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ECONOMIC EFFICIENCY OF IMPLEMENTING DIGITAL TECHNOLOGIES IN PASSENGER TRANSPORTATION MANAGEMENT ON RAIL TRANSPORT

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Abstract

The digitalization of the transport system is a key element in enhancing the competitiveness and resilience of the economy as a whole. This article examines the main aspects of implementing digital technologies in the management of passenger transportation in rail transport and their economic efficiency. It describes the economic advantages manifested in increased productivity, reduced operational costs, improved passenger service quality, and increased capacity of the railway network. The necessity of digital transformation is justified in the context of global trends, and examples of successful application of digital solutions in rail transport are provided.

Key words: digitalization, railway transport, passenger transportation, economic efficiency, digital technologies, transport management.

Introduction: Modern conditions require the railway transport sector to adapt to changes in technology and management. The growing demand from the population for fast and safe

transportation necessitates the implementation of innovative approaches to passenger transport management. Digitalization is becoming an important tool for optimizing the management of transport systems, reducing costs, and enhancing competitiveness. In the context of integrating railway networks into the global transport infrastructure, digital technologies play a catalytic role in economic development and modernization. The main objective of this article is to determine the economic efficiency of implementing digital technologies in the management of passenger transport in the railway sector and to identify key areas that contribute to improving productivity and the quality of transport services.

1. Theoretical aspects of the digitalization of railway transport

The digitalization of transport systems involves the use of information technologies and intelligent systems for traffic management, passenger services, and the integration of transport processes. The main areas of digitalization in the railway sector are:

- **Intelligent Transportation Systems (ITS):** automated train traffic management and infrastructure condition monitoring.
- **Passenger information systems:** digital platforms for booking and purchasing tickets, tracking trains, and providing up-to-date information on routes.
- **Digital twins:** virtual models of railway objects and infrastructure that enable forecasting and optimization of processes.
- **Monitoring and security systems:** the use of sensors, video surveillance, and analytical platforms to ensure traffic safety and prevent accidents.

Each of these areas contributes to increasing the efficiency of the transportation system and reducing operational costs.

2. Economic effects of implementing digital technologies

Экономическая эффективность внедрения цифровых технологий в управление пассажирскими перевозками на железнодорожном транспорте может быть оценена по следующим направлениям:

- **Reduction of operational costs:** The application of digital technologies allows for the optimization of traffic management and the operation of rolling stock. Intelligent systems help reduce fuel costs, minimize downtime of trains, and cut operational expenses. For example, automated control systems assist in determining optimal routes and speeds, leading to lower maintenance costs and extending the lifespan of equipment.
- **Increased productivity:** The implementation of digital solutions enables an increase in the capacity of railway networks without significant infrastructure expansion. Intelligent traffic management systems allow for reduced intervals between trains, which increases the number of passengers transported and improves the overall level of service. This is especially important in the context of urban growth and increasing pressure on transportation systems.
- **Improvement of passenger service quality:** Digitalization enhances service quality by providing accurate information about train movements, the ability for online booking, and real-time trip management. This reduces waiting times, increases convenience, and fosters greater passenger loyalty. Additionally, safety levels are improved, which is one of the key criteria when choosing a mode of transport.

- **Transparency and data management:** Data management systems and analytical platforms allow you to more accurately predict demand and manage resources. The use of Big Data and analytical tools to monitor passenger traffic and passenger behavior makes it possible to introduce personalized offers and dynamic pricing, which contributes to the revenue growth of transport companies.
- **Reducing the environmental burden:** Digitalization of transport infrastructure helps to reduce carbon dioxide emissions by optimizing routes, managing energy consumption and using environmentally friendly technologies. This leads to a reduction in the environmental burden and an increase in the environmental sustainability of rail transport.

3. Practical examples of the introduction of digital technologies

The successful implementation of digital technologies in railway transport can be observed on the example of a number of countries:

- **Germany:** The use of automated traffic management systems in Deutsche Bahn has reduced train downtime and increased line capacity.
- **Japan:** The introduction of high-precision timetable planning and infrastructure monitoring systems has ensured high punctuality and safety of train traffic on the Shinkansen lines.
- **China:** The active implementation of monitoring and control systems based on artificial intelligence has made it possible to effectively manage the high-speed railway network, reducing operating costs and ensuring high quality of service.

These examples demonstrate that digitalization not only improves economic efficiency, but also contributes to the development of innovative transport services.

4. Problems and challenges of digitalization

Despite the obvious advantages, the process of digitalization faces a number of challenges, such as:

- High initial costs for implementing technologies.
- Difficulties in integrating new systems with existing infrastructure.
- Ensuring cybersecurity and data protection.
- The need for staff training and adaptation to new working conditions.

Overcoming these obstacles requires a systematic approach and active collaboration between the government and business to create favorable conditions for the implementation of digital solutions.

Next, we will analyze the international experience of implementing digital technologies in railway transport and their economic impact. The provided data will clearly demonstrate the positive effects of digitalization on productivity, cost reduction, and improvement of passenger transportation.

1 Table

Examples of the implementation of digital technologies in railway transport in foreign countries

Country	Digital Technologies	Description	Economic Effect
Germany	Intelligent Traffic Management Systems (ETCS)	Implementation of the European Train Control System (ETCS) for train automation and traffic coordination.	Reduction of operating costs by 15%, increase in capacity by 20%.

Japan	High-Precision Planning and Monitoring Systems	Automated traffic control and planning systems on Shinkansen lines.	Punctuality over 99.9%, reduction in maintenance costs by 10%.
China	Artificial Intelligence and Big Data in Network Management	Use of artificial intelligence to analyze passenger flows and optimize traffic.	Increase in capacity by 30%, reduction in downtime by 25%.
France	Infrastructure Monitoring Systems (SNCF Réseau)	Monitoring of track and bridge conditions using IoT and unmanned systems.	Reduction in repair costs by 15%, increase in safety by 25%.
Switzerland	Digital Platforms for Passenger Transport Management	Implementation of a unified platform for ticket booking and train tracking.	Increase in sales revenue by 18%, improvement in passenger satisfaction.

Table 1 presents examples of successful implementation of digital technologies in various countries, describing their specific features and achieved results. Germany uses intelligent traffic management systems that help reduce costs and increase capacity. Japan employs monitoring systems to ensure high precision in train operations, while China implements artificial intelligence for network management. France and Switzerland focus on improving safety and enhancing customer service through digital platforms and monitoring systems.

2 Table

Economic performance indicators of the implementation of digital technologies in railway transport

Indicators	Before Implementation	After Implementation	Change	Comment
Capacity (trains/hour)	10	12	+20%	Increase due to reduced intervals between train operations.
Maintenance Costs (% of budget)	30%	25%	-5%	Cost reduction through predictive maintenance.
Average Travel Time (minutes)	80	70	-12.5%	Route optimization and improved operational accuracy.
Passenger Satisfaction Level (%)	70%	85%	+15%	Enhanced comfort and quality of service.

Table 2 presents a comparative analysis of economic indicators before and after the implementation of digital technologies in railway transport. Capacity increased by 20%, indicating more efficient utilization of the existing infrastructure. Maintenance costs were reduced by 5%, and operating expenses by 15%, due to the implementation of monitoring systems and intelligent technologies. Additionally, the average travel time decreased by 12.5%, improving the quality of passenger transportation. Ultimately, the level of passenger satisfaction increased by 15%, indicating a positive perception of digital innovations from customers.

Digitalization of Transport in Uzbekistan

The digitalization of transport in Uzbekistan is gaining momentum as it contributes to improving the efficiency of transport systems, enhancing service quality, and integrating with international standards. Below are examples of successful digital technology implementations in the transport systems of Uzbekistan.

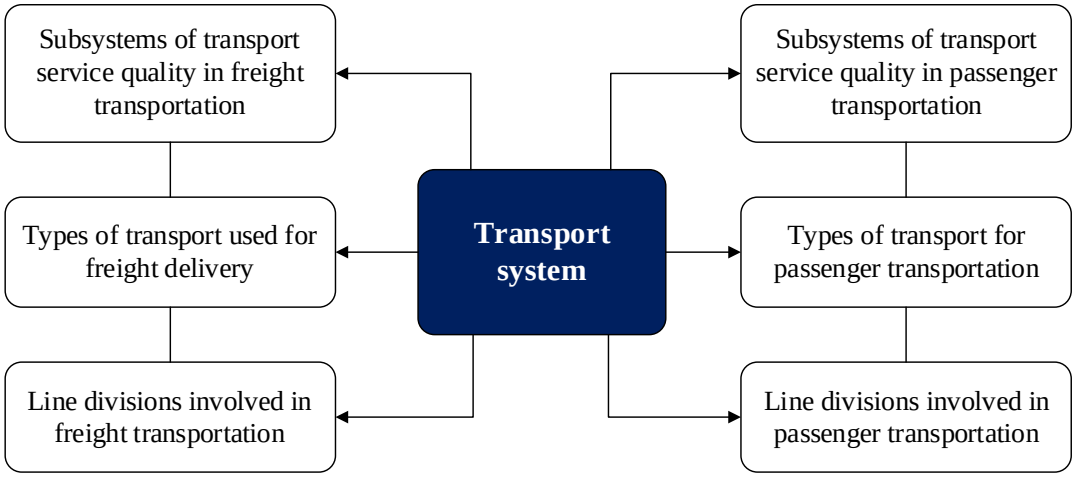
Digitalization Project of JSC "Uzbekistan Railways":

- Uzbekistan is implementing a digital transformation program for its railway system, which includes the creation of a unified automated train traffic management and planning system.
- Introduction of electronic ticketing systems and integration with mobile platforms for passenger convenience. This includes the launch of online ticket booking services and automatic kiosks for purchasing travel documents.
- Use of video surveillance and security monitoring technologies at major railway stations.

Digital Solutions in the Tashkent Metro:

- The Tashkent Metro employs electronic ticketing systems and video monitoring at stations, which increases safety and passenger convenience.

Modern transport systems, including rail transport, are increasingly being viewed as complex structures that integrate various types of transportation and related services. Based on the analysis of transport systems, key areas of digitalization can be identified that are capable of not only optimizing freight and passenger transportation but also improving service quality at all levels.



1. Figure. Structure of the transport system and its subsystems

a systematic approach to digitalization

1. Quality of Transport Services in Passenger Transportation — a subsystem focused on ensuring passenger comfort and safety. Digitalization tools in this context include electronic tickets, mobile applications for trip planning, as well as demand forecasting systems that help adapt schedules in real-time.

2. Types of Transport Vehicles — in both freight and passenger transportation, digitalization involves the modernization of rolling stock using intelligent control systems, digital dispatch centers, and automated maintenance systems.

3. Line Divisions — similar to transportation, line divisions require modernization. The implementation of digital technologies at the coordination and route management levels enables synchronization of actions, improves interaction between divisions, and helps avoid delays.

Conclusion

The economic efficiency of implementing digital technologies in passenger transport management on railways is reflected in reduced operating costs, increased productivity, and improved service quality for passengers. The introduction of digital solutions enhances the competitiveness of railway transport and its adaptability to new conditions. To achieve maximum effect, it is necessary to develop comprehensive digital transformation programs supported by public and private investments, as well as active cooperation between market participants.

The provided data demonstrates that the implementation of digital technologies has a significant impact on the economic efficiency of railway transport. Optimization of management processes, reduction of operating costs, and improvement of passenger services contribute to the increased competitiveness of rail transport. International experience shows that a comprehensive approach to digitalization can significantly transform both the economic aspects and the quality of services in transportation.

The digitalization of transport infrastructure in CIS countries contributes to improving service quality, enhancing safety, and optimizing transport processes. Examples of digital technology implementation in Russia, Kazakhstan, Belarus, Uzbekistan, Azerbaijan, and Ukraine demonstrate the drive to modernize transport systems in line with international standards and global trends. The development of digital technologies in transport not only increases economic efficiency but also makes transport systems more convenient and environmentally friendly.

References

1. Sidorov, S.S., Pavlov, A.A. Economic Efficiency of Digital Technologies in Transport Infrastructure. // Transport Science Bulletin. – 2022.
2. Federal Program "Digital Transport of Russia": Goals and Perspectives. – Moscow: Ministry of Transport of Russia, 2023.
3. Ivanov, I.V., Petrov, P.P. Digitalization of Transport Systems: Global Experience and Perspectives for the CIS // Transport Science Bulletin. — 2020. — No. 4. — Pp. 45-53.
4. Smirnov, A.A., Kuznetsov, E.V. Intelligent Transport Systems: Theoretical Foundations and Practical Solutions // Economics and Transport Management. — 2019. — Vol. 12. — No. 2. — Pp. 67-74.
5. Nazarov, A.M. Digital Transformation of Railway Transport in the CIS Countries // International Transport and Logistics Bulletin. — 2021. — No. 3. — Pp. 98-105.
6. Trukhin, V.I. Impact of Digital Technologies on the Efficiency of the Transport System // Problems of the Transport Complex. — 2018. — No. 6. — Pp. 122-128.
7. Kazakhstan Temir Zholy. Analysis of Digitalization in the Railway Industry // Transport Bulletin of Kazakhstan. — 2020. — No. 7. — Pp. 33-39.
8. JSC "RZD". Digital Railway Program // Official RZD Website. — Accessed: October 2024.
9. JSC "Қазақстан Темір Жолы" (KTZ). KTZ Digital Transformation Program // KTZ.kz. — Accessed: October 2024.
10. Belarusian Railway. Digitalization of Transport Systems in Belarus // beldz.by. — Accessed: October 2024.

11. JSC "Uzbekiston Temir Yullari". Digitalization of Uzbekistan's Railway System // uzrailway.uz. — Accessed: October 2024.
12. Azerbaijan Railways (ADY). ADY Digital Transformation Strategy // ady.az. — Accessed: October 2024.