logistics in the Russian Federation. The authors assess the performance of transport logistics and its integral components. In the course of the research the Rosstat data and the LPI coefficient were employed in the statistical analysis. Factors that influence logistics performance were identified, including weather and road conditions, customs operations, and information support. What is more, the technical readiness and status of vehicles were examined with due respect to the logistics performance indicators that prove its efficiency. As a result, the authors suggest a method for managing transport and logistics based on a multi-agent system with predictive analytics and IoT devices that contribute to better management and forecasting in transport logistics.

Keywords: transport logistics, multi-agent system, virtual private network, technical monitoring, predictive analytics

Citation: Gudkovskiy L. Multi-agent system as a tool for transport logistics planning: technical status of vehicles in the Russian Federation. Technoeconomics. 2025. 4. 3 (14). 15–25. DOI: https://doi.org/10.57809/2025.4.3.14.2

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.2

МУЛЬТИАГЕНТНАЯ СИСТЕМА КАК ИНСТРУМЕНТ ПЛАНИРОВАНИЯ ТРАНСПОРТНОЙ ЛОГИСТИКИ: ТЕХНИЧЕСКАЯ ГОТОВНОСТЬ ТРАНСПОРТНЫХ СРЕДСТВ В РОССИЙСКОЙ ФЕДЕРАЦИИ

Лев Гудковский ✉

Санкт-Петербургский политехнический университет Петра Великого,
Санкт-Петербург, Россия

✉ gudkovskij.lg@edu.spbstu.ru

Аннотация. Данная статья посвящена исследованию значимости транспортной логистики в Российской Федерации. В ходе работы, авторами был определён уровень эффективности транспортной логистики на основании статистических данных Росстата и коэффициента LPI. Были определены ключевые факторы, влияющие на логистический процесс, такие как погодные условия, состояние дорог, работа таможни, информационная поддержка. С учетом факторов влияния на транспортную логистику, была проведена оценка технической готовности транспортных средств, и определены коэффициенты эффективности. В результате исследования, разработан подход к управлению транспортно-логистическими процессами с учётом технического состояния на основе мультиагентной системы с предиктивной аналитикой и использованием IoT устройств для улучшения прогнозирования и управления в логистике.

Ключевые слова: транспортная логистика, мультиагентная система, ВП-сеть, учет технического состояния, предиктивная аналитика

Для цитирования: Гудковский Л. Мультиагентная система как инструмент планирования транспортной логистики: техническая готовность транспортных средств в Российской Федерации // Техноэкономика. 2025. Т. 4, № 3 (14). С. 15–25. DOI: https://doi.org/10.57809/2025.4.3.14.2

Introduction

The ongoing globalization and rapid technological advancement make logistics and delivery management an integral component of effective business management. Adaptive route management for deliveries is a relevant and in-demand area aimed at addressing challenges related to the optimization of logistics.

Modern consumers expect not only high-quality products but also timely delivery, thus posing new challenges for companies. Increasing delivery speed and flexibility requires organizations to implement innovative technologies that can provide an automated and intuitive approach to process management (Bulatov, 2024; Chandra, 2002). In this context, adaptive route management involves the use of methods and tools that enable dynamic and effective response to changes that arise during transportation. Key factors contributing to the successful adaptation of delivery routes include changing traffic conditions, fluctuations in demand, unforeseen climate events, and human factors (Zayats, 2019; Zhou, 2023).

Materials and Methods

In this research, a comprehensive approach based on a systemic analysis of existing scientific papers and practical experiences was used to examine the choice of management methods in transport logistics.

Results and Discussion

This research examines the application of a multi-agent system in transport logistics in the Russian Federation, focusing on the use of motor vehicles. It also explores its shortcomings and operational specifics.

In the Russian Federation, transport logistics takes a leading position in the economy due to the country's vast size and the diverse locations of its major economic centres. The share of transport costs in GDP in 2025 amounts to approximately 20%. In this respect, the Russian Federation ranks among the top 30 countries, making transport logistics the most important component of the Russian economy.

The significance of transport logistics for the Russian Federation should also be described with the help of the Logistics Performance Index (LPI). This index characterizes the convenience and relative ease of delivery, both nationally and internationally. It also measures the timeframe and percentage of on-time delivery (Ilyin, 2014; Kalinina, 2024; Malysheva, 2022). According to the Logistics Performance Index, the Russian Federation ranks 75th out of 100. Russia's score on this index is 2.6. By comparison, Germany and the Netherlands each have a score of 4.1.

Such a low position is influenced by several factors: country size, weather conditions, road quality, customs operations, and information tracking during the delivery. Table 1 presents the countries' areas in descending order.

Table 1. Areas of countries in descending order.

Country	Area, km²
Russia	17 098 242
Canada	9 984 670
USA	9 833 517
China	9 596 960
Brazil	8 515 770
Australia	7 741 220
India	3 287 263
Argentina	2 780 400
Kazakhstan	2 381 740

Customs operations in the Russian Federation rank 96th out of 100 countries. Communication and cargo tracking issues also arise in remote parts of the country. Tracking the delivery of material assets is particularly challenging.

In most cases, transport logistics involves not only road transport but also other means. Various modes of transport are used to deliver material assets in order to boost the efficiency and cost-effectiveness of logistics (Makarov, 2012; Nikitin, 2024).

One of the main bottlenecks of transport logistics is the low-quality of road infrastructure. Another major challenge in transport logistics is weather conditions, which greatly impact the complexity of delivery and quality of road surface (Egorov, 2020; Glushchenko, 2019). Table 2 and 3 provide data on the compliance of highways with regulatory requirements by region (Rosstat based).

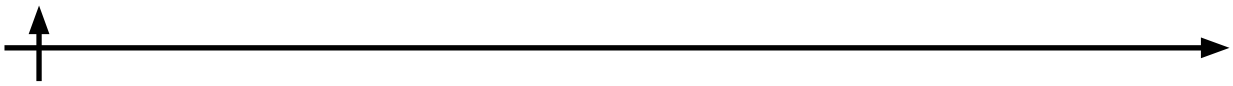


Table 2. Compliance of roads with regulatory requirements.

Region	Share of roads that meet the standard	Density of paved roads per 1000 km²
Top 20 Road Quality Projects		
Moscow	97.6	2521.6
Khanty-Mansi Autonomous Okrug - Yugra	88.4	11.7
Krasnodar Krai	88.4	481.0
Chelyabinsk Oblast	84.1	248.6
Republic of Ingushetia	82.8	1024.5
Belgorod Oblast	77.3	732.0
Republic of Adygea	77.1	578.8
Yamalo-Nenets Autonomous Okrug	74.9	3.7
Sevastopol	74.8	1213.5
Republic of Dagestan	74.2	477.5
Moscow region	73.9	848.8
Tyumen Oblast	72.8	93.2
Khabarovsk Krai	71.4	12.8
Chukotka Autonomous Okrug	71.3	1.3
Kemerovo Oblast	71.2	183.1
Saint Petersburg	70.7	2542.4
Republic of Bashkortostan	67.1	325.1
Republic of Tatarstan	65.2	476.0
Stavropol Krai	65.0	280.7
Perm Krai	64.5	146.9
Total for the country		
Russian Federation	54.1	65.6

Table 3. Total road length by regions.

Region	2022	2023
Central Federal Region	230 405.6	231 030.7
Northwestern Federal Region	74 316.2	74 513.3
Southern Federal Region	110 660.3	113 446.4
North Caucasian Federal Region	68 819.8	68 925.7
Volga Federal Region	254 986.2	255 527.8
Ural Federal Region	62 269.6	62 722.3
Siberian Federal Region	135 634.7	134 621.8
Far Eastern Federal Region	70 932.2	71 460.2
Total for the country		
Russian Federation	1008 024.6	1012 248.2

According to Table 1, – only 54.1% of the Russian Federation's roads are open, with a road density of 65.6 km^2 per 1.000 km^2 – it is clear that one of the main problems in transport logistics is poor-quality roads. This issue impacts the condition of logistics vehicles and, subsequently, increases the economic burden for their maintenance, provokes emergencies, hinders the on-time delivery, and damages to material assets on the way.

One of the main factors in transport logistics is the wear and tear of a logistics vehicle. Any transport vehicle has a lifespan, and in some cases, it can vary depending on road and weather conditions. It also touches upon the distribution of resources and modern approaches to minimizing costs and increasing efficiency under resource constraints (Kuznetsova, 2013; Li, 2021).

One of the key challenges in transport logistics is determining the actual lifespan of a logistics vehicle, taking into account maintenance costs versus the residual value. This requires continuous and systematic analysis of several parameters, including the vehicle condition, efficiency, and road quality.

Another challenge should also be considered: insufficient information support during delivery, resulting in delays and emergencies. Despite today's high level of information support and automation, communication and delivery process tracking issues do persist. International and long-distance deliveries particularly suffer from this imperfection.

Due to the aforementioned problems in transport logistics, the average vehicle utilization rate was 22%. Based on over 15.000 measurements, the following freight vehicle utilization pattern was recorded: 56% of vehicles were completely empty, and 44% were loaded. More than 80% of rolling stock (freight vehicles) travelling from the Siberian and Far Eastern Federal Regions was unloaded.

A possible solution to this problem involves implementing an information system capable of managing logistics vehicles by tracking them promptly, and creating up-to-date timeframes and schedules for cargo movement using GPS and GLONASS systems (Borremans et al., 2024 ; Korablev et al., 2021; Skobelev, 2011; Taniguchi, 2024).

It is also worth noting why so much attention is paid to road transport. Road transport is one of the primary modes of delivery, as it is the most mobile mode of transport, capable of delivering materials to remote parts of Russia. The imperfections of road transport lead to reduced efficiency of logistics and a slowdown in economic growth in the Russian Federation.

Transport vehicles are technologically complex machines containing over 10.000 parts. Each part or element of a logistics vehicle may have varying degrees of reliability in different conditions. Reliability is the ability of a transport vehicle to ensure its uninterrupted operation under specified conditions. Reliability is featured by such properties as longevity, trouble-free operation, and maintainability.

A transport failure is an abnormal situation when a vehicle loses its ability to perform the intended tasks. Failure most often occurs due to wear and tear on vehicle parts or excessive load. Figure 1 depicts the main failure conditions.

Maintainability is a criterion for a logistics vehicle, calculated using residual value and maintenance costs. This criterion indicates when it is most profitable and necessary to replace or maintain a transport vehicle.

The area of technical support of a logistics vehicle is a complex of interconnected technical, economic, and organizational events, which include timely organization and transfer of logistics vehicles for maintenance and ensuring their proper performance, taking into account the condition at economic value and calculations of minimum maintenance costs and safety. Such concerns as ecology, labour protection, and personnel safety are also considered.

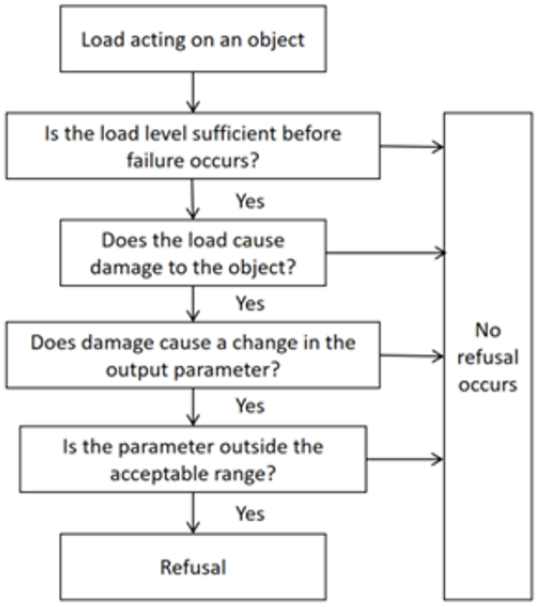


Fig. 1. Failure conditions.

There are several criteria for assessing the technical condition of transport and logistics vehicles, including timeliness and safety, maximum efficiency, operational properties, quality of the performed logistics tasks under conditions of maximum load, as well as technical condition.

Efficiency of technical support of a logistics vehicle depends on the technical support service. Depending on the type of logistics tasks, enterprises, and the location of the transportation activities, the technical support service for logistics vehicles can provide the functions of a production structure based on a specific enterprise – an independent entity that provides services to owners of various logistics vehicles.

The primary role of technical support is to ensure that a company or fleet of logistics vehicles is properly maintained in a timely manner. In other words, this area of support enables the most efficient use of serviceable logistics vehicles, taking into account the asset's cost.

From the point of view of logistics transport, reliability must be divided into several groups (Achatbi, 2020; Alibekov, 2017):

Reliability of vehicles during production and design – achieved by designing components with a reserve to withstand the loads that will be encountered during vehicle operation;

Reliability of vehicles during the operational phase – for example, limitations on the load capacity and speed.

Every year, the demands on the reliability and safety of logistics vehicles increase because the economic system demands greater efficiency and an increase in the number of deliveries. However, as the demands and number of vehicles increase, the maintenance-associated problems arise. In most cases, vehicle maintenance is untimely and poorly performed. This arises from a number of issues: lack of qualified personnel; outdated maintenance equipment; lack of a wide-scale system for diagnosing failures. These problems are logically more relevant for the remote regions.

The primary objective of assessing the technical status of logistics vehicles is to study changes in reliability criteria, taking into account most delivery route conditions, such as weather and regional road quality. The operating conditions of individual vehicle models should also be considered, as the reliability of the same components may vary across models. Another objective is to study the algorithm for economical vehicle operation and timely maintenance until the

vehicle can continue to generate adequate profits.

Thus, there is a need to create a system that will take into account the technical condition of the vehicle, as well as its management with the maximum efficiency. Taking into account the abovementioned factors, it is necessary to determine which management system will most effectively manage the fleet of vehicles in terms of their technical readiness.

For a more detailed analysis, key performance indicators are provided below. These are necessary for a quantitative analysis of transport logistics performance.

Key performance indicators of the technical support of a logistics vehicle:

Technical Readiness Coefficient (TRC):

$$TRC = \frac{Number\ of\ serviceable\ vehicles}{Total\ number\ of\ vehicles\ in\ the\ fleet} * 100\%$$

Mean Time To Repair (MTTR):

$$MTTR = \frac{Total\ time\ spent\ on\ repairs}{Number\ of\ vehicle\ failures}$$

Mean Time Between Failures (MTBF):

$$MTBF = \frac{Total\ operating\ time\ of\ the\ vehicle}{Number\ of\ vehicle\ failures}$$

Percentage of Unscheduled Repairs (UOR):

$$UOR = \frac{Number\ of\ unscheduled\ repairs}{Total\ number\ of\ repairs} * 100\%$$

Maintenance costs for a vehicle per 1 km:

$$cost\ per\ kilometer = \frac{Total\ vehicle\ maintenance\ costs}{Total\ mileage\ of\ the\ vehicle\ fleet}$$

Reduction of Accident Situations (RAS) on public roads:

$$RAS = \frac{Number\ of\ road\ accidents\ up\ to - Number\ of\ accidents\ after}{Number\ of\ road\ accidents\ up\ to}$$

Key performance indicators from a logistics perspective:

Vehicle Fleet Rate (VFR):

$$VFR = \frac{Vehicle\ operation\ time\ (on\ the\ route)}{Total\ explotation\ time} * 100\%$$

On Time In Full (orders completed on time – OTIF):

$$OTIF = \frac{Number\ of\ on-time\ delieveries\ without\ incidents}{Total\ number\ of\ delieveries} * 100\%$$

Once the key performance indicators for the future system have been identified, it is necessary to consider several solutions that will shape the basis of the logistics management system.

Telematics and the IoT will enable the real-time collection, analysis, and use of data on the vehicle status and fleet management. They can be installed in various vehicle parts, such as the engine, transmission, chassis, and electrical components. Each engine type will track the necessary parameters for maintaining the vehicle's technical condition. At the same time, the use of GLONASS will enable the tracking of other important parameters, such as speed, location, and vehicle operating mode.

Another option that could form a management system is the development of digital twins. A digital twin is a virtual copy of a physical object that can reflect the condition and behaviour of a vehicle in real time (Kardashova, 2016; Kiryushin, 2019). This twin will allow for the prediction and real-time monitoring of the vehicle's technical status, as well as its failures. A digital twin includes the real object, IoT devices, and a digital model of the vehicle.

Another missing element for the vehicle control system is a predictive analytics unit. This unit is needed to analyze data coming from the IoT devices, which is difficult for humans to in-

terpret. Data from complex powertrains (engine, transmission) will be analyzed using machine learning. This is necessary to predict the failure of any component in the vehicle and promptly dispatch the vehicle for scheduled maintenance.

One of the most promising approaches to optimizing logistics processes in this area is the use of multi-agent systems (MAS). These systems are distributed software solutions consisting of multiple interacting agents, where each performs specific functions and tasks.

Multi-agent systems have features that are particularly suitable for logistics management systems, including:

Flexibility and Adaptability. Multi-agent systems provide high flexibility and adaptability in logistics process management. Each agent can respond to changes in real time, reacting to unscheduled repairs, loss of connection to the system, route changes, or order sequencing. This allows for rapid adaptation to new conditions and minimizes negative economic impacts.

Route and resource optimization. Agents in a multi-agent system can effectively interact with each other to optimize delivery routes and distribute vehicles. Using routing algorithms and data analysis, such systems can find the most efficient routes, reducing transportation costs and delivery times. This is especially important in situations with limited resources and the need to respond quickly to various situations.

Risk reduction and increased fault tolerance. The use of multi-agent systems helps reduce the risks associated with logistics operations. Thanks to the decentralized structure, failures in the operation of a single agent do not lead to the shutdown of the entire system. This increases the resilience of logistics processes and allows for faster recovery from unforeseen situations.

The multi-agent system will be implemented using neural networks (reinforcement learning) with a virtual machine learning network structure. This approach to multi-agent systems will shift their operational methodology from reactive coordination to predictive analytics.

The implementation of neural networks will expand the functionality of agents from simple programs with conditions to adaptive control elements capable of learning and prediction. In other words, each agent in the system is equipped with its own neural network that analyzes big data and real-time data. For instance:

Cargo agent. Predicts the risk of delays on a specific route segment (by analyzing the weather, traffic jams, and the history of downtime at a specific warehouse).

Logistics Agent. Analyzes peak loads at loading centres and adjusts the arrival times of logistics vehicles to minimize downtime during loading and unloading.

Vehicle Status Agent. Predicts the likelihood of vehicle failure using predictive analytics, based not only on current IoT metrics but also on past correlations.

Conclusion

As a result, it can be concluded that a multi-agent system will improve the efficiency of deliveries. The new management system will allow for rapid adaptation to changing conditions. Further development of the management system should consider many factors related to transport, including weather and road conditions, technical and information support, as well as the technical status of the vehicle fleet. In the process of implementation, it will be also important to consider such integral parameters as the work and rest schedules, and driver safety.

REFERENCES

Achatbi A., Amechnoue Kh., Haddadi T., Allouch S. 2020. Advanced system based on ontology and multi agent technology to handle upstream supply chain: intelligent negotiation protocol for supplier and transportation provider selection. Decision Science Letters, 337-354. doi:10.5267/j.dsl.2020.5.002

Alibekov B., Mamaev E. 2017. Multi-agent systems in logistics: information and analytical aspects. Bulletin of Dagestan State University. Natural Sciences 4.

Borremans A., Dubgorn A., Levina A., Trifonova N., Gugutishvili D. 2024. Arctic Sustainable Development: Digital and Logistics Infrastructure in the Region. In: Understanding the Digital Transformation of Socio-Economic-Technological Systems. Lecture Notes in Networks and Systems, 951. doi:10.1007/978-3-031-56677-6_1

Bulatov S. 2024. Comparative analysis of spare parts consumption and technical and operational indicators of electric vehicles and vehicles with internal combustion engines. TTPS 3 (69).

Chandra C., Smirnov A., Sheremetov L. 2002. Multi-agent technology for supply chain network information support. SAE Technical Papers. doi:10.4271/2002-01-0326

Egorov S., Sabah S., Zatonsky A. 2020. Simulation model of the technical readiness of a large vehicle fleet. SUSU Bulletin. Computer Technologies, Control, and Radioelectronics 2.

Glushchenko A. 2019. Technical operation of vehicles: a study guide for students of the faculty of engineering physics. UlSU, 232.

Golubev P. 2016. Analysis of shortcomings in transport logistics in Russia. European Research 11 (22).

Gorodetsky V., Bukhvalov O., Skobelev P. 2017. Current state and prospects for industrial applications of multi-agent systems. UBS 66.

Ilyin I., Levina A., Frolov K., Kalyazina S., Trifonova N., Chemeris O. 2014. Enterprise architecture: agent-based solutions. Study Guide.

Kalinina E. 2024. Digital transformation in logistics using digital twin technology. Technoeconomics 3 (10), 48–56. doi:10.57809/2024.3.3.10.5

Kardashova M., Dalgatova I. 2016. Prospects for the development of transport logistics. Russian Journal of Economics and Management 9 (71), 69-75.

Kiryushin I., Retyunskikh V. 2019. On the relationship between the vehicle technical readiness factor and the operational cycle. RGATU Bulletin 2 (42).

Korablev V., Gugutishvili D., Lepekhin A., Gerrits B. 2021. Developing a Traffic Management System Architecture Model. Transportation Research Procedia 54, 918-926. doi:10.1016/j.trpro.2021.02.147

Kuznetsova A. 2013. Financial criteria for the efficiency of the logistics system of an industrial company. Production organizer 2 (57).

Li Q., Lin W., Liu Zh., Prorok A. 2021. Message-aware graph attention networks for large-scale multi-robot path planning. IEEE Robotics and Automation Letters 6 (3), 5533-5540. doi:10.1109/lra.2021.3077863

Makarov M., Martynyuk A., Zaretsky A. 2012. Transport logistics. Actual Problems of Humanities and Natural Sciences 12.

Malysheva T. 2022. Automatization of a logistic process using platooning technology for cargo transportation from Finland to Saint-Petersburg. Technoeconomics 1 (1), 43–53. DOI: https://doi.org/10.57809/2022.1.1.4

Nikitin N., Ilin I., Dubgorn A. 2024. The task of allocating operations to work centers: modern approaches to cost minimization and efficiency improvement under resource constraints. Sustainable Development and Engineering Economics 4, 9-22. doi:10.48554/SDEE.2024.4.1

Skobelev P. 2011. Multi-agent technologies for real-time resource management. Mechanics, Control, and Informatics, 2-4.

Taniguchi E., Thompson R., Qureshi A. 2024. Recent developments in urban freight analytics for collaborative city logistics. Transportation Research Procedia 79, 3-12. doi:10.1016/j.trpro.2024.03.003

Zayats Yu., Salnikov A., Maslennikova I. 2019. Criteria for assessing the fulfillment of life cycle contract terms for automotive equipment at the operational stage and the risks of their

application. Bulletin of Tula State University. Technical Sciences 3.

Zhou Q., Huang Yu., Xiong X., Zhao J. 2023. Distributed model predictive control methods for intermodal transport cooperative planning based on ADMM. IET Intelligent Transport Systems 17 (1), 102-118. doi:10.1049/itr2.12241

СПИСОК ИСТОЧНИКОВ

Achatbi A., Amechnoue Kh., Haddadi T., Allouch S. 2020. Advanced system based on ontology and multi agent technology to handle upstream supply chain: intelligent negotiation protocol for supplier and transportation provider selection. Decision Science Letters, 337-354. doi:10.5267/j.dsl.2020.5.002

Алибеков Б. И., Мамаев Э. А. 2017. Мультиагентные системы в логистике: информационно-аналитические аспекты. Вестник Дагестанского государственного университета. Естественные науки 4.

Borremans A., Dubgorn A., Levina A., Trifonova N., Gugutishvili D. 2024. Arctic Sustainable Development: Digital and Logistics Infrastructure in the Region. In: Understanding the Digital Transformation of Socio-Economic-Technological Systems. Lecture Notes in Networks and Systems, 951. doi:10.1007/978-3-031-56677-6_1

Булатов С. В. 2024. Сравнительный анализ расхода запасных частей и технико-эксплуатационных показателей парка электромобилей и автомобилей с двигателями внутреннего сгорания. ТТПС 3 (69).

Chandra C., Smirnov A., Sheremetov L. 2002. Multi-agent technology for supply chain network information support. SAE Technical Papers. doi:10.4271/2002-01-0326

Егоров С. Я., Сабах С. Х., Затонский А. В. 2020. Имитационная модель технической готовности крупного автопарка. Вестник ЮУрГУ. Серия: Компьютерные технологии, управление, радиоэлектроника 2.

Глущенко А.А. 2019. Техническая эксплуатация автомобилей: учебное пособие для студентов инженерно-физического факультета. УлГУ, 232.

Голубев П. В. 2016. Анализ недостатков транспортной логистики в России. European research 11 (22), 41-44.

Городецкий В. И., Бухвалов О. Л., Скобелев П. О. 2017. Современное состояние и перспективы индустриальных применений многоагентных систем. УБС 66.

Ильин И.В., Лёвина А.И., Фролов К.В., Калязина С.Е., Трифонова Н.В., Чемерис О.С. 2024. Архитектура предприятия: агент-ориентированные решения. Учебное пособия.

Kalinina E. 2024. Digital transformation in logistics using digital twin technology. Technoeconomics 3 (10), 48–56. doi:10.57809/2024.3.3.10.5

Кардашова М., Далгатова И. 2016. Перспективы развития транспортной логистики. Региональные проблемы преобразования экономики 9 (71), 69-75.

Кирюшин И. Н., Ретюнских В. Н. 2019. К вопросу изучения связи коэффициента технической готовности автомобилей с эксплуатационным циклом. Вестник РГАТУ 2 (42).

Korablev V., Gugutishvili D., Lepekhin A., Gerrits B. 2021. Developing a Traffic Management System Architecture Model. Transportation Research Procedia 54, 918-926. doi:10.1016/j.trpro.2021.02.147

Кузнецова А.А. 2013. Финансовые критерии эффективности логистической системы промышленной компании. Организатор производства 2 (57).

Li Q., Lin W., Liu Zh., Prorok A. 2021. Message-aware graph attention networks for large-scale multi-robot path planning. IEEE Robotics and Automation Letters 6 (3), 5533-5540. doi:10.1109/lra.2021.3077863

Макаров М., Мартынюк А., Зарецкий А. В. 2012. Транспортная логистика. Актуальные проблемы гуманитарных и естественных наук 12.

Malysheva T. 2022. Automatization of a logistic process using platooning technology for cargo transportation from Finland to Saint-Petersburg. Technoeconomics 1 (1), 43–53. DOI: https://doi.org/10.57809/2022.1.1.4

Никитин Н., Ильин И., Дубгорн А. 2024. Задача распределения операций по рабочим

центрам: современные подходы к минимизации затрат и повышению эффективности в условиях ресурсных ограничений. Устойчивое развитие и инженерная экономика 4 (14), 9-22. doi:10.48554/SDEE.2024.4.1

Скобелев П.О. 2011. Мультиагентные технологии для управления ресурсами в реальном времени. Механика, управление и информатика, 2-4.

Taniguchi E., Thompson R., Qureshi A. 2024. Recent developments in urban freight analytics for collaborative city logistics. Transportation Research Procedia 79, 3-12. doi:10.1016/j.trpro.2024.03.003

Заяц Ю. А., Сальников А. В., Масленникова И.Л. 2019. Критерии оценки выполнения условий контрактов жизненного цикла автомобильной техники на стадии эксплуатации и риски их применения. Известия ТулГУ. Технические науки 3.

Zhou Q., Huang Yu., Xiong X., Zhao J. 2023. Distributed model predictive control methods for intermodal transport cooperative planning based on ADMM. IET Intelligent Transport Systems 17 (1), 102-118. doi:10.1049/itr2.12241

INFORMATION ABOUT AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

GUDKOVSKIY Lev G. – student.
E-mail: gudkovskij.lg@edu.spbstu.ru
ГУДКОВСКИЙ Лев Геннадьевич – студент.
E-mail: gudkovskij.lg@edu.spbstu.ru

Статья поступила в редакцию 09.08.2025; одобрена после рецензирования 14.08.2025; принята к публикации 21.08.2025.

The article was submitted 09.08.2025; approved after reviewing 14.08.2025; accepted for publication 21.08.2025.

Technoeconomics. 2025, Vol. 4, No. 3 (14). Pp. 26–34.
Техноэкономика. 2025, Том 4, № 3 (14). С. 26–34.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.3

INNOVATIONS IN THE DEVELOPMENT OF THE IT SECTOR: DATA PROCESSING, BLOCKCHAIN, THE IOT

Olga Kimirilova ✉

Financial University under the Government of the Russian Federation, Novorossiysk, Russia

✉ kimirilova.2003@gmail.com

Abstract. In the context of rapid technological progress, new solutions and approaches are required to ensure competitiveness of organizations. Currently, areas such as artificial intelligence, blockchain, cloud technologies, and the Internet of Things are being widely considered, as well as their application in various aspects of our lives, from business to healthcare. This article focuses on modern innovations in information technologies and their impact on business development and societal processes. In the course of this research, special attention is paid to the risks associated with the implementation of innovations, such as data security issues and ethical concerns. Examples of technology implementation are provided to highlight the best areas for further development. In conclusion, the article emphasizes the importance of adapting educational programs and professional development for the successful integration of new technologies into practice.

Keywords: information technologies, blockchain, artificial intelligence, the Internet of Things

Citation: Kimirilova O. Innovations in the development of the IT sector: data processing, blockchain, the IoT. Technoeconomics. 2025. 4. 3 (14). 26–34. DOI: https://doi.org/10.57809/2025.4.3.14.3

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.3

ИННОВАЦИИ В РАЗВИТИИ IT-СЕКТОРА: ОБРАБОТКА ДАННЫХ, БЛОКЧЕЙН, ИНТЕРНЕТ ВЕЩЕЙ

Ольга Кимирилова ✉

Финансовый университет при Правительстве Российской Федерации, Новороссийск, Россия

✉ kimirilova.2003@gmail.com

Аннотация. В условиях стремительного технологического прогресса требуются новые решения и подходы, способные обеспечить высокую конкурентоспособность организаций. В настоящее время в научной среде широко рассматриваются такие направления, как искусственный интеллект, блокчейн, облачные технологии и интернет вещей, а также их применение в различных сферах нашей жизни – от бизнеса до здравоохранения. Данная статья посвящена анализу современных инноваций в области информационных технологий, их влиянию на развитие бизнеса и общества в целом. Особое внимание уделяется рискам, связанным с внедрением инноваций, таким как вопросы безопасности данных и этические аспекты. Приводятся примеры внедрения технологий, которые позволяют выявить наиболее перспективные направления дальнейшего развития. В заключение подчеркивается важность адаптации образовательных программ и повышения квалификации специалистов для успешной интеграции новых технологий в практическую деятельность предприятий.

Ключевые слова: информационные технологии, блокчейн, искусственный интеллект, интернет вещей

Для цитирования: Кимирилова О. Инновации в развитии IT-сектора: обработка данных, блокчейн, интернет вещей // Техноэкономика. 2025. Т. 4, № 3 (14). С. 26–34. DOI: https://doi.org/10.57809/2025.4.3.14.3

Introduction

Economic systems and technological progress are interconnected factors that determine socio-economic development. From agrarian societies to post-industrial eras, we can observe how economic systems not only adapted to technological systems but also actively stimulated them. Entire mechanisms are being created that ultimately lead to technological innovations, improvements in labour productivity, and enhancing living standards.

This research examines information technologies as a field related to the use of computers, software, networks, and other technologies for processing, storing, transmitting, and managing information. Information technologies encompass a wide range, including the Internet of Things, artificial intelligence, cybersecurity, and others. Technologies play a key role in modern business; their application significantly changes ways of conducting business. For example, technologies such as the Internet and mobile applications enable businesses to access new markets and attract customers from around the world.

Materials and Methods

This research relies on the existing works on the topic and author's assessment of the most promising innovations in the IT sector. The authors invited the following research methods:

evaluation, synthesis, classification, and description. These methods contributed to the wholescale examination of the theoretical and practical framework related to the experience of implementation of blockchain and the IoT in different industries.

Results and Discussion

A key element of information technologies is the information processing algorithm, which establishes a sequence of actions to obtain the information necessary for processing, while information technologies provide the means for implementing and storing this data.

Let us examine the stages of information processing (Figure 1). The first stage is the collection of specific information and its input into the system. Next, the selected data needs to be structured, sorted, and cleaned of unnecessary elements. The third stage involves the analysis and processing of the sorted data. After data analysis, it is possible to proceed to storing, exchanging, or outputting the processed data.

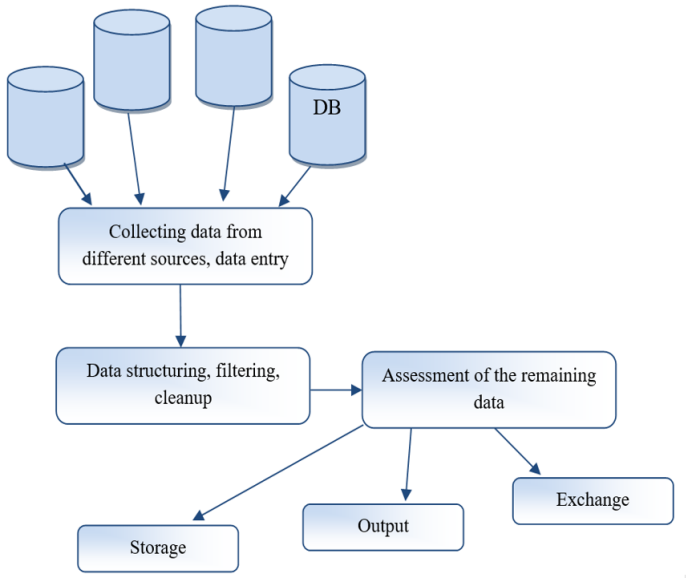


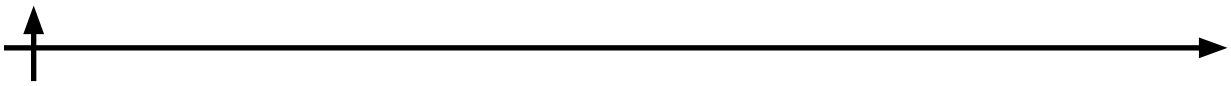
Fig. 1. Stages of Data Processing.

Digital transformation has now taken a central position in the strategic planning and operational activities of companies seeking to maintain their competitiveness. This process affects both the external and internal environments of an enterprise. Due to significant changes, digital transformation requires a comprehensive approach to adaptation and innovation.

The external ecosystem of digital development is characterized by several factors. Ongoing changes in regulatory policies are necessary, including issues related to data security and antitrust regulation, and special attention must be paid to cybersecurity concerns. Equally important are innovations that determine the pace and direction of the enterprise's development. The search for new competitive advantages and rapid adaptation to changes are integral parts of global competition (Bialetskaya, 2025; Boden, 2025; Chertkova, 2025; Churilov, 2025; Curley, 2022).

The internal environment for digital business development involves optimizing organizational processes, implementing automation systems, analytics, and machine learning, as well as retraining and upskilling personnel.

In sectors such as healthcare, financial technology, manufacturing, and energy, artificial intelligence, blockchain, and the Internet of Things are tools for achieving efficiency and im-



proving the quality of products and services.

The Internet of Things (IoT) and blockchain technologies have increasingly become integral components in the transformation of various industries, including healthcare, financial technology, manufacturing, and energy. Their convergence offers unprecedented opportunities to enhance transparency, efficiency, and security across these sectors.

In healthcare, the integration of IoT devices and blockchain has the potential to revolutionize patient care and data management. IoT enables continuous monitoring of patients through wearable medical devices, smart implants, and remote sensing technologies, thereby facilitating real-time data collection on vital signs and other health metrics. When combined with blockchain, this data can be securely stored and shared among authorized stakeholders such as healthcare providers, patients, and researchers, while ensuring data integrity and privacy.

Blockchain's decentralized ledger mitigates risks related to data tampering, unauthorized access, and fragmentation of medical records. Together, these technologies support more personalized treatment plans, improve diagnostic accuracy, and enhance healthcare delivery systems.

Within the realm of financial technology, IoT and blockchain collaborate to foster more secure, transparent, and efficient transactions. IoT devices provide real-time data streams that can inform financial decision-making, credit scoring, and asset tracking, which is particularly valuable for insurance and lending sectors. For example, IoT-enabled sensors can monitor physical assets used as collateral, providing verifiable evidence of their condition and existence. Blockchain reinforces this ecosystem by offering immutable transaction records and automating contract execution through smart contracts, thereby reducing fraud, settlement times, and operational costs. The synergy of these technologies contributes to a more resilient and transparent financial infrastructure that enhances trust among participants.

In manufacturing, IoT and blockchain contribute to the realization of Industry 4.0 by enabling smart factories characterized by automation, interconnectivity, and data-driven operations. IoT sensors embedded in machinery and production lines facilitate continuous monitoring of equipment performance, environmental conditions, and supply chain logistics. Captured data enables predictive maintenance and real-time optimization of manufacturing processes, reducing downtime and improving quality control. When blockchain technology is integrated, it ensures secure and tamper-proof tracking of components, materials, and products throughout the production and distribution lifecycle. This traceability supports compliance with regulatory standards and enhances accountability while enabling more efficient inventory management and reducing counterfeit risks (Zaramenkikh, 2025; Zudenkova, 2025).

In the energy sector, the combination of IoT and blockchain technologies promotes more sustainable, decentralized, and efficient energy management systems. IoT devices, including smart meters and sensors, monitor energy consumption patterns, production levels from renewable sources, and grid status in real time. This granular data enables dynamic demand-response strategies, grid balancing, and optimized resource allocation. Blockchain facilitates peer-to-peer energy trading platforms by recording transactions transparently and securely, allowing consumers and producers to exchange energy directly without intermediaries. Moreover, blockchain's immutable ledger can verify the provenance of renewable energy certificates and carbon credits, supporting regulatory compliance and incentivizing green energy adoption. These innovations collectively contribute to the advancement of smarter and more resilient energy ecosystems (Dawod, 2022; Ezhova, 2024; Kudryavtseva, 2025; Lunyakov, 2025; Maydanova, Ilin, 2023; Na, 2022; Narayandas, 2021).

Therefore, the integration of IoT and blockchain technologies across healthcare, financial technology, manufacturing, and energy sectors drives significant improvements in operational efficiency, transparency, security, and user empowerment. Their combined capabilities enable

real-time data acquisition, secure data management, and enhanced traceability, which are critical for addressing contemporary challenges and fostering innovation in these diverse industries.

Decentralized data storage and transmission technology, which allows recording information in the form of a chain of blocks called blockchain, is an important innovation. Each block contains a set of transactions and is linked to the previous block using cryptographic hash functions, making the data protected from modification and forgery. The main characteristics of blockchain include decentralization, transparency, security, and immutability (Prokhorov, 2025; Saranya, 2020; Shchegolyova, 2025; Smirnova, 2025; Sovetov, 2025).

Blockchain provides a high level of transparency, as all network participants can view transaction records. This can enhance trust between parties, especially in fields such as financial services, supply chain management, and government administration. In healthcare, blockchain can be used for the secure storage of medical records and ensuring their accessibility to various institutions, thereby improving the quality of patient care. Blockchain has revolutionized the financial sector through the creation of cryptocurrencies, smart contracts, and decentralized finance (DeFi). This enables faster and cheaper transactions and reduces reliance on traditional financial institutions. The core financial services of DeFi are presented below.

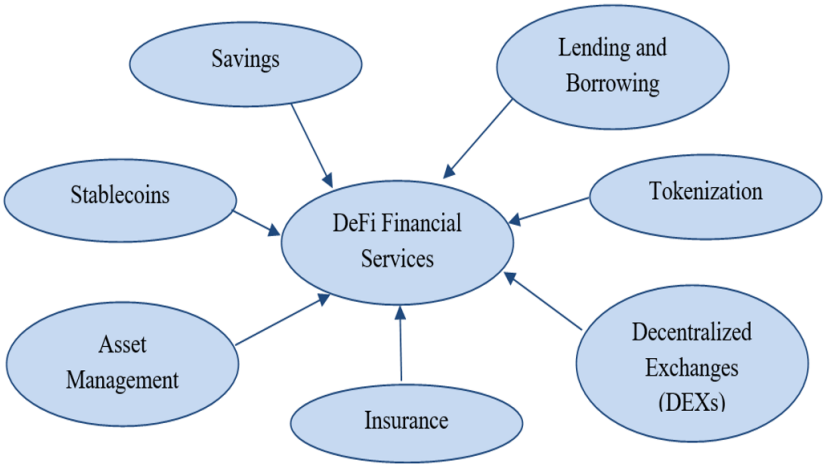
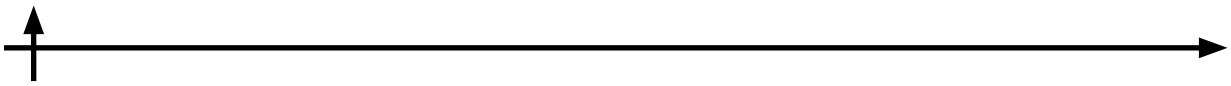


Fig. 2. DeFi Financial Services.

DeFi, or decentralized finance, represents a vast ecosystem of financial applications and services operating based on blockchain technologies. This ecosystem offers a variety of financial instruments, including lending, insurance, derivatives, and stablecoins. The main advantage of DeFi lies in its ability to make financial services more accessible: it eliminates the need for intermediaries and significantly reduces transaction costs.

Decentralized Finance (DeFi) presents a transformative shift in the provision and accessibility of financial services by leveraging blockchain technology. One of the primary benefits of DeFi is its ability to greatly enhance financial inclusion. Unlike traditional banking systems, which often require intermediaries and are restricted by geographic, regulatory, or economic barriers, DeFi platforms enable any individual with internet access to participate in a wide range of financial activities. This democratization of finance broadens the reach of services to underserved or unbanked populations globally.

Another significant advantage of DeFi lies in its potential to reduce operational costs and improve transaction efficiency. By eliminating the need for intermediaries such as banks, brokers, and payment processors, DeFi lowers transactional fees, making financial services more affordable. Moreover, the use of smart contracts automates many processes, enabling faster



execution and settlement of transactions compared to conventional financial systems. This increase in speed and reduction in cost significantly enhances the overall efficiency of financial operations.

Transparency also constitutes a core benefit of DeFi systems. Since all transactions and contractual procedures are recorded on public blockchains, users have the ability to audit and verify activities independently. This openness mitigates risks associated with fraud or manipulation and fosters greater trust among participants. Additionally, DeFi encourages financial innovation by allowing the creation of novel financial instruments such as programmable loans, yield farming, and decentralized exchanges. These innovations expand the diversity and sophistication of financial products available to users without the constraints imposed by traditional frameworks.

Furthermore, DeFi empowers users by granting them direct control over their assets through the management of private keys, thereby reducing dependence on third-party custodians and intermediaries. This enhancement in user sovereignty not only increases security but also aligns with broader trends toward decentralization and user autonomy. And finally, DeFi's global nature removes geographic boundaries, enabling seamless cross-border financial interactions and contributing to the integration of international markets.

Collectively, these characteristics illustrate how DeFi aims to create a more open, efficient, and inclusive financial ecosystem by leveraging the unique properties of blockchain technology and innovative decentralized architectures.

Nevertheless, despite all these benefits, digital finance has its drawbacks. Electronic money, which plays a key role in this system, also carries certain risks. While it provides convenience and speed, it is vulnerable to threats from hackers, fraudsters, and other cybercriminals. Additionally, the lack of clear regulation in the field of electronic money creates opportunities for illegal activities such as money laundering and terrorism financing.

Artificial intelligence (AI) is defined as a branch of computer science focused on creating systems capable of performing tasks that require intelligence, such as speech recognition, decision-making, learning, natural language understanding, and perception. AI includes various approaches and technologies, such as machine learning, neural networks, and natural language processing.

AI can improve people's quality of life through more efficient medical services, personalized learning, and enhanced living conditions. For example, AI can assist in disease diagnosis or offer individualized learning recommendations. Additionally, AI systems can analyze customer behaviour and suggest targeted advertising campaigns. For instance, algorithms determine which medications might interest patients based on their purchase history.

The Internet of Things (IoT), in turn, represents a global infrastructure in which physical and virtual objects are connected via a network. This technology has the potential to transform everything from industrial production to smart cities. The main goal of IoT development is to create an integrated and automated environment where data from various devices and systems can be collected, analyzed, and used to improve quality of life and business efficiency. For example, IoT devices such as RFID tags and GPS trackers enable companies to monitor the location and condition of goods at all stages of the supply chain. In the medical field, smartwatches and fitness trackers have gained popularity because they help collect health data.

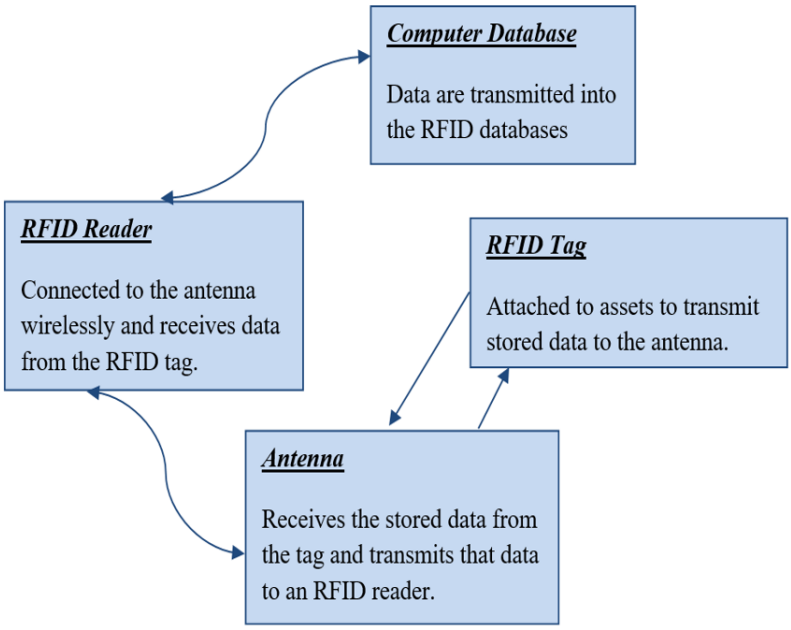


Fig. 3. How RFID works in Tech and revolutionizes industries.

Nevertheless, the adoption of new technologies is accompanied by a range of ethical and moral issues. Problems related to labour automation, replacing human participation, and the potential violation of workers' rights are becoming increasingly relevant. Additionally, there is a threat of expanding social inequality, as access to high-skilled jobs becomes limited. These aspects require a deep and multilayered analysis that encompasses sociological, psychological, and economic perspectives.

Conclusion

In the global digitalization context, modern technologies such as neural network solutions and interfaces attract particular attention. These innovations open up new opportunities for creating more intuitive and adaptive management systems that can take into account the unique characteristics and needs of each employee. Neural networks and machine learning algorithms are capable of analyzing user behaviour, preferences, and reactions, allowing for the formation of more effective and personalized workflows.

These technological advances lead to the emergence of a new type of “dream job,” where adaptive technologies create more flexible and dynamic working conditions. Employees gain the ability to customize their workspace, choose flexible schedules, and utilize resources for continuous professional development through online courses and virtual seminars.

In conclusion, we stand on the threshold of a new era where the integration of intelligent management systems, neural network technologies, and adaptive work models is shaping a new economic and social reality. However, the successful realization of this potential requires a comprehensive study of all related ethical and moral concerns. This demands an interdisciplinary approach and active collaboration among all stakeholders, from scientists and researchers to business leaders and legislators.

REFERENCES

Bialetskaya E., Kudryavtsev O. 2025. Operating algorithm of the strategic center for digital technologies in the fishing industry. Technoeconomics 2 (13), 50-59. doi:0.57809/2025.4.2.13.5

Boden M. 2025. Artificial Intelligence. How machines are getting smarter and changing our lives, 180.

Chertkova E. 2025. Statistics. Automation of Information Processing, 195.

Churilov A. 2025. Law of new technologies, 201.

Curley N. 2022. Blockchain disruption: digital assets are changing how we do business. SMU Science and Technology Law Review 25 (2), 265. doi:10.25172/smustlr.25.2.6

Dawod A., Georgakopoulos D., Jayaraman P. 2022. IoT device integration and payment via an autonomic blockchain-based service for IoT device sharing. Sensors 22 (4), 1344. doi:10.3390/s22041344

Ezhova L., Ryabova O., Statsuk L. 2024. Information technologies for business information visualization, 257.

Kudryavtseva O., Kudryavtsev M., Bialetskaya E. 2025. Development of a MongoDB database for change management in DEVOPS. Engineering and Construction 2 (52), 81-86.

Lunyakov O. 2025. Digital financial assets and blockchain technology, 298.

Maydanova S.A., Ilin I.V. 2023. Digital transformation strategy development in an enterprise architecture context. Technoeconomics, 2, 1 (4), 64–75. DOI: https://doi.org/10.57809/2023.2.1.4.6

Na D. 2022. IoT-chain and monitoring-chain using multilevel blockchain for IoT security. Sensors 22 (21), 8271. doi:10.3390/s22218271

Narayandas V., Archana M., Raman D. 2021. Concerns of modern IoT exploration over attainments of past observational challenges in IoT. International Journal of Innovative Technology and Exploring Engineering 10 (5), 18-23. doi:10.35940/ijitee.e8647.0310521

Prokhorov V., Rozhnov I. 2025. Digital financial assets, 298.

Saranya S. 2020. Context aware data fusion on massive IOT data in dynamic IOT analytics. Webology 17 (2), 957-970. doi:10.14704/web/v17i2/web17080

Shchegolyova N. 2025. Technologies and financial innovations, 81.

Smirnova L. 2025. Using activity-based approach in digital transformation projects in education, 170.

Sovetov B. 2025. Databases, 403.

Zaramenkikh E. 2025. Fundamentals of business informatics, 470.

Zaramenkikh E. 2025. Information systems in business, 470.

Zudenkova S., Panina O., Rozhdestvenskaya I. 2025. “Smart Cities” as centers for the implementation of innovative technologies, 301.

Business in numbers: from crypto and blockchain to phygital systems. URL: https://stepik.org/course/182693/info (accessed: 15.08.2025).

СПИСОК ИСТОЧНИКОВ

Bialetskaya E., Kudryavtsev O. 2025. Operating algorithm of the strategic center for digital technologies in the fishing industry. Technoeconomics 2 (13), 50-59. doi:0.57809/2025.4.2.13.5

Боден М. 2025. Искусственный интеллект. Как машины умнеют и меняют нашу жизнь, 180.

Черткова Е. 2025. Статистика. Автоматизация обработки информации, 195.

Чурилов А. 2025. Право новых технологий, 201.

Curley N. 2022. Blockchain disruption: digital assets are changing how we do business. SMU Science and Technology Law Review 25 (2), 265. doi:10.25172/smustlr.25.2.6

Dawod A., Georgakopoulos D., Jayaraman P. 2022. IoT device integration and payment via an autonomic blockchain-based service for IoT device sharing. Sensors 22 (4), 1344. doi:10.3390/s22041344

Ежова Л., Рябова О., Стацюк Л. 2024. Информационные технологии визуализации бизнес-информации, 257.

Кудрявцева О., Кудрявцева М., Бялецкая Е. 2025. Разработка базы данных в MON-

GODB для управления изменениями в DEVOPS. Инженерно-строительный вестник 2 (52), 81-86.

Луняков О. 2025. Цифровые финансовые активы и технология блокчейн, 298.

Maydanova S.A., Ilin I.V. 2023. Digital transformation strategy development in an enterprise architecture context. Technoeconomics, 2, 1 (4), 64–75. DOI: https://doi.org/10.57809/2023.2.1.4.6

Na D. 2022. IoT-chain and monitoring-chain using multilevel blockchain for IoT security. Sensors 22 (21), 8271. doi:10.3390/s22218271

Narayandas V., Archana M., Raman D. 2021. Concerns of modern IoT exploration over attainments of past observational challenges in IoT. International Journal of Innovative Technology and Exploring Engineering 10 (5), 18-23. doi:10.35940/ijitee.e8647.0310521

Прохоров В., Рожнов И. 2025. Цифровые финансовые активы, 298.

Saranya S. 2020. Context aware data fusion on massive IOT data in dynamic IOT analytics. Webology 17 (2), 957-970. doi:10.14704/web/v17i2/web17080

Щеголева Н. 2025. Технологии и финансовые инновации, 81.

Смирнова Л. 2025. Использование деятельностного подхода в проектах цифровой трансформации в образовании, 170.

Советов Б. 2025. Базы данных, 403.

Зараменских Е. 2025. Основы бизнес-информатики, 470.

Зараменских Е. 2025. Информационные системы в бизнесе, 470.

Зуденкова С., Панина О., Рождественская И. 2025. "Умные города" как центры внедрения инновационных технологий, 301.

Бизнес в цифре: от крипты и Blockchain до Phygital-систем. URL: https://stepik.org/course/182693/info (дата обращения: 15.08.2025).

INFORMATION ABOUT AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

KIMIRILOVA Olga S. – student.
E-mail: kimirilova.2003@gmail.com
КИМИРИЛОВА Ольга Сергеевна – студент.
E-mail: kimirilova.2003@gmail.com

Статья поступила в редакцию 19.08.2025; одобрена после рецензирования 26.08.2025; принята к публикации 27.08.2025.

The article was submitted 19.08.2025; approved after reviewing 26.08.2025; accepted for publication 27.08.2025.

Technoeconomics. 2025, Vol. 4, No. 3 (14). Pp. 35–45.
Техноэкономика. 2025, Том 4, № 3 (14). С. 35–45.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.4

CONCEPTUAL MODEL FOR THE IMPLEMENTATION OF LEAN MANUFACTURING IN LOGISTICS ORGANIZATIONS

Boris Lyamin, Margarita Yanchevskaya ✉

Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia

✉ myuyanch@gmail.com

Abstract. Digitalization plays a key role in the development of lean manufacturing, especially at large enterprises involved in logistics. The integration of digital technologies significantly enhances the transparency, controllability, and efficiency of production and logistics processes, contributing to the minimization of losses and costs. This study evaluates prospects for implementing lean technologies based on the example of the Russian Post—one of the largest logistics enterprises in the country. The research involved an analysis of key bottlenecks and problems at the company, as well as a detailed breakdown of each current loss. In accordance with obtained results, the authors suggest a conceptual model for process improvement to ensure continuous enhancement of processes and growth in operational efficiency.

Keywords: lean manufacturing, logistics, operational efficiency, conceptual model, the Russian Post

Citation: Lyamin B., Yanchevskaya M. Conceptual model for the implementation of lean manufacturing in logistics organizations. Technoeconomics. 2025. 4. 3 (14). 35–45. DOI: https://doi.org/10.57809/2025.4.3.14.4

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.4

КОНЦЕПТУАЛЬНАЯ МОДЕЛЬ ВНЕДРЕНИЯ БЕРЕЖЛИВОГО ПРОИЗВОДСТВА В ДЕЯТЕЛЬНОСТЬ ЛОГИСТИЧЕСКОЙ ОРГАНИЗАЦИИ

Борис Лямин, Маргарита Янчевская ✉

Санкт-Петербургский политехнический университет Петра Великого,
Санкт-Петербург, Россия

✉ myuyanch@gmail.com

Аннотация. Цифровизация играет ключевую роль в развитии бережливого производства, особенно на крупных предприятиях, связанных с логистикой. Интеграция цифровых технологий позволяет значительно повысить прозрачность, управляемость и эффективность производственных и логистических процессов, способствуя минимизации потерь и издержек. В данном исследовании оценивается потенциал реализации lean-технологий на примере Почты России – одного из наиболее крупных предприятий логистической отрасли в стране. В ходе исследования был проведен анализ ключевых узких мест и проблем на предприятии, а также проведена детализация каждого типа текущих потерь. На основании полученных результатов авторами была разработана концептуальная модель совершенствования процессов, необходимая для обеспечения непрерывного улучшения работы предприятия и роста операционной эффективности.

Ключевые слова: бережливое производство, логистика, операционная эффективность, концептуальная модель, Почта России

Для цитирования: Лямин Б., Янчевская М. Концептуальная модель внедрения бережливого производства в деятельность логистической организации // Техноэкономика. 2025. Т. 4, № 3 (14). С. 35–45. DOI: https://doi.org/10.57809/2025.4.3.14.4

Introduction

In the modern conditions of global competition and increasing market dynamics, enterprises face the necessity to improve production efficiency and optimize business processes. One of the most effective tools to achieve these goals is lean manufacturing. It is a management philosophy focused on identifying and eliminating all types of loss, reducing costs, and enhancing the quality and flexibility of production operations.

However, despite its widespread adoption, many organizations experience difficulties in properly understanding and implementing lean approaches. This necessitates the development of conceptual models and methods for adapting lean manufacturing to the specifics of particular enterprises (Jones, 2003; Kahramanova, 2024).

Lean manufacturing represents a philosophy and management concept aimed at the most efficient use of enterprise resources while simultaneously improving product quality and value for the end customer. The value creation flow is a sequential set of actions, operations, and processes required to transform initial resources (such as raw materials, data, or components) into a final product or service that meets customer requirements and expectations. The key task is to ensure the most efficient and continuous movement of this flow, minimizing delays, downtime, and unnecessary operations. For this reason, the constant search for and elimination of loss (Muda) that does not add value and increases costs is the core of lean manufacturing. Such

losses may include overproduction, downtime, waiting, defects, unnecessary transportation, etc.

The implementation of lean technologies allows for the formation of a culture of continuous improvement, engaging every employee in this process. This system not only increases the economic efficiency and competitiveness of enterprises but also contributes to sustainable development by reducing time, material, and labour costs, increasing productivity, and improving product quality. Understanding and managing flows creates the foundation for eliminating bottlenecks, reducing order lead times, lowering inventory levels, and enhancing quality (Sharafullina, 2020; Sirotkin, 2022).

Lean manufacturing tools are practical methods and techniques used to identify, eliminate, and prevent loss, as well as to improve the efficiency and quality of processes. Their application allows for systematic optimization of production and business processes, reducing costs and increasing value for the customer.

Effective use of these tools requires a systematic approach, the involvement of all employees, and continuous analysis of results. Ultimately, this path leads to sustainable improvements in efficiency and competitiveness. The implementation of lean manufacturing tools at the "Russian Post" has significant potential to enhance efficiency, reduce costs, and improve the quality of services provided. Given the specifics of the activity—mass customer service, logistics, processing, and delivery of postal items—the adoption of lean methods necessitates adaptation to the industry's features and business processes.

The current market dynamics, quality requirements, cost reduction, and the need for increased flexibility in production processes make the adoption of lean manufacturing essential for enterprises. Applying lean technologies helps identify and eliminate bottlenecks in production, reduce order fulfillment times, increase customer satisfaction, and boost economic efficiency. This is especially relevant for large enterprises with complex manufacturing and logistics systems, where traditional optimization methods are no longer sufficient.

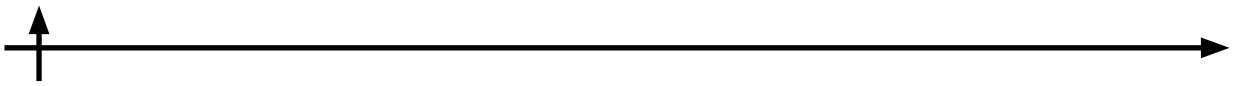
Digital systems automate accounting for raw materials, supplies, defects, and waste; enable precise planning; and ensure timely replenishment of resources, forming a fundamental basis for the implementation of lean principles (Belova, 2024; Chelombitko, 2020).

At large logistics enterprises, digitalization promotes the optimization of material flows through automated transport systems, reduces downtime, and increases order processing speed. Business analytics platforms and artificial intelligence tools allow real-time analysis of key performance indicators (KPIs), supply chain control, and more informed decision-making. Overall, these advancements contribute to increased production flexibility and the competitiveness of companies (Lyamin, 2025; Petrova, 2019; Pulin, 2020; Savina, 2022).

In logistics companies, where key resources are time, accuracy, and the speed of moving goods and documents, the application of lean manufacturing tools significantly contributes to reducing costs and improving customer service levels. The main lean tools most frequently used in logistics include:

1. 5S—a method for organizing the workspace to enhance order, ergonomics, and safety;
2. Value Stream Mapping (VSM)—visualizing the entire process chain to identify bottlenecks and sources of waste;
3. Kanban—a visual inventory and process management system to maintain optimal resource levels with minimal delays;
4. Kaizen—a method of continuous improvement involving employee engagement and ongoing analysis;
5. The analysis of eight types of loss (Muda) present in logistics operations, such as excess movement, waiting, defects, and unnecessary transportation.

Effective implementation of these tools requires adaptation to the specifics of the logistics



sector—high variability in orders and the need to synchronize multiple participants and technological stages, as well as requirements for speed and accuracy of information processing.

Modern research, such as that by Liker (2020), notes that implementing 5S and VSM leads to significant reductions in order fulfillment times and inventory levels without sacrificing service quality. The use of Kanban in logistics systems allows for the optimization of material and information flows, enabling flexible responses to demand changes and efficient inventory management (Liker, 2020).

Materials and Methods

Within the framework of this research, a thorough analysis of contemporary literature on the examined topic was conducted. Modern studies consider the impact of digitalization and information systems in supporting lean tools at logistics enterprises, which enhances transparency, controllability, and adaptability of operations. Researchers today pay significant attention to the application of lean manufacturing tools to improve the efficiency of logistics processes and optimize the functioning of logistics-focused companies. K.P. Ilyina and V.F. Gorshenin explore modifications of the lean management model considering the digitalization of logistics processes. Their work emphasizes the importance of adapting traditional Lean methods to modern digital technologies to increase transparency and manageability of operations (Golubenko, 2020; Ikramov, Emelyanov, 2022; Ilicheva, 2022; Ilyina, 2022).

V.A. Khamanova, as well as M.I. Danilenko and O.V. Korkacheva, investigate the application of lean manufacturing concepts in warehouse logistics, highlighting ways to improve processes based on specific enterprise examples. The authors note that an essential aspect is the use of flow mapping tools and the analysis of eight types of loss to identify bottlenecks. Furthermore, the researchers analyze the optimization of logistics business processes based on lean principles, identifying the main losses characteristic of logistics and methods for their elimination. They highlight that applying lean tools significantly reduces delivery times and costs (Khamanova, 2020; Danilenko, 2019).

In her work, T.V. Glavatskaya focuses particularly on the features of the concept of lean logistics, analyzing a set of methods and tools aimed at creating pull-based supply chains and increasing efficiency. The author substantiates the need for a systematic approach to implementing lean principles across all stages of logistics operations (Glavatskaya, 2019).

Another researcher, S.A. Korelov, explores the possibility of using lean manufacturing tools in transportation companies, emphasizing the importance of Kaizen sessions and the 5S system for improving the quality and speed of service delivery (Korelov, 2019).

M.A. Alexandrova et. al. emphasizes lean manufacturing as a key tool for increasing labour productivity and operational efficiency across various types of enterprises, including logistics organizations (Alexandrova M. 2022.).

Thus, scientific studies confirm that a comprehensive application of lean manufacturing tools in logistics promotes the systematic identification and elimination of losses, improves customer service quality, and supports sustainable enterprise development.

Modern logistics companies, especially state communication operators, face a number of systemic problems related to inefficient process organization, a high share of manual labour, and insufficient digitalization. Lean manufacturing, adapted to the specifics of logistics, serves as an effective tool for identifying and resolving these issues. The implementation of lean methods not only reduces costs and operation times but also enhances customer service quality. A systematic approach—involving the creation of specialized teams, the use of digital technologies, and the integration of continuous improvement methodologies—is critically important.

Results and Discussion

In this research, the "Russian Post" is taken as a case study due to its key role in the national postal and logistics system. This organization provides a wide range of services, including the delivery of correspondence and parcels, as well as offering financial and transport-forwarding services. The scale of its operational activities and its geographical coverage create unique conditions accompanied by significant complexity in organizational and technological processes. Furthermore, the company faces the need to improve efficiency, optimize costs, and adapt to modern challenges such as digitalization and increased competition in the logistics market. Therefore, the analysis and implementation of lean manufacturing tools specifically within the "Russian Post" possess high practical and scientific significance, allowing for the identification of systemic problems and the development of comprehensive recommendations for sustainable enterprise development and improvement of service quality.

To enhance the operational efficiency of the "Russian Post," a systemic approach to identifying problem areas and bottlenecks in business processes is critically important and an immediate priority. This approach enables a fundamental understanding of the causes of delays and inefficiencies at various stages of postal item processing and delivery. In particular, based on a detailed process analysis, implementing lean manufacturing tools becomes a mechanism not only for identifying losses but also for developing comprehensive solutions to minimize them, which significantly contributes to improving the company's key operational indicators (Table 1).

Table 1. Main Bottlenecks in Processes (designed by the authors).

Problem	Description	Impact
Long processing and sorting time of shipments	Multiple manual sorting steps, insufficient automation	Delays, increased delivery time
Insufficient automation of logistics operations	High level of manual labor, data entry errors	Errors, repeated operations, delays
Long delivery times in remote regions	Limited logistics infrastructure, inadequate routing	Low service quality, customer dissatisfaction
High error rates in shipment acceptance and delivery	Inefficient procedures, lack of standardization	Increased costs, customer dissatisfaction
Excessive operations and movements within branches	Inefficient arrangement of equipment and staff	Wasted time and resources

The table presents an analysis of the key problem areas identified in the activities of the postal operator, detailing their causes and impacts. The conducted analysis reveals consistent cause-and-effect relationships. In particular, the prolonged cycle of processing and sorting shipments is directly correlated with the predominance of manual labour and the low level of automation in these processes. As a result, excessive delays occur, extensively increasing the overall delivery time and predictably lowering the level of customer service.

Similarly, the insufficient level of automation in the logistics chain leads to a high proportion of manual operations. This, in turn, results in an increased number of errors caused by human factors, the need to perform repeated (corrective) actions, and the cumulative growth of time losses at all stages.

Additionally, a significant bottleneck is the long delivery times in remote regions, caused by limited logistics infrastructure and inefficient routing. This negatively affects service quality and customer satisfaction. Furthermore, the high frequency of errors during shipment acceptance and delivery, caused by the lack of regulated and standardized procedures, leads to increased

costs and decreases trust in the company.

Excessive operations and unnecessary movements within branches, arising from irrational placement of equipment and staff, result in unjustified expenditures of time and resources.

To systematically identify and subsequently optimize these issues, the following key methods are applied:

1. Value Stream Mapping (VSM)—a method for visualizing the entire process of handling postal shipments, from acceptance to delivery to the final consumer. The use of VSM allows for detailed identification of non-value-added operations, redundant actions, downtime, and function duplications, which facilitates targeted implementation of measures to eliminate waste (Table 2).

2. Loss analysis based on the eight types of Muda, which involves a comprehensive examination of the following aspects:

— Overproduction—manifested in the excessive creation of documents or services that are not demanded by end consumers.

— Waiting—idle intervals between stages of postal shipment processing.

— Transportation—suboptimal and prolonged logistics routes.

— Overprocessing—duplication of operations and checks that do not affect quality.

— Excess inventory—accumulation of unsold or unused resources.

— Unnecessary motions—non-ergonomic placement of work zones and employee movements.

— Defects—sorting errors, loss, or damage to shipments.

— Underutilized employee potential—lack of involvement in improvement processes and absence of a suggestion incentive system.

3. The “5 Whys” method—a root cause analysis tool consisting of repeatedly asking "why?" to identify the primary cause of problems, such as delivery delays.

4. Pareto charts and ABC analysis—used to determine priority problems that have the greatest impact on process efficiency.

5. Gemba Walk—the practice of direct observation of processes at workplaces, which helps uncover hidden and unforeseen inefficiencies.

For a deeper understanding, Table 2 displays a detailed breakdown of each loss type.

Table 2. Loss types (designed by the authors).

Type	Example in the “Russian Post”	How to Identify?
Overproduction	Printing excess receipts that remain unused	Material consumption analysis
Waiting	Truck downtime due to uncoordinated scheduling	Time tracking of logistics operations
Transportation	Non-optimal delivery routes (excess kilometers)	GPS data analysis of transport
Overprocessing	Data duplication across different systems	Comparison of IT processes
Inventory	Accumulation of unused goods	Inventory audits
Movement	Non-ergonomic layout of sorters’ workstations	Motion Study
Defects	Address errors, lost shipments	Analysis of complaints
Unexploited potential	Lack of employee suggestion systems	Staff surveys

Table 2 presents a detailed classification of types of operational losses, where each type is not only identified but also illustrated with specific examples from the activities of "Russian Post" and accompanied by practical tools for its identification. This creates a clear diagnostic mechanism: for example, overproduction is diagnosed through material consumption analysis, waiting losses are identified using time tracking of work processes, and inefficient transportation is detected by monitoring routes using GPS data.

— Overprocessing is revealed during audits and comparisons of IT processes.

— Inefficient employee movements are recorded using video work analysis (motion study).

— Defects and their causes are uncovered through systematic analysis of complaints.

— Underutilized employee potential is assessed via specialized surveys.

Thus, the application of lean manufacturing tools forms a systematic methodology for reorganizing the business processes of Russian Post. This scientifically grounded approach allows for the targeted elimination of "bottlenecks," leading to a comprehensive positive effect: increased operational efficiency, cost reduction, and significant improvement in customer service quality. In the long term, this transformation ensures the company builds a flexible and resilient operating model, which is a key factor in strengthening its competitiveness in the market.

The “Russian Post” is a enterprise performing critically important communication and correspondence handling functions throughout the country. According to the results of the Accounts Chamber audit, the enterprise faces issues in many areas of its operations. Among the main problems are irrational resource allocation, poor cost optimization, imprudent investments, and others. The introduction of lean manufacturing in many areas of the enterprise's activity will help solve most of these problems. Lean tools are aimed at identifying issues at various process levels, their resolution, and continuous process monitoring. This approach optimizes processes and standardizes necessary reports, procedures, and other assets depending on the specifics of each department, sector, or activity area. It helps reduce costs, increase enterprise transparency, simplify decision-making, and enhance employee engagement.

To ensure the competent and effective implementation of lean manufacturing tools, it is necessary to develop a conceptual model for improving organizational processes. However, an important preliminary step before using the model is to form a Lean team consisting of company employees. Below, an algorithm for creating such a group will be presented with practical examples to provide a fuller understanding of the specifics and tasks of the Lean team, which will specialize in implementing lean manufacturing at different levels and stages of company activities. For applying lean tools in strategic and financial planning areas, the creation of a similar group from senior management employees is envisaged.

Formation of a Lean Team:

At enterprises implementing lean manufacturing, establishing an internal lean team is a key stage of transformation. Typically, its composition includes production specialists (masters, technologists, and engineers) (60-70%), representatives of adjacent departments (logistics, quality control, and procurement) (20-25%), an HR specialist, and an internal trainer (10-15%).

At “KAMAZ,” such teams are formed based on the “5+2” principle: 5 core members from production units and 2 mentors (a Lean methodology expert and an HR business partner).

Functions and Areas of Responsibility:

Practical experience of leading industrial enterprises shows the following typical directions of lean teamwork:

A. Operational Activities: Conducting Kaizen sessions (at “Severstal”—12-15 sessions monthly); analyzing losses using Value Stream Mapping (mapping 3-5 key processes quarterly); implementing 5S tools (weekly audits at 20-30 workstations).

B. Educational Function: Monthly training for 5-7% of personnel (as in “ROSATOM”);

developing standards and visual instructions; conducting problem-solving workshops (at "Gazprom Oil"—40-50 events annually).

Recommendations for Development:

— Gradual Scaling: start with 1-2 pilot shops/lines.

— Motivational System: At "UralVagonZavod," bonuses are used for implemented improvements (up to 15% of savings).

— Integration with Digital Systems: use of mobile applications for recording losses (experience of "SIBUR").

— Knowledge Succession: mentoring systems and a "School of Lean Leaders."

Properly organized, Lean teams formed from enterprise employees become drivers of continuous improvement, achieving on average 15-25% growth in operational efficiency within the first two years. Key success factors are involvement of frontline personnel, alignment with business goals, and a systematic approach to measuring results.

After forming the team, it is necessary to refer to the model (Figure 1).

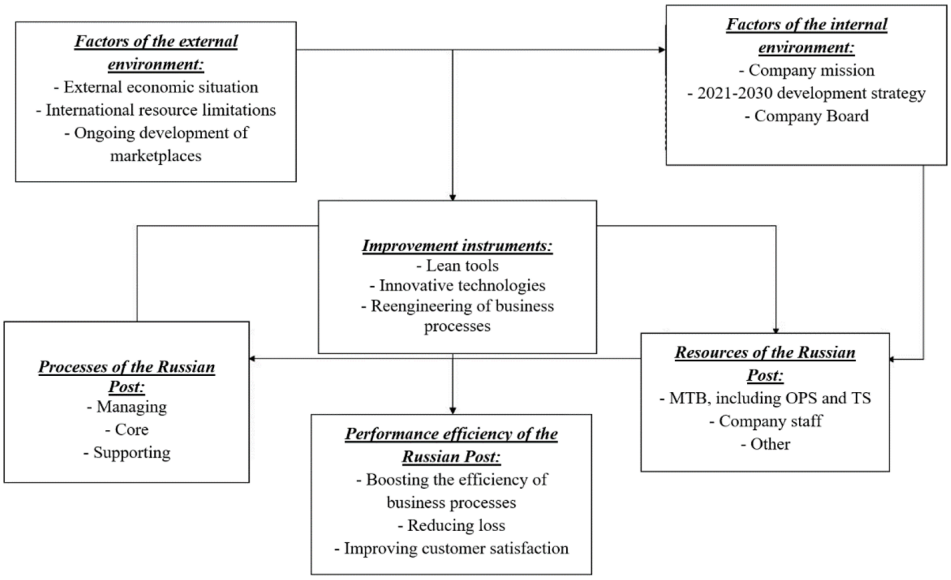


Fig. 1. Conceptual Model for Process Improvement (designed by the authors).

The model represents a dynamic system where external and internal factors form the context for applying improvement tools that transform the company's processes through the lens of available resources, directing efforts toward achieving strategic goals of efficiency enhancement.

The developed conceptual model (Fig. 1) is a dynamic process management system that transforms identified problem areas (Table 1) through the application of targeted Lean tools (Table 2). The model functions as a continuous improvement cycle, where each element is interconnected with the others.

External factors (sanctions, resource constraints, marketplace pressures) create direct challenges for the processes of Russian Post. For example, the disruption of international logistics chains forces a revision of core delivery processes, requiring resource adaptation—redistribution of transport or switching to alternative routes. Simultaneously, the development of marketplaces stimulates innovative technologies (API integration with Ozon), which impacts supporting IT infrastructure processes.

Internal factors act as a filter for responding to external impacts. The company's mission, emphasizing its social role, limits the optimization of loss-making rural postal offices, linking

resources (finances, equipment) and budgeting management processes. The 2021-2030 strategy sets priorities; for instance, the focus on digitalization directs reengineering tools toward redesigning data processing workflows, which requires resource investments (software updates, staff training).

The research results demonstrate significant potential for applying lean manufacturing in the logistics activities of the "Russian Post". Based on the identified data and conducted analysis, key conclusions can be drawn, reflecting perspectives and directions for the company's further development to improve efficiency and the quality of services provided.

The conducted analysis of the significance and application of lean manufacturing tools in the "Russian Post" operations confirmed the high effectiveness of this approach to enhancing operational efficiency and client service quality. Using methods such as VSM, 5S, Kanban, and Kaizen made it possible to identify key problem areas in the company's business processes, including long processing and sorting cycles, insufficient automation levels, and frequent errors during parcel handling.

Conclusion

The implementation of the conceptual model for introducing lean manufacturing, with the formation of specialized lean teams, promotes a systematic approach to continuous process improvement and staff engagement in efficiency enhancement. Particular importance is attached to the integration of digital technologies, which increases transparency and manageability of production and logistics operations, reducing losses and costs.

Thus, comprehensive application of lean principles and tools contributes to reducing order fulfillment times, lowering defect rates, and improving customer satisfaction. Incorporating these methods into postal and logistics activities ensures the formation of a sustainable, competitive operational model that meets modern market demands and supports the enterprise's sustainable development.

The analysis confirmed systemic problems in the operational activities of the "Russian Post", including a high share of manual labour, suboptimal routing, and insufficient process standardization. The application of lean manufacturing tools (VSM, Muda analysis, 5S) enables effective identification and classification of these issues. A conceptual model for implementing lean manufacturing was developed, taking into account the industry specifics of a logistics company and integrating external (sanctions, marketplace development) and internal (mission, strategy) influencing factors. The model ensures a systematic approach to process transformation through targeted use of Lean tools.

Further research should focus on developing a KPI system to evaluate the implementation effectiveness of the model.

REFERENCES

Alexandrova M. 2022. Implementing lean production to improve logistic center productivity. Young Researcher, 117–125.

Belova E., Shpineva T. 2024. Optimization of logistic processes using lean logistics tools. Bulletin of the Academy of Knowledge, 3(68), 60-64.

Chelombitko A. 2020. The impact of lean manufacturing on the main performance outcomes of universities. University Management: Practice and Analysis, 24(4), 100–115.

Danilenko M., Korkacheva O. 2019. Application of lean manufacturing concept in warehouse logistics (case of OOO "Vostok-Service-Kuzbass"). Economics, Entrepreneurship, and Law, 9(4), 659–670.

Glavatskaya T. 2019. The concept of lean logistics. Actual Scientific Research in the Modern

World, 1(2), 73–78.

Golubenko O., Nikitin A. 2020. "Lean production" system and digitalization. Science and Society, 1, 60–66.

Ikramov M.A., Emelyanov A.D. 2022. "Lean Production" in Warehouse Real Estate Management: Russian and Foreign Experience of Implementing Digital Technologies at Warehouse Facilities. Technoeconomics 3 (3), 51–64. DOI: https://doi.org/10.57809/2022.3.3.5

Ilicheva A., Antropov A. 2022. Features of implementing lean manufacturing in Russia (Case of "KAMAZ"). Russia and the World in New Realities: Changing Global Economic Links, 223–225.

Ilina K., Gorshenin V. 2022. Society, Economics, Management, 7(1), 55–59.

Jones D. 2003. Lean thinking: banish waste and create wealth in your corporation. Journal of the Operational Research Society, 48(11). doi:10.1038/sj.jors.2600967

Kahramanova D., Repkina O., Hetsuriani G. 2024. Logistic concepts as a means to improve competitiveness of transportation organizations. Education, Technology, and Society in the Changing Epochs, 132–138.

Khamanova V. 2020. Optimization of logistic business processes based on lean manufacturing. Trubuna Uchenogo, 1, 118–124.

Korelov S. 2019. Application of lean manufacturing tools in transport companies and logistics. Transport and Machinery Building in Western Siberia, 2, 22–25.

Liker J. 2020. The Toyota way: 14 management principles from the world's greatest manufacturer, 392.

Lyamin B., Yanchevskaya M., Protsyuk M. 2024. Development of a conceptual model for the work of a higher education institution's structural unit in the conditions of digital transformation. Economic Sciences, 10(239), 98–103.

Lyamin B., Yanchevskaya M., Protsyuk M. 2025. Integration of lean production tools into university administrative processes as a driver of participant satisfaction in the educational process. Bulletin of the Academy of Knowledge, 4(69), 356–361.

Petrova L. 2019. Lean production as a tool for quality management in Russian Federation's public administration. Sci. Time, 10(70), 47–49.

Pulin I. 2020. Lean manufacturing in the context of digitalization of the economy. Formation of a Competitive Environment, Competitiveness, and Strategic Management of Enterprises, Organizations, and Regions, 151–155.

Savina T., Shvayka O. 2022. "Lean Production" as a factor of increasing the economic efficiency of enterprises. Science in the Modern World, 26–32.

Sharafullina R., Gainanova L. 2020. Digitalization and innovation in lean production. Vector of Economics, 5, 94.

Sirotkin A., Konicheva A. 2022. Logistics from the lean approach perspective. Current Problems of Modern Transport, 2(9), 27.

СПИСОК ИСТОЧНИКОВ

Александрова М. 2022. Внедрение бережливого производства для повышения производительности логистического центра. Молодой исследователь, 117–125.

Белова Е., Шпинева Т. 2024. Оптимизация логистических процессов с применением инструментов бережливой логистики. Вестник Академии знаний 3 (68), 60-64.

Челомбитко А. 2020. Влияние бережливого производства на основные результаты деятельности вузов. Университетское управление практика и анализ 24 (4), 100–115.

Даниленко М., Коркачева О. 2019. Применение концепции бережливого производства в складской логистике (на примере ООО «Восток-Сервис-Кузбасс»). Экономика, предпринимательство и право 9 (4), 659–670.

Главацкая Т. 2019. Концепция бережливой логистики. Актуальные научные исследования в современном мире 1 (2), 73–78.

Голубенко О., Никитин А. 2020. Система «Бережливое производство» и цифровизация. Наука и общество 1, 60–66.

Ikramov M.A., Emelyanov A.D. 2022. "Lean Production" in Warehouse Real Estate Management: Russian and Foreign Experience of Implementing Digital Technologies at Warehouse

Facilities. Technoeconomics 3 (3), 51–64. DOI: https://doi.org/10.57809/2022.3.3.5

Ильичева А., Антропов А. 2022. Особенности внедрения бережливого производства в России (на примере ПАО «КамАЗ»). Россия и мир в новых реалиях: изменение мирохозяйственных связей, 223–225.

Ильина К., Горшенин В. 2022. Общество, экономика, управление 7 (1), 55–59.

Jones D.T. 2003. Lean thinking: banish waste and create wealth in your corporation Journal of the Operational Research Society 48 (11). doi:10.1038/sj.jors.2600967

Кахриманова Д., Репкина О., Хецуриани Г. 2024. Логистические концепции как способ повышения конкурентоспособности транспортных организаций. Образование, технологии и общество на смене эпох, 132–138.

Хаманова В. 2020. Оптимизация логистических бизнес-процессов на основе бережливого производства. Трибуна ученого 1, 118–124.

Королев С. 2019. Применение инструментов бережливого производства в транспортных компаниях и логистике. Транспорт и машиностроение Западной Сибири 2, 22–25.

Liker J. 2020. The Toyota way: 14 management principles from the world's greatest manufacturer, 392.

Лямин Б., Янчевская М., Процюк М. 2024. Разработка концептуальной модели работы структурного подразделения высшего учебного заведения в условиях цифровой трансформации. Экономические науки 10 (239), 98–103.

Лямин Б., Янчевская М., Процюк М. 2025. Интеграция инструментов бережливого производства в административные процессы вузов как драйвер удовлетворённости участников образовательного процесса. Вестник Академии знаний 4 (69), 356–361.

Петрова Л. 2019. Бережливое производство как один из инструментов менеджмента качества в государственном управлении Российской Федерации. Sci. Time 10 (70), 47–49.

Пулин И. 2020. Бережливое производство в условиях цифровизации экономики. Формирование конкурентной среды, конкурентоспособность и стратегическое управление предприятиями, организациями и регионами, 151–155.

Савина Т., Швайка О. 2022. «Бережливое производство» как фактор повышения экономической эффективности предприятий. Наука в современном мире, 26–32.

Шарафуллина Р., Гайнанова Л. 2020. Цифровизация и инновации в бережливом производстве. Вектор экономики 5, 94.

Сироткин А., Конычева А. 2022. Логистика с позиции lean-подхода. Актуальные проблемы современного транспорта 2 (9), 27.

INFORMATION ABOUT AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

LYAMIN Boris M. – Associate Professor, Candidate of Economic Sciences.
E-mail: lyamin.bm@gmail.com
ЛЯМИН Борис Михайлович – доцент, к.э.н.
E-mail: lyamin.bm@gmail.com
ORCID: https://orcid.org/0000-0002-5153-7727

YANCHEVSKAYA Margarita Yu. – student.
E-mail: myuyanch@gmail.com
ЯНЧЕВСКАЯ Маргарита Юрьевна – студент.
E-mail: myuyanch@gmail.com
ORCID: https://orcid.org/0009-0000-1775-7964

Статья поступила в редакцию 22.08.2025; одобрена после рецензирования 28.08.2025; принята к публикации 29.08.2025.

The article was submitted 22.08.2025; approved after reviewing 28.08.2025; accepted for publication 29.08.2025.

Technoeconomics. 2025, Vol. 4, No. 3 (14). Pp. 46–54.
Техноэкономика. 2025, Том 4, № 3 (14). С. 46–54.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.5

INFORMATION SYSTEM DESIGN FOR THE NEWSPAPER EDITORIAL OFFICE: ARCHITECTURAL APPROACH

Marina Kartasheva ✉

Financial University under the Government of the Russian Federation, Novorossiysk, Russia

✉ kartasheva.02@bk.ru

Abstract. The modern business environment is constantly changing due to the influence of technology and customer needs. In conditions of high competition and rapid pace of change, traditional methods of marketing process management are no longer able to cope with the challenges that have arisen. In this regard, the introduction of information systems (IS) in marketing departments is becoming not only relevant but also vital. Information systems can significantly improve work efficiency by optimizing data collection and analysis, automating processes, and improving communication within a team. This implementation helps companies adapt to changes in the market, providing more accurate targeting and a personalized approach to customers. In modern conditions, when information is becoming an essential asset, the use of information technology in marketing shapes foundation for business success and sustainability.

Keywords: business process, business structure, architectural model, information system, information technologies

Citation: Kartasheva M. Information system design for the newspaper editorial office: architectural approach. Technoeconomics. 2025. 4. 3 (14). 46–54. DOI: https://doi.org/10.57809/2025.4.3.14.5

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.5

ПРОЕКТИРОВАНИЕ ИНФОРМАЦИОННОЙ СИСТЕМЫ РЕДАКТОРСКОГО ОТДЕЛА ГАЗЕТНОГО ИЗДАНИЯ: АРХИТЕКТУРНЫЙ ПОДХОД

Марина Карташева ✉

Финансовый университет при Правительстве Российской Федерации, Новороссийск, Россия

✉ kartasheva.02@bk.ru

Аннотация. Современная бизнес-среда постоянно меняется под влиянием технологий и растущих клиентских потребностей. В условиях высокой конкуренции и быстрого темпа происходящих измененицц, традиционные методы управления маркетинговыми процессами уже не способны справляться с возникшими вызовами. В этой связи внедрение информационных систем (ИС) в маркетинговые отделы становится не просто актуальным, но и жизненно необходимым. Информационные системы могут существенно улучшить эффективность работы, позволяя оптимизировать сбор и анализ данных, автоматизировать процессы и улучшить коммуникацию внутри команды. Данное внедрение помогает компаниям адаптироваться к изменениям на рынке, обеспечивая более точное таргетирование и персонализированный подход к клиентам. В современных условиях, где информация становится важнейшим активом, использование информационных технологий в маркетинговых процессах служит гарантом успеха и устойчивости бизнеса.

Ключевые слова: бизнес-процесс, структура предприятия, архитектурная модель, информационная система, информационные технологии

Для цитирования: Карташева М. Проектирование информационной системы редакторского отдела газетного издания: архитектурный подход // Техноэкономика. 2025. Т. 4, № 3 (14). С. 46–54. DOI: https://doi.org/10.57809/2025.4.3.14.5

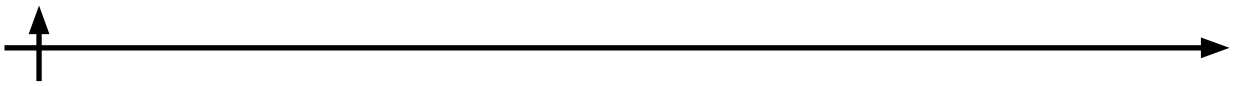
Introduction

This research considers a variety of methods for designing an information system, examines the architectural method, analyzes the company OOO "Editorial Office of the "Prizyv" Newspaper," identifies the organizational structure of this company, and suggests a framework for the architectural vision of the IT system for the marketing department.

According to GOST R 57193-2016, "Systems Engineering—Lifecycle Processes of Systems," which also describes the process of architecture design, the system architecture is seen as the fundamental organization of the system embodied in its elements, their internal and external connection, as well as the principles guiding its design and evolution.

The result of architecture design is a solution project that meets both functional and non-functional requirements. Such an architectural design, documented in an appropriate document (specification), can be presented in the form of sketches, drawings, or other descriptive methods.

The architectural method rests on frameworks that can be easily adapted to meet all technical requirements of potential clients. A distinctive feature of this approach is dividing the design task into two separate subtasks: developing a reusable framework and creating a specific software product based on it (Asanov, 2025; Blinov, 2023; Dulesov, 2024). These two tasks can



be performed by different specialists.

The architectural approach allows for prompt modifications of existing functionalities and adds new features to the designed information system.

Materials and Methods

The authors conducted expert assessment and review of domestic and international scientific studies on business processes. In order to evaluate the efficiency of suggested IT solutions the IDEF0 notation was used for pre and post implementation effect at all levels.

Results and Discussion

OOO "Editorial Office of the "Prizyv" Newspaper," founded in 1969, is one of the most well-known publishers in the Crimean region. The company's main activities are related to the publication and distribution of newspapers, as well as providing informational services. The company is located in Krymsk. Its primary activities include conducting investigations, writing articles, interviewing interesting personalities, and covering relevant topics. The team of journalists actively researches a wide variety of locally important issues.

In addition to the print version, the company develops its website and social media platforms to attract a broader audience. This includes posting news, interviews, and material on current topics.

The "Prizyv" newspaper offers advertising opportunities for local businesses, thus supporting the editorial funding and fostering mutually beneficial relationships with entrepreneurs.

The staff of OOO "Editorial Office of the "Prizyv" Newspaper" consists of 18 employees. The newspaper's circulation in April 2025 amounts to approximately 2.500 copies. The sales volume varies depending on the current circulation and advertising revenue. The main target market is the Crimean reagion.

The primary goal of the company is to become a leading regional media outlet, providing high-quality journalistic content, prompt news coverage, and significant reader engagement in societal processes.

The "Prizyv" newspaper aims to inform and educate the population about important events, social initiatives, and cultural activities. In order to serve as a reliable source of information, the newspaper sets the following strategic objectives:

— Increase sales volume and circulation
— Expand the audience
— Develop partnership relations
— Maintain high quality standards

The OOO "Editorial Office of the "Prizyv" Newspaper" offers the following products and services:

1. Newspaper Publications: The core product is the printed edition of the newspaper, covering a broad range of topics including politics, economics, culture, sports, social news, and events.

2. Online Platform: The website provides access to current news, an archive of past publications, and analytical materials.

3. Special Editions: Periodic thematic magazines and brochures dedicated to specific events or social issues.

4. Advertising: The company offers advertising services for businesses both in print and online.

5. Events and Activities: Coverage of local events, contests, and campaigns aimed at strengthening ties with the local community.

Each department uses specialized software tailored to their specific requirements. The accounting department uses 1C:Accounting, the journalism department uses the Microsoft Office, and the documentation-related department uses 1C:Enterprise.

Business processes within the "Editorial Office" can be divided into several key stages (Fomin, 2025; Galimyanov, 2017, 2019; Grekul, 2025):

1. Research and Planning: Audience analysis, calendar planning
2. Content Creation: Journalism, editing, design, and layout
3. Production: Printing and quality Control
4. Distribution: Logistics and delivery
5. Promotion and Advertising: Marketing and advertising partner engagement
6. Feedback and Analytics: Collecting feedback, sales analysis
7. Continuous Improvement: Strategy adaptation
8. Financial Accounting: Budgeting and reporting
9. Staff Training and Development: Courses and training programs

To implement the information system in the marketing department of the "Editorial Office" it is essential to determine the functionalities to offer (Grigoryev, 2025; Karpova, 2025; Nagel, 2022; Orlova, 2022; Rogozov, 2014):

1. Customer Data Management – storing customer information, audience segmentation
2. Marketing Campaign Automation – planning and managing campaigns, email distribution
3. Data Analysis and Reporting – collecting and analyzing data, generating reports
4. Social Media Management – content publication, interaction monitoring
5. Content Management – content calendar, resource library
6. Customer Interaction Support – CRM features, chatbots, tech support
7. Effectiveness and Adaptability – A/B testing, real-time analytics
8. Integration with other systems – CRM and ERP, APIs for third-party applications

Using the IDEF0 notation we will develop the IS architecture of the OOO "Editorial Office of the "Prizyv" for a more comprehensive assessment (Voronova, 2019, 2025; Zaromensky, 2025; Zykov, 2025).

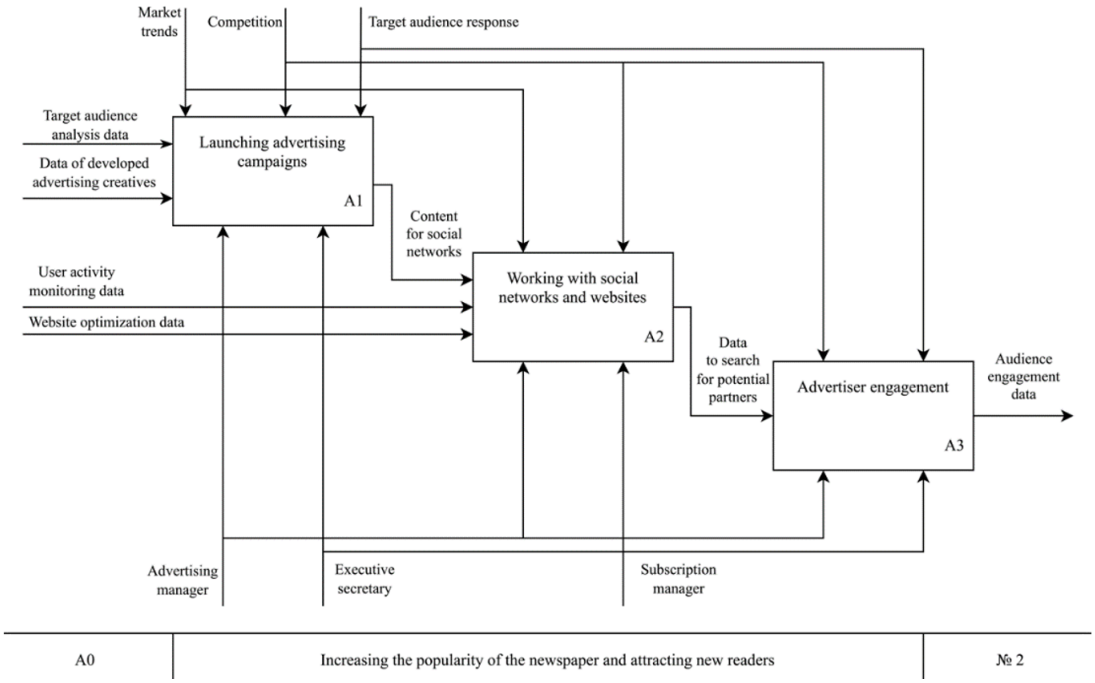


Fig. 1. Level 2 business processes of the marketing department.

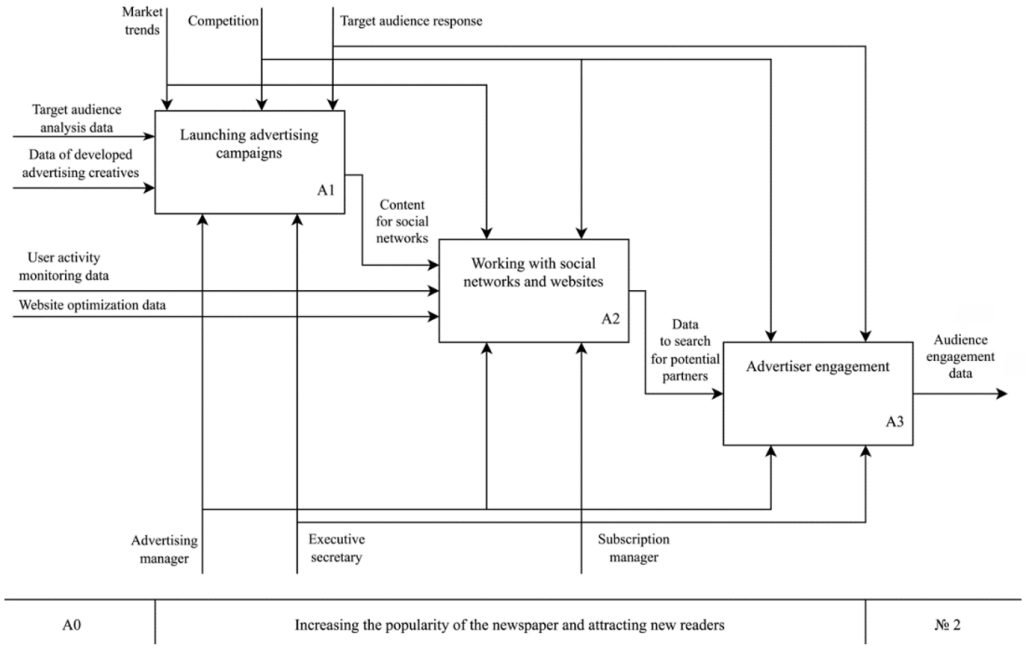


Fig. 2. Level 3 business processes of the marketing department.

Implementing an information system (IS) in the marketing department has a significant impact on business processes. One of the main changes is the improvement in data management. With centralized access to information about clients, markets, and campaigns, the collection and analysis of data are automated, allowing for more accurate and faster analytical reports. In turn, it enhances strategic planning, as employees can rely on up-to-date information and improve the precision of target audience segmentation.

Let us detail the architecture of the information system for launching advertising campaigns in OOO "Editorial Office of the "Prizyv" Newspaper."

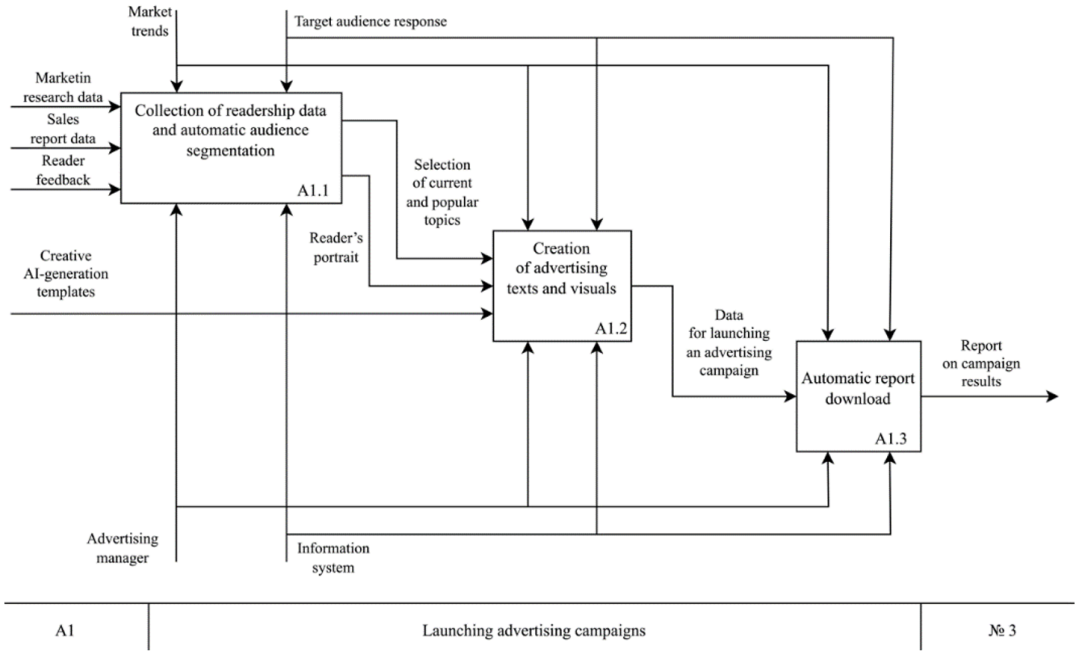


Fig. 3. Level 3 business processes of the marketing department post IS implementation.

Automation of campaign launch and management processes, as well as the use of A/B testing tools, significantly reduces the time required for organizing and monitoring advertisements. This leads to an increase in return on investment (ROI) through more rational budget allocation and improved quality of advertising materials based on their effectiveness analysis (Ryzhko, 2025; Tappuni, Vakorin, 2022; Van Looy, 2020).

Moreover, the implementation of the IS contributes to enhancing internal team collaboration. Platforms for joint work and data sharing improve communication between different departments, which speeds up decision-making processes and reduces errors and misunderstandings. Ultimately, this increases the overall productivity of the department's employees.

Decision-making algorithm for OOO "Editorial Office of the "Prizyv" Newspaper":

Step 1: Data Collection

At this stage, metrics and data from various sources related to the editorial activity are collected:

— $Dt = \{Mt, Lt, Tt, Ct\}$, where:

— *Mt* —Metrics (circulation, audience coverage, material views);

— *Lt* —Logs (publication dates, website outages, responses to materials);

— *Tt* —Traces (visitor interactions with websites and applications);

— *Ct* —Contextual data (reader feedback, competitor analysis).

Step 2: Incident Classification

Incidents may occur during operations, such as a sharp decline in website traffic or negative reactions to a material:

1. We use a machine learning-based approach to classify incidents:

— When determining an incident, the conditional probability $P(I \mid Dt)$ is calculated, where I = incident.

2. Incidents are classified into:

— *Type 1*: Negative reaction (reviews, comments);

— *Type 2*: Technical failures (website downtime);

— *Type 3*: Reputation violation (scandals, information leaks).

Step 3: Decision Path Selection

The decision depends on the incident type and probability:

— *Fast route* (hybrid approach): Predefined solutions for certain incident types (e.g., changing headlines, publishing materials upon reader requests).

— *Slow route* (analytical approach): Using algorithms to analyze the consequences of more complex incidents (e.g., social media analysis during a crisis).

Step 4: Execution and Feedback

1. Implement solutions through the editorial team (using content management systems).

2. Collect results and feedback from readers:

— Analyze changes in traffic Tf and reader interactions Rf.

— Calculate the revised perception of reviews Nr compared to initial data.

Mathematical Optimization Model

The optimization of the decision-making process involves calculating the total costs associated with incidents:

$C_{total} = \alpha * t_{response} + \beta * C_{neg} + \gamma * C_{reputation}$, where:

— C_{neg} — costs associated with negative reactions;

— $C_{reputation}$ — expenses for reputation recovery;

— $t_{response}$ — response time to an incident;

— α, β, γ — weighting coefficients that determine the significance of each factor.

Optimization condition:
$\min(C_{total})\ with\ t_{response} < t_{\max}$
where $t_{\max}$ – maximum response time.
Let us consider the example of algorithm operation.
Suppose the editorial office encounters an incident of subscriber shortage:
1. Data collection shows a decrease in traffic.
2. Classification: the system identifies this as a Type 1 incident.
3. Decision path selection:
— Fast route: promotional subscription offers.
— Slow route: analyzing reasons through surveys and gathering reader opinions.
4. Execution: implement promotional offers and publish surveys.
5. Feedback: Analyze the growth in subscribers Tf and feedback received (Nr).

Conclusion

The hybrid decision-making algorithm, which combines machine learning methods with predefined solutions, ensures flexibility and efficiency in incident management within the newspaper's editorial office. Cost optimization helps reduce risks and increase reader loyalty, which is a vital aspect in the highly competitive media environment.

Automation of reporting and analytics also becomes increasingly important. Using automated report generation tools and interactive dashboards for data visualization decreases the workload on analysts, allowing them to focus on more complex tasks. Rapid response to changes in audience behavior and campaign results enhances understanding of customer preferences, which is a key factor in maintaining competitiveness.

Moreover, customer interaction significantly improves through the integration of CRM systems, which help better manage relationships with clients. A personalized approach based on collected data increases customer satisfaction, enables prompt resolution of their issues, and facilitates effective feedback management. This, in turn, fosters loyal customers and extends Customer Lifetime Value (LTV).

Finally, the IS provides the ability to quickly adapt to changing market conditions, an especially critical feature in today's business environment. Fast realignment of strategies in response to new trends and competitive actions ensures sustained competitiveness. The ability to adjust marketing campaigns in real time helps quickly meet evolving audience needs.

In summary, implementing an information system in the marketing department leads to numerous positive changes, enhancing operational efficiency, decision-making quality, and customer relations. These improvements make business processes more flexible, adaptive, and productive, contributing to the overall growth of the company.

The impact of information systems on a company's operations cannot be underestimated. Through IS deployment, companies can not only boost the efficiency of internal processes but also improve interactions with clients. Automating routine tasks frees employees to focus on strategic issues, positively affecting overall business success. Additionally, employing IS shapes conditions for rapid and flexible response to market changes, which is especially important in today's dynamic environment. Companies leveraging modern information technology create a sustainable competitive advantage by delivering greater value to clients and ensuring sustained long-term growth and development.

Therefore, information systems are becoming an integral part of future marketing strategies, fostering innovation and efficient management.

REFERENCES

Asanov V. 2025. Architectural Management and Administration, 202.

Blinov S. 2023. Architecture of the software asset management system. Technoeconomics 2, 4 (7), 25–37. DOI: https://doi.org/10.57809/2023.2.4.7.3

Dulesov A. 2024. Architecture model of it solutions: creation and solution generation. Modern Innovations, Systems, and Technologies 4(2), 212-220. doi:10.47813/2782-2818-2024-4-2-0212-0220

Fomin V. 2025. IT management: information business, 240.

Galimyanov A., Galimyanov F. 2019. Information systems architecture, 117.

Grekul V. 2025. Designing information systems: textbook and practical guide for vocational education, 404.

Grigoryev M. 2025. Designing information systems, 278.

Karpova S. 2025. Fundamentals of marketing: textbook for vocational education, 383.

Nagel T. 2022. Methods of designing information system architecture, 23–26.

Orlova V., Voronova O. 2022. Development of business models for service companies: theoretical and methodological aspects. Technoeconomics 3(3), 17-26. doi:10.57809/2022.3.3.2

Rogozov Y., Sviridov A., Kucheryov S. 2014. Architecture of information systems, 117.

Ryzhko A. 2025. Information management systems for manufacturing companies, 354.

Tappuni J. 2020. Blockchain solutions for book publishing. Logos 30(4), 7-15. doi:10.1163/18784712-03004001

Vakorin M. 2022. Enterprise architecture and information systems, 62.

Van Looy A. 2020. Innovating organizational processes with new technologies: problems and solutions. IT Professional 22(5), 71-80. doi:10.1109/mitp.2020.2969614

Voronova O., Ilyin I. 2019. Functionally-oriented model of organizational structure as a key element in designing business architecture of an FMCG retail network company. St. Petersburg State University of Economics Proceedings 5-1(119), 84-94.

Voronova O., Vasilyev V. 2025. Development of an architectural model of information and technological services for managing operational activities of network trading companies (based on “Development Management” and “Business Process Management” business processes). Modern Economy Success 2, 239-249.

Zaromensky E. 2025. Fundamentals of business informatics, 470.

Zaromensky E. 2025. Information systems: lifecycle management, 486.

Zykov S. 2025. Architecture of information systems. fundamentals of design, 260.

Methods of designing information systems. URL: https://brasmlibras.ru/metody-proektirovaniya-informacionnyh-sistem/ (accessed: 04.07.2025).

СПИСОК ИСТОЧНИКОВ

Асанов В. 2025. Архитектурный менеджмент и администрирование, 202.

Blinov S. 2023. Architecture of the software asset management system. Technoeconomics 2, 4 (7), 25–37. DOI: https://doi.org/10.57809/2023.2.4.7.3

Дулесов А. 2024. Модель архитектуры ИТ-решений: создание, генерация решений. Современные инновации, системы и технологии 4 (2), 212-220. doi:10.47813/2782-2818-2024-4-2-0212-0220

Фомин В. 2025. Менеджмент в IT: информационный бизнес, 240.

Галимянов А., Галимянов Ф. 2019. Архитектура информационных систем, 117.

Грекул В. 2025. Проектирование информационных систем: учебник и практикум для среднего профессионального образования, 404.

Григорьев М. 2025. Проектирование информационных систем, 278.

Карпова С. 2025. Основы маркетинга: учебник для среднего профессионального образования, 383.

Нагель Т. 2022. Методы проектирования архитектуры информационных систем, 23-26.

Orlova V., Voronova O. 2022. Development of business models for service companies: theoretical and methodological aspects. Technoeconomics 3(3), 17-26. doi:10.57809/2022.3.3.2

Рогозов Ю., Свиридов А., Кучеров С. 2014. Архитектура информационных систем, 117.
Рыжко А. 2025. Информационные системы управления производственной компанией, 354.
Tappuni J. 2020. Blockchain solutions for book publishing. Logos 30(4), 7-15. doi:10.1163/18784712-03004001
Вакорин М. 2022. Архитектура предприятий и информационных систем, 62.
Van Looy A. 2020. Innovating organizational processes with new technologies: problems and solutions. IT Professional 22(5), 71-80. doi:10.1109/mitp.2020.2969614
Воронова О., Ильин И. 2019. Функционально-ориентированная модель организационной структуры как основной элемент проектирования бизнес-архитектуры сетевой компании FMCG-ритейла. Известия Санкт-Петербургского государственного экономического университета 5-1 (119), 84-94.
Воронова О., Васильев В. 2025. Разработка архитектурной модели информационно-технологических сервисов информационной поддержки управления операционной деятельностью сетевых торговых компаний (на примере бизнес-процессов «Управление развитием» и «Управление бизнес-процессами»). Modern Economy Success 2, 239-249.
Зараменских Е. 2025. Основы бизнес-информатики, 470.
Зараменских Е. 2025. Информационные системы: управление жизненным циклом, 486.
Зыков С. 2025. Архитектура информационных систем. Основы проектирования, 260.
Методы проектирования информационных систем. URL: https://brasmlibras.ru/metody-proektirovaniya-informacionnyh-sistem/ (дата обращения: 04.07.2025).

INFORMATION ABOUT AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

KARTASHEVA Marina M. – student.
E-mail: kartasheva.02@bk.ru
КАРТАШЕВА Марина Михайловна – студент.
E-mail: kartasheva.02@bk.ru
ORCID: https://orcid.org/0009-0007-3743-5584

Статья поступила в редакцию 25.07.2025; одобрена после рецензирования 04.08.2025; принята к публикации 11.08.2025.
The article was submitted 25.07.2025; approved after reviewing 04.08.2025; accepted for publication 11.08.2025.

Technoeconomics. 2025, Vol. 4, No. 3 (14). Pp. 55–63.
Техноэкономика. 2025, Том 4, № 3 (14). С. 55–63.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.6

APPROACHES TO ASSORTMENT LAUNCH STRATEGY IN MARKETPLACES: SPECIFICS AND PROSPECTS

Sergey Lepikhin, Alex Krasnov ✉

Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia

✉ krasnov_as@spbstu.ru

Abstract. This research is dedicated to the justification of specific features in developing a strategy for the successful launch of a new product assortment on marketplaces amid the rapid growth of e-commerce in the Russian Federation. The authors identify the key components involved in analyzing the enterprise's micro- and macro-environment, examine the advantages and disadvantages of platforms available for introducing new assortments, and explore the characteristics of defining the target audience. As a result of the study, an algorithm was developed to determine the framework of assortment launch with an emphasis on minimizing risks.

Keywords: e-commerce, marketplace, target audience, microenvironment, macroenvironment

Citation: Lepikhin S., Krasnov A. Approaches to assortment launch strategy in marketplaces: specifics and prospects. Technoeconomics. 2025. 4. 3 (14). 55–63. DOI: https://doi.org/10.57809/2025.4.3.14.6

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.6

РАЗРАБОТКА СТРАТЕГИИ ВЫВОДА АССОРТИМЕНТА НА МАРКЕТПЛЕСЫ: КЛЮЧЕВЫЕ ОСОБЕННОСТИ И ПЕРСПЕКТИВЫ

Сергей Лепихин, Алекс Краснов ✉

Санкт-Петербургский политехнический университет Петра Великого,
Санкт-Петербург, Россия

✉ krasnov_as@spbstu.ru

Аннотация. Данное исследование посвящено обоснованию и структурированию процесса разработки стратегии успешного вывода нового ассортимента на маркетплейсы в условиях стремительного развития электронной коммерции в Российской Федерации. В ходе исследования были выделены основные составляющие анализа микро- и макросреды предприятия, рассмотрены достоинства и недостатки платформ, доступных для вывода нового ассортимента, а также особенности определения целевой аудитории. В результате исследования, был разработан алгоритм, определяющий порядок вывода нового ассортимента с учетом минимизации рисков.

Ключевые слова: электронная коммерция, маркетплейс, целевая аудитория, микросреда, макросреда

Для цитирования: Лепихин С., Краснов А. Разработка стратегии вывода ассортимента на маркетплесы: ключевые особенности и перспективы // Техноэкономика. 2025. Т. 4, № 3 (14). С. 55–63. DOI: https://doi.org/10.57809/2025.4.3.14.6

Introduction

The e-commerce market in Russia has demonstrated steady growth in recent years, along with one of the highest rates of growth in online retail. One of the key elements of e-commerce is marketplaces—online platforms that connect a large number of buyers and sellers. Among them, Wildberries stands out as one of the largest marketplaces in Russia. Daily, approximately 20 million users visit the platform, and about 9 million orders are processed. The platform also hosts not only Russian sellers but also vendors from CIS countries.

Due to the active growth of the marketplace and the intensifying competition, conducting business and entering new markets or categories has become increasingly difficult year by year. Small and medium-sized enterprises (SMEs) are particularly affected, facing challenges such as the inability to offer a wide product range and limited resources for promotion, primarily due to budget constraints. To succeed in trading on such platforms, small and medium-sized businesses need to develop and implement strategies for entering new product categories effectively (Varlamova, 2021; Vetryakova, 2022; Voinova, 2021; Ziyatdinov, 2023).

Materials and Methods

To develop an approach for launching and promoting a new assortment on marketplaces, a review of scientific literature on the current state of e-commerce in the Russian Federation was conducted (Pyanova, 2024; Romantsova, 2022; Starikova, 2020; Tarasova, 2022). The methodology of this paper includes a system of theoretical (analysis, synthesis, classification, deduction, and induction) and practical (description) research. Application of the above men-

tioned methods allows assessing the theoretical framework and business practice related to e-commerce for retail. In this study, the case-study method is used to analyze the features and prospects of introducing products to a marketplace, using Wildberries as the example.

Results and Discussion

The e-commerce market in Russia has demonstrated steady growth over recent years. According to industry analysts, the volume of online trade exceeded 6 trillion rubles in 2023, with more than 60% of all purchases made through marketplaces. Among the leaders are Wildberries, Ozon, Yandex.Market, and Lamoda, each having its own features, rules, and approaches to product promotion.

To select the most promising platform for launching a new assortment project, an expert survey was conducted among entrepreneurs operating on various e-commerce platforms. The experts included active marketplace sellers, online store owners, marketers, and logisticians. The purpose of the survey was to identify the strengths and weaknesses of different platforms from the perspective of real business experience.

The evaluation was carried out based on the following parameters:

— Entry barriers,
— Trading conditions,
— Promotion opportunities,
— Characteristics of the target audience,
— Key advantages and disadvantages of each platform.

Based on the aggregated expert survey, which involved representatives of small and medium-sized businesses working with various e-commerce platforms, the key features and differences of leading marketplaces were identified: Wildberries, Ozon, Yandex.Market, and Lamoda, as well as their own online stores.

The analysis of the responses revealed several characteristic patterns:

Wildberries was recognized by the majority of experts as the most flexible and scalable channel. It features a low entry barrier, extensive delivery geography, simple integration, and ready-made logistics. Despite strict internal rules and competition, the platform enables rapid sales scaling thanks to its high traffic, active female audience, and built-in promotional tools.

Ozon, by contrast, requires more preparatory steps but offers in-depth analytics and flexibility in advertising settings. Yandex.Market and Lamoda are seen as more niche solutions that require technical or brand readiness, while own websites demand significant investments in traffic and marketing.

Thus, based on the expert analysis, Wildberries was chosen as the marketplace for project launch, being the most suitable platform considering a combination of factors: accessibility, speed of launch, logistics, and built-in growth mechanisms.

The next logical step is to determine the product niche within which the assortment will be launched and developed.

During the development of the marketplace entry strategy, one of the key tasks is to justify the choice of the product niche. In this project, the priority area for analysis is the category of women's clothing, specifically the “dresses” segment.

This segment was preliminarily identified as potentially promising based on several logical assumptions: broad representation of the category on Wildberries, the visual appeal of the products, and the possibility of flexible assortment adaptation to seasonal and stylistic trends. However, to make a final decision, more in-depth applied analytics is required.

Additionally, during a hypothetical expert survey among active Wildberries sellers, the “dresses” category was noted as one of the accessible and scalable options. Despite high competition,

experts emphasize that having high-quality visual content, trendy designs, and an approach focused on the target audience enables new entrants to successfully enter the market.

This category is highly saturated: Wildberries displays tens of thousands of active SKUs covering various styles—from casual to evening, office, corrective, and oversize models. This variety indicates a broad and segmented product offering, which potentially allows for the identification of niches within the category.

Competition in this segment is considered high. Nevertheless, according to the results of the expert interviews, the niche remains accessible to new players, provided that they focus on high-quality positioning, visually appealing product listings, and alignment with current fashion trends.

For a deeper assessment of the market niche and to clarify the project's strategic guidelines, it is necessary to conduct an analysis of key competitors already present in the "dresses" category on the Wildberries marketplace. Competitor analysis allows not only to determine the market saturation level and dominant price segments but also to identify effective positioning models, as well as visual and marketing approaches used by active sellers.

Table 1. Competitive analysis in the "dresses" niche.

Brand	SKU	Price (rub)	USP	Style	Average rating	Range
MOZZA R	215054424	4433	Oversize, comfort boho	Oversize, boho	4.6	51 items
Aimerstore	153018421	1934	Festive with ruffles	Festive, oversize	4.5	24 items
Aesthevision	233201065	3577	Chiffon evening mini dresses	Evening gowns, oversize	4.6	15 items
Pranchella	318451556	3669	Festive with ruffles, romantic	Mini, romantic	4.1	26 items
MelixClo	244680979	3324	Festive with ruffles and flounces	Festive, romantic	4.5	22 items

An analysis of the product card structure of these competitors was also conducted to identify the strengths and weaknesses of their presentation on the Wildberries platform. The evaluation was carried out based on key parameters that influence the buyer's perception of the product and its promotion within the marketplace (Novikova, 2023; Panasenko, 2022).

The analysis showed that the most effective competitor product cards have the following characteristics: a clear Unique Selling Proposition (USP) in the title, diverse and high-quality visual content (including photos on models and videos), informative descriptions, as well as active management of reviews and a clear size chart. The presence of a related products section also positively impacts customer engagement and the average order value (Ivanova, 2021; Kove, 2021).

The conducted analysis of the market niche, competitors, and product card structure allowed for a comprehensive assessment of both the external environment and the specifics of product presentation in the "dresses" category on the Wildberries marketplace. Despite high competition, the niche remains open to new entrants ready to offer a visually strong and strategically well-considered product (Averkieva, 2023; Gushchina, 2020; Martynov, 2023).

The results of the competitive analysis revealed a variety of approaches to visualization, positioning, and content structuring of product cards. Further examination of the card structure allowed the identification of key elements that influence audience perception and engagement: the presence of a USP, photo content, description format, review block, and size tables.

The target audience analysis within this project is based on empirical data obtained from

studying the product cards of leading competitors in the "dresses" niche on the Wildberries marketplace. The analysis focused on items with the highest sales volume and number of reviews, which allowed concentrating on products that have gained wide popularity and active customer feedback.

Studying reviews and user questions provided an opportunity to identify recurring themes, preferences, motives, and concerns expressed during the purchasing decision process. This approach ensures a more accurate understanding of the audience's real needs and expectations, as well as the factors influencing consumer behaviour (Krivchenko, 2019; Mamanazarova, 2023).

Based on the collected data, a generalized profile of the target audience was developed, reflecting both behavioural and psychographic characteristics, including pain points, benefits, motivations, and interaction scenarios with the product. These insights formed the basis for subsequent segmentation and strategic positioning of the future product assortment.

Table 2. Target audience segmentation.

Segment	Practical Fashionistas	Romantic and feminine buyers	Conscious Consumers
Description	Women aged 25–35, employed, active, trend-conscious, but making thoughtful purchases	Young women aged 23–40, focused on image, emotions, and self-expression	Women aged 35–45, minimalist style, capsule wardrobe, quality over quantity
Psychographics	Moderately rational, enjoy trends but are not prone to impulsive purchases	Emotional, inspired by social media visuals, and inclined toward visual perception	Rational, accustomed to planning their purchases, and not easily influenced by fashion trends
Demands	Combination of style and comfort, suitable for everyday wear and work	Bright look, festive or celebratory styling	High-quality fabrics, durability, neutral style, convenience
Weaknesses	Incorrect size, poor fabric quality and/or fit	A basic dress that does not create a "wow" effect and fails to meet expectations	Easily sheds, cannot be washed at home, and does not match the wardrobe
Strenghts	Time-saving, versatile design, the ability to quickly select and purchase	Bright and memorable image	Practicality, versatility, and brand reliability
Buying behavior	Read reviews, analyze components, examine photos, and pay attention to length and style	Make choice based on photos, paying attention to presentation, reviews, and visuals	Study the fabric composition and care instructions, prefer neutral colors, willing to overpay
Core target audience	Core	Secondary segment	Growing segment

Based on the analysis of reviews, questions, and behavioral patterns identified through studying the product cards of top-selling items in the "dresses" niche on the Wildberries marketplace, a target audience typology was developed, reflecting its key characteristics, needs, and pain points. This segmentation highlighted three main groups: "Practical Fashionistas," "Romantic and Feminine," and "Conscious Buyers."

Each segment has its own motivations and expectations, differing in terms of rationality, sensitivity to visual content, attitude towards fashion, fabric composition, and comfort. At the same time, all segments share common focus areas: attention to fit quality, visual appearance, reviews, and product expectations (Marchenkov, 2019; Masterov, 2015).

The formed segmentation provides a foundation for further analysis of audience needs.

Next, to provide a more detailed visualization of the customer journey, we will proceed to create a user journey map. This will help identify key touchpoints, behavioral patterns, and opportunities to enhance loyalty and conversion.

Table 3. Target audience segmentation.

Stage	Action	Impression and emotions	Fears	Brand opportunities
Acknowledging the demand	Realizes the need for a new dress: for everyday wear, office, or an event	Wants to look stylish and feel confident	Worries about making the wrong choice	Create a recognizable brand style by showcasing real-life cases and looks
Search and selection	Searches for dresses on Wildberries, filtering by price, color, and size	Compares options, doubts, reads reviews, and examines photos	Lacks precise information; the style and fit are unclear.	Improve product cards by adding model measurements, real photos
Order Placement	Adds multiple sizes to the cart and selects a pickup option	Weighs the pros and cons, hoping the dress will fit well	Doubts about size accuracy, delivery, and quality.	Pack with care, provide a return guarantee, and include a letter or recommendations
Receiving and Trying On	Trying it on at home, consulting with close ones, and deciding whether to keep it or not	Emotions: likes it or not, fits the figure or not	The dress didn't fit well, the color was off, or the fabric was disliked.	Highlight the uniqueness of the fit and create a wow factor through intricate details
Reviews after trying on	Writes a review, shares impressions in comments, and rates how well the product meets expectations	Feels useful, wants to leave a review	Lack of time to leave a review, uncertainty about how to phrase it.	Use the "Bonus for Reviews" feature
Rating and repeat purchase	Takes photos, leaves reviews, shares with friends, and returns to the brand	When satisfied, returns to the brand	Fears to make the same mistake in the next purchase	Encourage leaving a review by offering a bonus or recommending a similar product, and collect feedback

The user journey map also enables identifying influence zones and opportunities for the brand: working with visual presentation, expanding product descriptions, supporting customers after purchase, encouraging reviews, and creating additional contact points. These elements can be integrated into the communication strategy and serve as tools to increase conversion rates and build sustainable loyalty.

Thus, the user journey map is not only a tool for describing audience behaviour but also a vital foundation for constructing a personalized customer experience when launching a new product assortment.

Applying the FBO model (placing products in WB warehouses), timely participation in promotions, optimizing product listings according to platform requirements, and refining the user experience based on reviews and ratings are essential conditions for a successful launch. Additionally, proper inventory management and leveraging built-in promotion tools help enhance visibility and accelerate sales growth.

In this way, considering microenvironment factors allows adapting the project strategy to the platform's actual conditions and minimizing risks related to technical, logistical, and behavioural constraints.

All these insights should be incorporated into the development of a comprehensive product launch strategy.

Conclusion

During the research, a comprehensive applied marketing analysis was conducted to substantiate the strategic choice of product niche and sales platform. As a result of expert surveys, analysis of macro- and micro-environmental factors, the competitive landscape, and target audience insights, the high potential of launching an assortment in the "dresses" category on the Wildberries marketplace was confirmed.

Based on platform data and analytical tools, it was established that this niche exhibits high turnover, visual sensitivity to demand, and segmented offerings. Despite significant competition, the market remains accessible for new entrants with a well-developed strategy that emphasizes visual presentation and effective review management.

The target audience analysis identified three key segments, with the core project segment being “practical fashionistas”—women focused on functionality, style, and affordability. Additionally, a user journey map was created, providing insights into customer motivations and expectations.

The analysis of the marketplace’s microenvironment—including logistics, seasonality, promotions, ranking algorithms, and promotional tools—was identified as a crucial factor in forming the strategy for assortment launch.

REFERENCES

Averkieva O. 2023. Sales dynamics of women's clothing on online trading platforms: comparative analysis of Wildberries, Amazon, and Ozon. Innovation and Investment, 3, 77-81.

Gushchina I. 2020. Accounting for advertising and certification expenses of a new product. Financial Bulletin: Finance, Taxes, Insurance, Accounting, 11, 50-57.

Ivanova E. 2021. Marketplaces as a tool for small business development. Innovative Economy and Modern Management, 2(33), 29-30.

Kove K. 2021. Marketplaces and ecosystems as alternative financial technologies. Innovation. Science. Education, 29, 1125-1130.

Krivchenko V. 2019. Interrelation of commodity science and marketing research as a factor in forming an effective assortment. Bulletin of Belgorod University of Cooperation, Economics and Law, 1(74), 193-203.

Mamanazarova G. 2023. Niche research for Wildberries. Scientific Aspect, 9(12), 1070-1082.

Marchenkov A. 2019. Marketplaces as the main trend in e-commerce. Scientific Aspirations, 26, 65-67. doi:10.31882/2311-4711.2019.26.14

Martynov P. 2023. Affiliate Marketing as a Part of the Digital Marketing Strategy of Banks and Fintech Companies. Technoeconomics 2, 2 (5), 45−53. DOI: https://doi.org/10.57809/2023.2.2.5.4

Masterov A. 2015. Managerial accounting and analysis of assortment and pricing policy as instruments to increase organizational efficiency. International Accounting, 9(351), 27-39.

Novikova E. 2023. Marketplaces as new social networks: product promotion as an SMM project. Modern Scientific Research and Innovations, 1(142).

Panasenko S., Suray N., Nikishin A. 2022. Domestic marketplaces: current state and development prospects. BIST Bulletin, 2(55), 27-36. doi:10.47598/2078-9025-2022-2-55-27-36

Pyanova N., Salenkova S., Pyanov R., Kryzhanovskaya O. 2024. Marketplace: business model of the modern economy. Bulletin of Southwest State University. Economics. Sociology. Management, 14(2), 175-185. doi:10.21869/2223-1552-2024-14-2-175-185

Romantsova P. 2022. Marketplaces as the main trend in e-commerce. Innovative Economy and Law, 4(23), 80-87. doi:10.53015/2782-263X_2022_4_80

Starikova M. 2020. Methods of forming a balanced assortment structure. Vector of Economics, 5(47), 19.

Tarasova E. 2022. Marketplaces as online platforms for internet trade development in Rus-

sia. Bulletin of Belgorod University of Cooperation, Economics and Law, 4(95), 100-112. doi:10.21295/2223-5639-2022-4-100-112

Varlamova D. 2021. Quality assessment of online stores on the example of Wildberries and Ozon. Practical Marketing, 5(291), 30-35. doi:10.24412/2071-3762-2021-5291-30-35

Vetryakova I. 2022. Development of marketplaces in the context of digital economy transformation on the example of Wildberries. Modern Science, 4(1), 30-34.

Voinova M. 2021. The Modern retail market in Russia − Marketplaces. Problems of Economics, Finance, and Production Management, 49, 74-77.

Ziyatdinov R. 2023. Study of the effectiveness of Wildberries' advertising tools. Bulletin of the University of Management TISBI, 3, 45-51.

Analytics of women's dress brand sales on Wildberries. URL: https://wildbox.ru/brand-analytics/plate-zhenskoe (accessed 12.07.2005).

Wildberries analytics service. URL: https://wildbox.ru/ (accessed: 12.07.2025).

СПИСОК ИСТОЧНИКОВ

Аверкиева О. 2023. Динамика продаж женской одежды на онлайн-торговых площадках: Сравнительный анализ Wildberries, Amazon и Ozon. Инновации и инвестиции 3, 77-81.

Гущина И. 2020. Учет расходов на рекламу и сертификацию нового продукта. Финансовый вестник: Финансы, налоги, страхование, бухгалтерский учет 11, 50-57.

Иванова Е. 2021. Маркетплейсы как инструмент развития малого бизнеса. Инновационная экономика и современный менеджмент 2 (33), 29-30.

Кове К. 2021. Маркетплейсы и экосистемы как альтернативные финансовые технологии. Инновации. Наука. Образование 29, 1125-1130.

Кривченко В. 2019. Взаимосвязь товароведных и маркетинговых исследований как фактор формирования эффективного ассортимента. Вестник Белгородского университета кооперации, экономики и права 1 (74), 193-203.

Маманазарова Г. 2023. Исследование ниш для Wildberries. Научный аспект 9 (12), 1070-1082.

Марченков А. 2019. Маркетплейсы как главный тренд электронной коммерции. Научные стремления 26, 65-67. doi:10.31882/2311-4711.2019.26.14

Martynov P. 2023. Affiliate Marketing as a Part of the Digital Marketing Strategy of Banks and Fintech Companies. Technoeconomics 2, 2 (5), 45−53. DOI: https://doi.org/10.57809/2023.2.2.5.4

Мастеров А. 2015. Управленческий учет и анализ ассортиментной и ценовой политики как инструмент повышения эффективности деятельности организации. Международный бухгалтерский учет 9 (351), 27-39.

Новикова Е. 2023. Маркетплейсы - новые социальные сети: продвижение товара как SMM-проект. Современные научные исследования и инновации 1 (142).

Панасенко С., Сурай Н., Никишин А. 2022. Отечественные маркетплейсы: современное состояние и перспективы развития. Вестник БИСТ 2 (55), 27-36. doi:10.47598/2078-9025-2022-2-55-27-36

Пьянова Н., Саленкова С., Пьянов Р., Крыжановская О. 2024. Маркетплейс: бизнес-модель современной экономики. Известия Юго-Западного государственного университета. Экономика. Социология. Менеджмент 14 (2), 175-185. doi:10.21869/2223-1552-2024-14-2-175-185

Романцова П. 2022. Маркетплейсы как главный тренд электронной коммерции. Инновационная экономика и право 4 (23), 80-87. doi:10.53015/2782-263X_2022_4_80.

Старикова М. 2020. Методы формирования сбалансированной структуры ассортимента. Вектор экономики 5 (47), 19.

Тарасова Е. 2022. Маркетплейсы как онлайн-платформы развития интернет-торговли в России. Вестник Белгородского университета кооперации, экономики и права 4 (95), 100-112. doi:10.21295/2223-5639-2022-4-100-112

Варламова Д. 2021. Оценка качества интернет-магазинов на примере Wildberries и Ozon. Практический маркетинг 5 (291), 30-35. doi:10.24412/2071-3762-2021-5291-30-35

Ветрякова И. 2022. Развитие маркетплейсов в условиях трансформации цифровой

экономики на примере Wildberries. Modern Science 4 (1), 30-34.

Воинова М. 2021. Современный рынок торговли в России – маркетплейсы. Проблемы экономики, финансов и управления производством 49, 74-77.

Зиятдинов Р. 2023. Исследование эффективности рекламных инструментов Wildberries. Вестник Университета управления ТИСБИ 3, 45-51.

Аналитика, продажи бренда платье женское на Wildberries. URL: https://wildbox.ru/brand-analytics/plate-zhenskoe (дата обращения: 12.07.2025).

Сервис аналитики Wildberries. URL: https://wildbox.ru/ (дата обращения: 12.07.2025).

INFORMATION ABOUT AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

LEPIKHIN Sergey S. – student.
E-mail: lepikhin_ss@spbstu.ru
ЛЕПИХИН Сергей Сергеевич – студент.
E-mail: lepikhin_ss@spbstu.ru

KRASNOV Alex S. – Associate Professor.
E-mail: krasnov_as@spbstu.ru
КРАСНОВ Алекс Сергеевич – доцент.
E-mail: krasnov_as@spbstu.ru
ORCID: https://orcid.org/0000-0003-4662-1905

Статья поступила в редакцию 23.07.2025; одобрена после рецензирования 31.07.2025; принята к публикации 01.08.2025.

The article was submitted 23.07.2025; approved after reviewing 31.07.2025; accepted for publication 01.08.2025.

Technoeconomics. 2025, Vol. 4, No. 3 (14). Pp. 64–77.
Техноэкономика. 2025, Том 4, № 3 (14). С. 64–77.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.7

DECAY-WEIGHTED FAIR PRICE FOR SOLANA BLOCKCHAIN TOKEN BUYBACK

Jose Emilio Phinney Dominguez ✉

Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia

✉ josemilio.1995@gmail.com

Abstract. This article investigates the problem of determining a fair reclaim price in fractionalized token markets on the Solana blockchain. The research object is the reclaim process, where minority holders must be compensated without exposure to short-term manipulation. The method introduces a program-derived account structured as an 11.5 kB circular buffer storing 720 hourly market prices, combined with an exponential decay weighting scheme with a 24-hour half-life to compute a time-weighted average price. Simulation results demonstrate that extreme pump or dump attempts within the final 72 hours before reclaim have a negligible effect on the computed value. The study concludes that the proposed mechanism ensures fairness for minority holders while maintaining cost efficiency in storage and transaction fees.

Keywords: fractionalized tokens, manipulation-resistant time-weighted average price, exponential decay weighting, Solana program-derived address account, circular buffer, on-chain pricing, reclaim mechanism, OpenBook order book, gas-efficient storage, DeFi fairness

Citation: Phinney Dominguez J.E. Decay-weighted fair price for Solana blockchain token buyback. Technoeconomics. 2025. 4. 3 (14). 64–77. DOI: https://doi.org/10.57809/2025.4.3.14.7

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2025.4.3.14.7

МОДЕЛЬ DECAY-ВЗВЕШЕННОЙ СПРАВЕДЛИВОЙ ЦЕНЫ ДЛЯ ВЫКУПА ТОКЕНОВ НА БАЗЕ БЛОКЧЕЙНА SOLANA

Хосе Эмилио Финни Домингес ✉

Санкт-Петербургский политехнический университет Петра Великого,
Санкт-Петербург, Россия

✉ josemilio.1995@gmail.com

Аннотация. Данная статья исследует проблему определения справедливой цены выкупа на рынке фракционных токенов в блокчейне Solana. Объектом исследования является процесс выкупа, при котором minor-держатели должны получить компенсацию без риска в краткосрочной перспективе. Метод включает использование аккаунта, структурированного в виде кольцевого буфера объемом 11,5 кБ, хранящего 720-часовую рыночную стоимость, в сочетании с схемой взвешивания с экспоненциальным затуханием в 24 часа для вычисления скользящей средней цены, взвешенной по времени. Результаты моделирования показывают, что экстремальные попытки pump-and-dump (памп-энд-дамп [“накачать и сбросить”]) в последние 72 часа перед выкупом оказывают незначительное влияние на рассчитанную стоимость. По результатам исследования, авторам удается заключить, что предложенный механизм обеспечивает справедливую цену для minor-держателей, при этом сохраняя эффективность затрат на хранение и комиссии за транзакции.

Ключевые слова: фракционные токены, манипуляционно-устойчивая взвешенная по времени средняя цена, взвешивание с экспоненциальным затуханием, аккаунт Solana, кольцевой буфер, ценообразование в блокчейне, механизм выкупа, OpenBook, энергоэффективное хранение, DeFi-справедливость

Для цитирования: Финни Домингес Х.Э. Модель decay-взвешенной справедливой цены для выкупа токенов на базе блокчейна Solana // Техноэкономика. 2025. Т. 4, № 3 (14). С. 64–77. DOI: https://doi.org/10.57809/2025.4.3.14.7

Introduction

Fractionalization Protocols

Fractionalization protocols (CoinMarketCap Academy) are decentralized systems that allow a digital asset, such as a token or NFT, to be split into many smaller fractions that can be traded individually (Chen, 2020; Mishra, 2024). For example, an artwork represented by a non-fungible token (NFT) (NFT Evening) can be fractionalized into hundreds or thousands of fungible tokens (Figure 1), enabling many users to hold partial ownership.

At some point, when a majority holder decides to reclaim the full asset, the protocol must determine a fair price to compensate the minority holders who give up their fractions. This reclaim price is critical, as it ensures fairness in the protocol and prevents disputes (Figure 2).

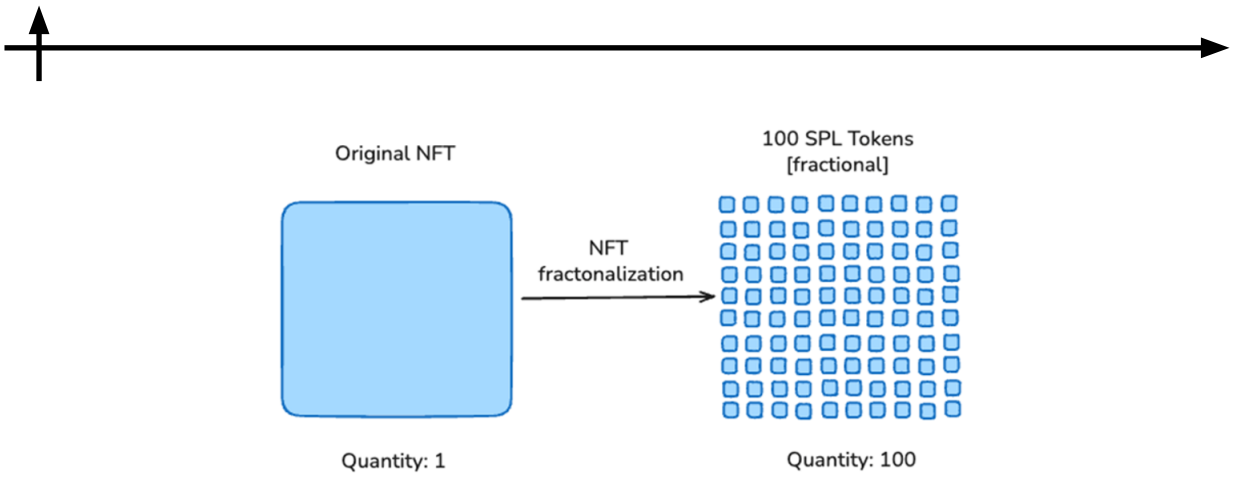


Fig. 1. Fractionalization.

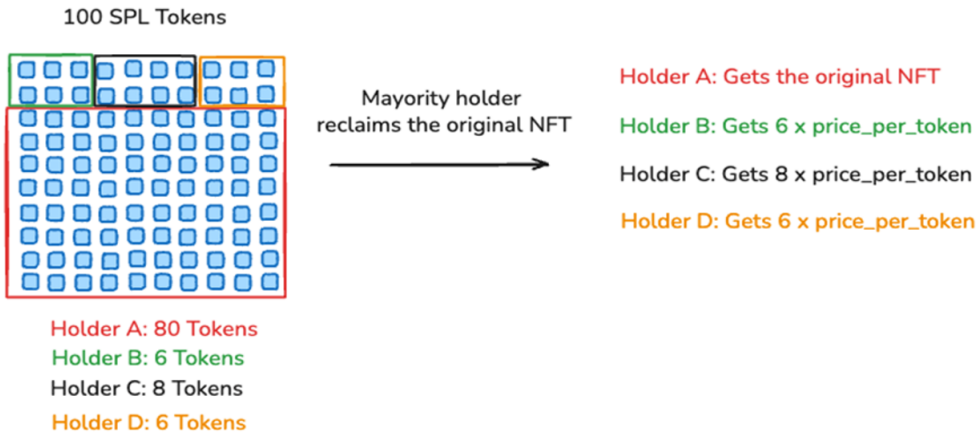


Fig. 2. Reclaim.

This work addresses the challenge of determining a fair, manipulation-resistant price for token reclaim events in fractionalized markets on the Solana blockchain (Solana Foundation). When tokens are fractionalized and later reclaimed, the reclaim price must reflect a stable and unbiased market value. Without safeguards, last-minute price manipulation, through artificial pumps or dumps (Fama, 1965; Faheem, 2024), could distort the average price, allowing majority holders to unfairly benefit at the expense of minorities. To solve this, we design a two-layer time-weighted average price (TWAP) system. First, we maintain a rolling 30-day window of hourly prices collected directly from the market. Second, we apply exponential decay weighting so that earlier values dominate, while the most recent values have negligible influence. This ensures resilience against manipulation attempts close to the reclaim event.

Requirement and Goal

The requirement is that a pool or market must exist for at least 30 days before a reclaim operation can be executed. During this period, hourly prices are recorded regardless of volume. The goal is to ensure that any reclaim price is derived from long-term market behaviour rather than short-term volatility (Lo, 1999; Painter, 2024; Pezzella, Pliushch, 2022).

Specifically, the system must:

— Collect and store 720 recent hourly prices (~30 days).

— Enforce exactly one price record per hour to avoid spam or manipulation.

— Provide a reclaim price that reflects long-term equilibrium.

— Prevent last-minute trades from altering the TWAP outcome.

Materials and Methods

The foundation of the design is a program-derived account (PDA) (Solana Foundation) called a PriceRing (Figure 3), which stores the most recent 720 hourly prices. The PriceRing is implemented as a circular buffer, meaning that once 720 entries are filled, the oldest entry is overwritten automatically by the newest price.

The account layout includes a pointer (head) to indicate the next write position and an array of 720 PricePoint structures, each containing a slot number and a price. The total memory requirement is approximately 11.5 kB, corresponding to 0.081125 SOL (Figure 4) of rent (Solana Foundation. Rent-Exemption and Accounts) on the Solana mainnet.

```rust
#[account(zero_copy)]
#[derive(Debug)]
pub struct PriceRing {
    pub head: u16,                // 2 bytes
    pub bump: u8,                 // 1 byte
    pub _pad: [u8; 5],            // 5 bytes
    pub points: [PricePoint; 720] // 720 * 16 bytes
}
const_assert_eq!(size_of::<PriceRing>(), 2 + 1 + 5 + 720 * 16);

#[derive(Copy, Clone, Debug, AnchorSerialize, AnchorDeserialize, Zeroable, Pod)]
#[repr(C)]
pub struct PricePoint {
    pub slot: u64,                // 8 bytes
    pub price: u64,               // 8 bytes  price in lots
}
```

Fig. 3. Program Derived Address (PDA).

```
joseemilio@MacBook-Air-de-Jose twitter-solana % solana config set --url https://api.mainnet-be
Config File: /Users/joseemilio/.config/solana/cli/config.yml
RPC URL: https://api.mainnet-beta.solana.com
WebSocket URL: wss://api.mainnet-beta.solana.com/ (computed)
Keypair Path: /Users/joseemilio/.config/solana/id.json
Commitment: confirmed
joseemilio@MacBook-Air-de-Jose twitter-solana % solana rent 11528
Rent-exempt minimum: 0.08112576 SOL

joseemilio@MacBook-Air-de-Jose twitter-solana %
```

Fig. 4. Rent-exempt on Solana mainnet for 11.528 kB.

Writing Logic and Circular Buffer

In the writing logic (Figure 5), we will store the newest 720 hourly prices in a circular buffer inside the PDA. That is, every ~9000 slots (1 hour) (Solana Foundation. Slots and Time), we call an instruction that reads the latest traded price and writes it into the ring.

```
// 1. Fetch price (lots)
let price: i64 = get_price(
    &ctx.accounts.event_heap,
    prev_price,          // PricePoint we stored 1 h ago (None for 1st hour)
    &ctx.accounts.bids,
    &ctx.accounts.asks,
)?;

// 2.  Circular write
let idx = ring.head as usize;        // where we write NOW
ring.points[idx] = PricePoint {
    slot: Clock::get()?.slot,        // current slot
    price: price as u64,             // lots
};
ring.head = (ring.head + 1) % 720;   // advance pointer (wraps at 719 => 0)
```

Fig. 5. Writing logic.

As we can see, after 720 calls, the pointer has wrapped once; in this case, ring.head represents the oldest entry and will be overwritten in the next hour, which means that we have an O(1) circular buffer. Furthermore, since this instruction writes the 16-byte struct PricePoint, it incurs a gas fee per update.

Slot-Gate (Anti-Spam)

Next, to enforce exactly one write per hour and prevent spam (someone calling multiple times in an hour), we add a slot gate at the beginning of the instruction (Figure 6):

```
// Every 9 000 slots (≈ 1 hour):

// 1. Gate: only one write per hour
const HOUR_SLOTS: u64 = 9_000; // ~1 h at 400 ms/slot
let clock = Clock::get()?;
let due_slot = market.creation_slot + (HOUR_SLOTS * (ring.head as u64));
require!(clock.slot >= due_slot, TooSoon);
```

Fig. 6. Slot gate.

As we can see:

— ring.head acts as an implicit hour-counter (mod 720).

— The formula gives the earliest slot at which the next price is allowed.

— Calling before that slot fails with TooSoon and costs only the transaction fee.

— Calling on or after that slot succeeds, stores the price, and advances ring.head.

Let us assume that the creation slot is slot number 100 (market.creation_slot = 100) for simplicity of illustration in Table 1.

Table 1. Example of writing logic.

ring.head (%-720)	hours	due_slot calculation	allowed succeeding slots	What happens after writing
0	0	100+9000x0=100	100 ... 8999	store at idx 0, head → 1
1	1	100+9000x1=9100	9100 ... 17999	store at idx 1, head → 2
2	2	100+9000x2=18100	18100 ... 26999	Store at idx 2, head → 3
...	...	...	...	...
719	719	100+9000x719=6471100	6471100 ... 6479999	store at idx 719, head → 0 (wraps)
0 (again)	720	100+9000x720=6480100	6480100 ... 6488999	overwrites idx 0, head → 1

So, anyone can call at any time, but the call will be processed only if it is in the range of the allowed succeeding slots.

Price Source (OpenBook)

Next, price sources come from OpenBook, an order book protocol that will allow us to create our market after fractionalization and trade the fractionalized tokens. The function get_price() in Figure 5 returns the last-traded price in lots from OpenBook using its FillEvent state and Market state. As we previously saw, the function is called once every hour and returns a single number we can directly store in the ring PDA. We can see the detailed implementation of the function in Figure 7.

```
/// Returns the price (in lots) we want to store this hour.
/// Falls back to the previous stored price if no trade happened.
/// Only uses mid-price for the very first point.
fn get_price(
    heap: &EventHeap,    // OpenBook event heap
    prev: Option<i64>,   // price we stored 1 hour ago (None for 1st point)
    bids: &BookSide,     // bids account
    asks: &BookSide,     // ask account

) -> i64 {

    // 1. Get the last trade in the past hour
    if let Some(fill) = heap
        .iter()
        .rev()
        .find_map(|(ev, _)| match ev.event_type.try_into().ok()? {
            EventType::Fill => Some(bytemuck::cast_ref::<FillEvent>(ev)),
            _ => None,
        })
    {
        return fill.price; // already in lots => store as-is
    }

    // 2. No trade => reuse previous hour price
    if let Some(p) = prev {
        return p; // keeps TWAP
    }

    // 3. First hour and still no trade => mid-price fallback
    let bb = bids.best_price()?; // best bid in lots
    let ba = asks.best_price()?; // best ask in lots
    (bb + ba) / 2                // mid-price in lots
}
```

Fig. 7. Function that gets the prices from OpenBook.

As we can notice, prices are sourced from the OpenBook market through the following hierarchy:

1. Last traded price from the event heap.
2. Previous stored price if no trade occurred.
3. Mid-price between best bid and best ask if no historical data is available.

This approach allows us that in case there is no trade in a specific hour, no slot is skipped because the ring simply duplicates the previous hour's price, which correctly shows the market's real feeling.

Once the buyback is triggered, for reading the prices data in our PDA for TWAP, we can start at the next write index (ring.head + 1) and walk forward 720 steps, wrapping around %720. Because the ring is circular, this gives us the entries from the oldest to the freshest. Figure 8 shows the reading logic.

```
TWAP window = [start, end]

let start = (ring.head + 1) % 720;
for i in 0..720 {
    let entry = ring.points[(start + i) % 720];
    // entry is chronologically ordered:
    // i=0 => oldest (720 h ago)
    // i=719 => newest (1 h ago)
}
```

Fig. 8. Reading logic.

For a better understanding, let's see an example. Let's we have a small ring of 4 slots.

Table 2. Example of reading logic with a small ring.

Index	0	1	2	3
Data	D	A	B	C

And let's suppose the head is at position 2 (head=2). Then, the iteration would be:

```
let start = (ring.head + 1) % 4;   // = 3
for i in 0..4 {
    let entry = points[(start + i) % 4];
}

i=0 => (3+0)%4 = 3 => C   (oldest)
i=1 => (3+1)%4 = 0 => D
i=2 => (3+2)%4 = 1 => A
i=3 => (3+3)%4 = 2 => B   (newest)

TWAP window = [C, D, A, B]
```

Fig. 9. Iration logic example.

That means that C, D, A, B is the chronological sequence we would need for the window prices. Same idea applies with 720 elements.

price_window=[price_1,price_2,price_3,...,price_719,price_720]

After 30 days (720 hourly entries) from the market start, the reclaim becomes possible. Now, the rolling prices window written in our PDA allows that we are always looking at the recent prices performances from the moment the reclaim is done (30 days = 720 hours = 6480000 slots). It doesn't matter if the claim is done right after it's unlocked or 10 years later. It will always show fresh market data.

2.5 Decay-Weight Formula

The next step, is calculate the weights w_i of each price in our window using exponential decay (Epstein, 1996; Mazieri, 2022) with a half-life parameter of 24 hours (every 24 hours, the weight gets cut in half). For that, we can use the formula (1):

$$w = 2^{-t/24} \tag{1}$$

Where t is the i-index of the price in the prices window. Weighting the prices using (1) we get:

Table 3. Price weighting process.

$Price_i$	$w_i = 2^{-t/24}$	w_i
$Price_1$	$w_1 = 2^{(-1/24)}$	$w_1 = 0.97$
$Price_2$	$w_2 = 2^{(-2/24)}$	$w_2 = 0.94$
$Price_3$	$w_3 = 2^{(-3/24)}$	$w_3 = 0.91$
...	...	...
$Price_{718}$	$w_{718} = 2^{(-718/24)}$	$w_{718} = 0.0000000009867018967$
$Price_{719}$	$w_{719} = 2^{(-719/24)}$	$w_{719} = 0.0000000009586124091$
$Price_{720}$	$w_{720} = 2^{(-720/24)}$	$w_{720} = 0.0000000009313225746$

Finally, the final price per token P for the minority pay-out will be calculated as follows:

$$P = \frac{\sum_{i=1}^{720}(p_i * w_i)}{\sum_{i=1}^{720} w_i} \tag{2}$$

Where p_i correspond to each price in the prices window and $\rightarrow$ the respective weight. As we can notice in Table 3, the latest prices in the window have less weight, hence less influence in the total average which prevents from any latest huge pump/dump influence in the total price. The Figure 10 below shows the graph of the equation (1). Notice that with 24 hours half-life parameter, after the first 25 hours (first 25 prices), the weight drops to 0.5, making practically impossible profitable to any attacker to influence the price in last minutes/hours before the reclaim.

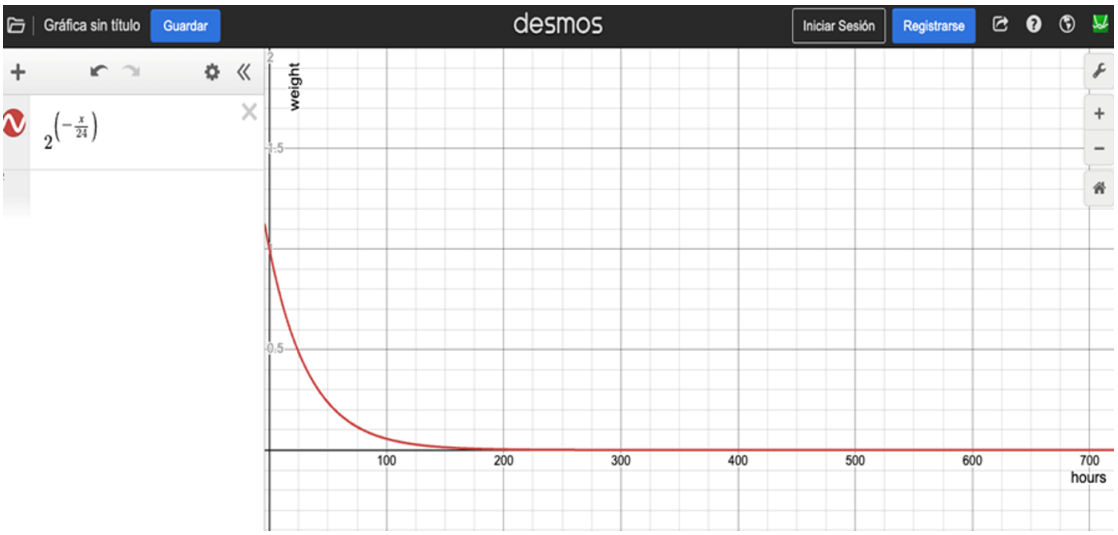


Fig. 10. Graph of equation (1).

Next, graphs in Figure 11 show that the smaller the half-life parameter, the faster the weight drops and the harder it becomes for an attacker to succeed.

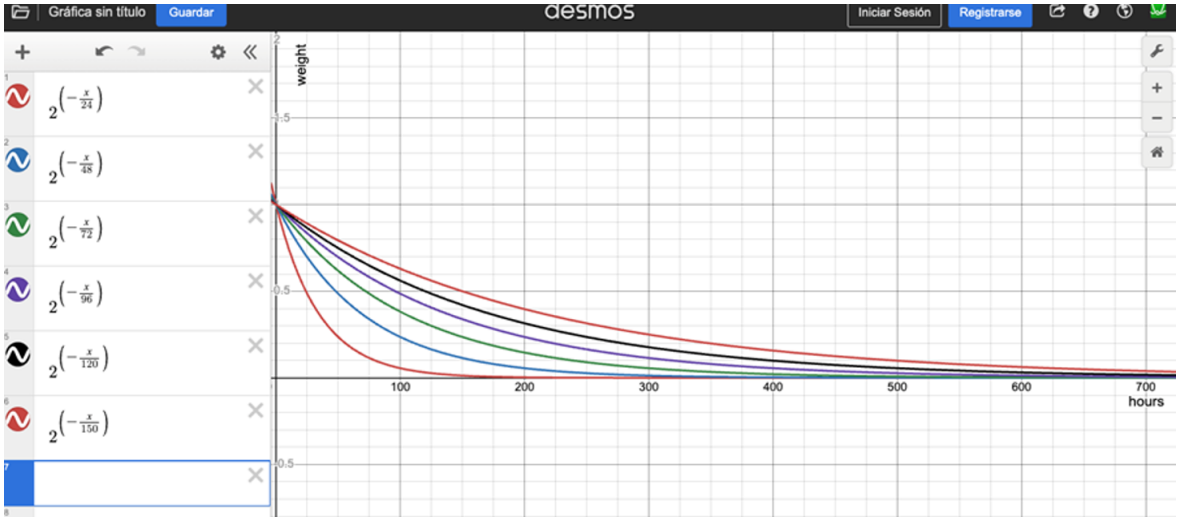


Fig. 11. Weights graphs for different half-life parameters.

Results and Discussion

Now, using the script in this repository, let us calculate, using the formula (2), the price per token in three different scenarios:

SCENARIO 1:

Let us assume that there is no attempt of price manipulation and the price per token in the 30-day window varies from $3.0 to $5.0 randomly. Figure 12 shows the simulation results:

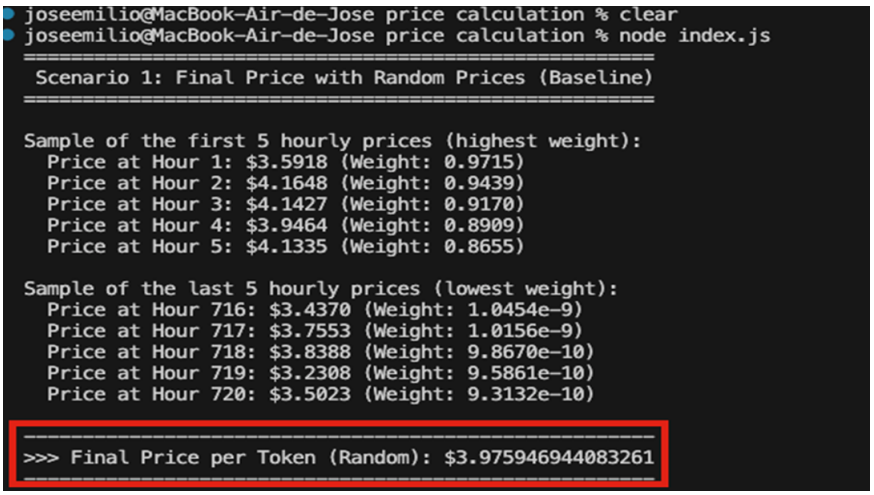


Fig. 12. Simulation results of scenario 1.

As we can notice in the figure above, the price in the first 5 hours after the start of the TWAP window have higher weights, and the prices in the last 5 hours have lower weights. Here, the final price per token is $3.975946944083261, reflecting the central tendency of the market.

SCENARIO 2:

The price per token has been moving from $3.0 to $5.0 randomly, but in the last 72 hours, the price has been intentionally pumped to $50.00 (pretty high compared to the range of $3.0-$5.0 that it has been moving in). The result is shown in Figure 13:

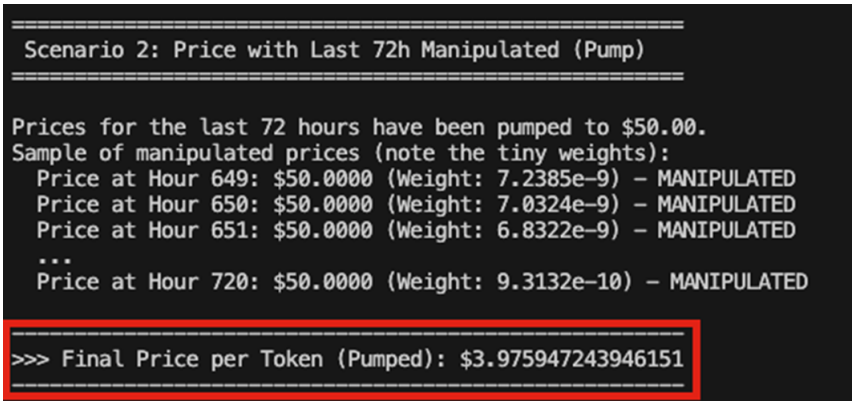


Fig. 13. Simulation results of scenario 2.

As we can notice, the extreme pump in the final 72 hours has a negligible effect on the final average price, so the final price per token is $3.975947243946151. This means that, even if the attacker intentionally pumps the prices by buying $3.00 - $5.00 tokens at $50 during the last 72 hours with the aim of having influence on the average price per token for when the reclaim is done, it has a completely negligible effect and at the same time is not profitable at all.

SCENARIO 3:

The price per token has been moving from $3.0 to $5.0 randomly, but in the last 72 hours, the price has been intentionally dumped to $0.10 (pretty low compared to the range of $3.0-$5.0 that it has been moving in). The result is shown in Figure 14:

Fig. 14. Simulation results of scenario 3.

Here, similar to the previous result, the extreme dump in the final 72 hours also has a negligible effect on the final average price, so the final price per token is $3.975946918635178.

These three scenarios confirm that exponential decay nullifies the effect of short-term anomalies while maintaining fairness for all participants.

Cost and Efficiency Analysis

— Storage: Each PDA requires 11.5 kB of space, equivalent to 0.081125 SOL for rent-exempt status. This cost is paid once and reclaimed when the account is closed.

— Transaction Costs: Each hourly update requires writing a 16-byte structure, costing about 5000 lamports [14].

— Performance: The circular buffer design ensures a constant time complexity (Cormen, 2009; Curley, 2022) for insertion and reading for TWAP calculation, which is computationally efficient on-chain.

Conclusion

The combination of a rolling 30-day window and exponential decay weighting provides a robust framework for reclaim pricing. Simulation confirms that manipulation attempts in the last 72 hours fail to meaningfully alter the outcome. Meanwhile, stale historical data is automatically excluded after 30 days, ensuring relevance.

This design balances efficiency and security. The PDA storage footprint is minimal, and the update cost is affordable. The reclaim mechanism guarantees fairness for minority holders while discouraging majority holders from attempting manipulative strategies.

1. A program-derived account (PDA) structured as a circular buffer efficiently stores 720 hourly prices, providing an on-chain dataset of 30 days with minimal memory footprint (~11.5 kB) and affordable rent cost (~0.081125 SOL).

2. The hourly update mechanism, combined with slot-gate validation, guarantees exactly one valid price record per hour. This prevents spam and manipulation, ensuring data integrity throughout the observation window.

3. The multi-source pricing method (last traded price, previous price reuse, and mid-price fallback) ensures that the system always produces a valid hourly price, even under conditions of low liquidity or no trading activity.

4. The application of exponential decay with a 24-hour half-life establishes a direct connection between time and price weight, making earlier prices significantly more influential than recent ones. This effectively neutralizes the impact of short-term volatility or last-minute manipulation attempts.

5. Simulated scenarios demonstrate that extreme price shocks (pump or dump within the last

72 hours) do not materially affect the final TWAP outcome, confirming the robustness of the weighting scheme.

6. The reclaim price, derived from the exponentially decay-weighted TWAP over the rolling 30-day window, reflects fair market value and ensures equitable treatment of minority holders during reclaim events.

7. The proposed method balances computational efficiency (O(1) insertion, O(720) retrieval) with economic feasibility (~5000 lamports per hourly update), proving its practical applicability in Solana-based fractionalization protocols.

REFERENCES

Chen Y., Bellavitis C. 2020. Blockchain disruption and decentralized finance: The rise of decentralized business models. Journal of Business Venturing Insights 13, 001512020. doi:10.1016/j.jbvi.2019.e00151

Cormen T., Leiserson C., Rivest R., Stein C. 2009. Introduction to algorithms. MIT Press.

Curley N. 2022. Blockchain disruption: digital assets are changing how we do business. SMU Science and Technology Law Review 25 (2), 265. doi:10.25172/smustlr.25.2.6

Epstein M., Mazzeo G. 1996. Exponential decay and its applications in economics and finance. Applied Mathematical Finance 3 (2), 119–134.

Faheem M., Kuusniemi H., Eltahawy B. 2024. A lightweight smart contracts framework for blockchain-based secure communication in smart grid applications. IET Generation, Transmission & Distribution 18 (3), 625-638. doi:10.1049/gtd2.13103

Fama E. 1965. The behavior of stock market prices. Journal of Business 38 (1), 34–105.

Lo A., MacKinlay A. 1999. A non-random walk down Wall Street. Princeton University Press.

Mazieri M., Scafuto I., Da Costa P. 2022. Tokenization, blockchain and web 3.0 technologies as research objects in innovation management. International Journal of Innovation 10 (1), 1-5. doi:10.5585/iji.v10i1.21768

Mishra D., Behera S. 2024. Solana blockchain technology: a review. International Journal of Informatics and Communication Technology 13 (2), 197. doi:10.11591/ijict.v13i2.pp197-205

Painter Z., Peterson Ch., Cook V., Dechev D. 2024. Blockchain scalability with proof of descriptor. Distributed Ledger Technologies: Research and Practice. doi:10.1145/3700148

Pezzella E., Pliushch E. G. 2022. Digital transformation of business: use of blockchain in the oil & gas industry. Technoeconomics 3 (3), 4-16. DOI: https://doi.org/10.57809/2022.3.3.1

CoinMarketCap Academy. Fractional NFTs: a complete guide to shared ownership of digital assets. URL: https://coinmarketcap.com/academy/article/what-are-fractional-nfts-f-nfts-and-how-do-they-work (accessed: 24.08.2025).

Decay-Weighted TWAP. GitHub Repository. URL: https://github.com/josephinney/decay-weighted-twap (accessed: 24.08.2025).

NFT Evening. What are Solana NFTs? Top Solana NFT projects in 2025. URL: https://nftevening.com/solana-nfts/ (accessed: 24.08.2025).

OpenBook Dex. Market State Module. GitHub Repository. URL: https://github.com/openbook-dex/openbook-v2/blob/master/programs/openbook-v2/src/state/market.rs (accessed: 24.08.2025).

OpenBook Dex. Orderbook Heap Module. GitHub Repository. URL: https://github.com/openbook-dex/openbook-v2/blob/master/programs/openbook-v2/src/state/orderbook/heap.rs (accessed: 24.08.2025).

Solana Foundation. Program Derived Addresses. Solana Documentation.URL: https://docs.solana.com/developing/programming-model/calling-between-programs#program-derived-addresses (accessed: 24.08.2025).

Solana Foundation. Rent-Exemption and Accounts. Solana Documentation. URL: https://docs.solana.com/developing/programming-model/accounts (accessed: 24.08.2025).

Solana Foundation. Slots and Time. Solana Documentation. URL: https://docs.solana.com/cluster/slots (accessed 24.08.2025).

Solana Foundation. Solana documentation: introduction to Solana. URL: https://docs.solana.com/ (accessed: 24.08.2025).

Solana Foundation. Transaction Fees. Solana Documentation. URL: https://docs.solana.com/transaction_fees (accessed: 24.08.2025).

СПИСОК ИСТОЧНИКОВ

Chen Y., Bellavitis C. 2020. Blockchain disruption and decentralized finance: The rise of decentralized business models. Journal of Business Venturing Insights 13, 001512020. doi:10.1016/j.jbvi.2019.e00151

Cormen T., Leiserson C., Rivest R., Stein C. 2009. Introduction to Algorithms. MIT Press.

Curley N. 2022. Blockchain Disruption: Digital assets are changing how we do business. SMU Science and Technology Law Review 25 (2), 265. doi:10.25172/smustlr.25.2.6

Epstein M., Mazzeo G. 1996. Exponential decay and its applications in economics and finance. Applied Mathematical Finance 3 (2), 119–134.

Faheem M., Kuusniemi H., Eltahawy B. 2024. A lightweight smart contracts framework for blockchain-based secure communication in smart grid applications. IET Generation, Transmission & Distribution 18 (3), 625-638. doi:10.1049/gtd2.13103

Fama E. 1965. The behavior of stock market prices. Journal of Business 38 (1), 34–105.

Lo A., MacKinlay A. 1999. A non-random walk down Wall Street. Princeton University Press.

Mazieri M., Scafuto I., Da Costa P. 2022. Tokenization, blockchain and web 3.0 technologies as research objects in innovation management. International Journal of Innovation 10 (1), 1-5. doi:10.5585/iji.v10i1.21768

Mishra D., Behera S. 2024. Solana blockchain technology: a review. International Journal of Informatics and Communication Technology 13 (2), 197. doi:10.11591/ijict.v13i2.pp197-205

Painter Z., Peterson Ch., Cook V., Dechev D. 2024. Blockchain scalability with proof of descriptor. Distributed Ledger Technologies: Research and Practice. doi:10.1145/3700148

Pezzella E., Pliushch E. G. 2022. Digital transformation of business: use of blockchain in the oil & gas industry. Technoeconomics 3 (3), 4-16. DOI: https://doi.org/10.57809/2022.3.3.1

CoinMarketCap Academy. Fractional NFTs: a complete guide to shared ownership of digital assets. URL: https://coinmarketcap.com/academy/article/what-are-fractional-nfts-f-nfts-and-how-do-they-work (дата обращения: 24.08.2025).

Decay-Weighted TWAP. GitHub Repository. URL: https://github.com/josephinney/decay-weighted-twap (дата обращения: 24.08.2025).

NFT Evening. What are Solana NFTs? Top Solana NFT projects in 2025. URL: https://nftevening.com/solana-nfts/ (дата обращения: 24.08.2025).

OpenBook Dex. Market State Module. GitHub Repository. URL: https://github.com/openbook-dex/openbook-v2/blob/master/programs/openbook-v2/src/state/market.rs (дата обращения: 24.08.2025).

OpenBook Dex. Orderbook Heap Module. GitHub Repository. URL: https://github.com/openbook-dex/openbook-v2/blob/master/programs/openbook-v2/src/state/orderbook/heap.rs (дата обращения: 24.08.2025).

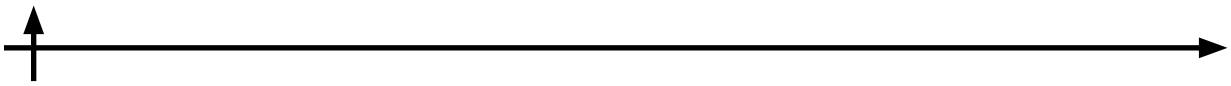
Solana Foundation. Program Derived Addresses. Solana Documentation.URL: https://docs.solana.com/developing/programming-model/calling-between-programs#program-derived-addresses (дата обращения: 24.08.2025).

Solana Foundation. Rent-Exemption and Accounts. Solana Documentation. URL: https://docs.solana.com/developing/programming-model/accounts (дата обращения: 24.08.2025).

Solana Foundation. Slots and Time. Solana Documentation. URL: https://docs.solana.com/cluster/slots (дата обращения: 24.08.2025).

Solana Foundation. Solana documentation: introduction to Solana. URL: https://docs.solana.com/ (дата обращения: 24.08.2025).

Solana Foundation. Transaction Fees. Solana Documentation. URL: https://docs.solana.com/transaction_fees (дата обращения: 24.08.2025).



INFORMATION ABOUT AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

PHINNEY DOMINGUEZ Jose Emilio – student.
E-mail: josemilio.1995@gmail.com
ФИННИ ДОМИНГЕС Хосе Эмилио – студент.
E-mail: josemilio.1995@gmail.com
ORCID: https://orcid.org/0009-0005-0370-7313

Статья поступила в редакцию 03.09.2025; одобрена после рецензирования 09.09.2025; принята к публикации 11.09.2025.
The article was submitted 03.09.2025; approved after reviewing 09.09.2025; accepted for publication 11.09.2025.

Научное издание

Technoeconomics

Том 4, № 3, 2025

Учредитель, издатель – Федеральное государственное автономное образовательное учреждение высшего образования
«Санкт-Петербургский политехнический университет Петра Великого»

Телефон редакции 8 (812) 550-36-52

E-mail: technoeconomics@spbstu.ru

Компьютерная верстка *Д.М. Гугутишвили*
Редактирование английского языка *И.В. Ильина*
Ответственный секретарь *О.В. Воронова*
Выпускающий редактор *А.И. Лёвина*