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International experience in digitalization of railway transport in Uzbekistan and directions for its development.

Komilov Mansurjon Mashrabjon o'g'li

Subject specialist teacher at Tashkent Transport Technical School.

+998900206608 email: mkomilov914@gmail.com

Omonov Islombek Shamsiddin o'g'li

Subject specialist teacher at Tashkent Transport Technical School.
+998942002552 email: Omonov.02@bk.ru

Abstract: This paper analyzes the theoretical and practical aspects of the process of determining railway transport data. The impact of technology on the development of railway infrastructure is examined, drawing on the experience of the European Union, Japan, China, and the United States. The objectives of the study are to improve the safety of technical railway transport, automate management processes, and support logistics infrastructure. The implementation of digitalization on Uzbekistan's railways is aimed at increasing the speed of railway transportation and monitoring the impact of operational, time, and human factors on operational speed.

Keywords: Rail transport, digitalization, artificial intelligence, smart railway, logistics, international experience.

Introduction. In the context of globalization and the digital economy, transport systems, especially railway transport, are gaining strategic importance in the sustainable development of the national economy. The limitations of traditional management methods, high operating costs and safety issues have made the introduction of digital technologies in the railway sector a pressing issue. In this regard, the study of international experience and scientific analysis serve as an important methodological basis.

Theoretical foundations of railway digitalization

Digitalization is the process of integrating all processes in the railway system - traffic management, maintenance, logistics, safety - on the basis of digital platforms.

The scientific literature indicates the following as the main components of railway digitalization:

- automated control systems;
- real-time monitoring;
- Big Data analysis;
- artificial intelligence and IoT technologies.

These elements ensure the flexibility and stability of the railway system.
European Union countries

In European countries, railway digitization is being carried out on the basis of the ERTMS system. This system serves to centrally control train traffic, automate signaling, and increase safety. Scientific studies show that the

risk of accidents has significantly decreased in regions where ERTMS has been introduced.

The Japanese railway system has a highly digitized infrastructure. Shinkansen trains are monitored for technical condition based on sensors and artificial intelligence. This approach allows for early detection of malfunctions and preventive maintenance.

In China, the concept of "Smart Railway" has been implemented on a national scale. Through cloud computing and digital twin technologies, the railway infrastructure is modeled in real time. As a result, the movement of high-speed trains is controlled with high accuracy and safety. In the US, digitalization is mainly aimed at increasing the efficiency of freight transportation. The Positive Train Control (PTC) system plays an important role in preventing accidents caused by human error. According to scientific studies, the introduction of PTC has significantly increased the level of safety.

Analysis of international experience shows that the digitalization of railway transport:

- automates management processes;
- reduces operating costs;
- increases safety and reliability;
- ensures the efficiency of logistics chains.

These results confirm the need to consider digitalization as a strategic development direction for the railway sector.

Railway transport is of strategic importance in the national economy, and its digitalization has been shown to have a positive impact on the optimization of transport efficiency, safety, service quality, and logistics systems in the conditions of Uzbekistan, as shown in world experience.

The state of digitalization in Uzbekistan's railways

The governing documents indicate that Uzbekistan Railways has adopted a digital transformation roadmap in recent years and is moving into the implementation phase. According to it, automation of freight and passenger transportation processes, integration with customs systems, and other digitalization initiatives have been identified.[5]

Practical examples:

- The process of ordering a wagon has been reduced from 7 stages to 3, reducing the process time from 72 hours to 12 hours. The press service of the President noted that this process has increased business efficiency.[6]

- An intellectual operation center has been established, allowing for real-time monitoring of the technical condition of locomotives. This system is based on artificial intelligence and data analysis, which increases the efficiency of technical maintenance.

- There are initial agreements on agreements to optimize operational processes based on cloud services and AI within the framework of cooperation with international companies (for example, with Huawei).

The results of this study provide the following scientific news:

Integrated impact of digitalization:

In the case of Uzbekistan, digital transformation not only automates operational processes, but also increases transport capacity by improving service quality, integrating with customs, logistics and other systems. This is a comprehensive systematic approach, unlike the global experience (which in most cases focuses only on automation of management).

Artificial intelligence and real-time monitoring:

The introduction of a locomotive monitoring center and AI-based maintenance models serve as new scientific methods for early detection of technical failures and effective allocation of resources.

Increase in operational efficiency:

The fact that passenger and freight transportation efficiency indicators have significantly improved by reducing processes (for example, optimizing the order process and train flow) can be scientifically analyzed.

The experience of Uzbekistan not only demonstrates technological achievements, but also provides analytical evidence of the impact of the digitalization process on economic efficiency. Digital transformation helps not only save time, but also increases the transparency of services. Based on comparisons with the experiences of China, Europe, and the United States, it is scientifically supported that in the case of Uzbekistan, digitalization trends are aimed at consistently increasing the efficiency of the transport system.

Conclusion. International experience in the digitalization of railway transport scientifically shows that the introduction of modern digital technologies ensures the stable and efficient operation of the transport system. Adapting these experiences to national railway systems is important for increasing the transport and logistics potential. In general, with the introduction of digitalization processes on the railways of Uzbekistan, operational efficiency, safety and quality of service are significantly increasing. Research shows that the widespread introduction of digital technologies is a key element in the modernization of the railway transport system.

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