Industry 4.0 technologies as a driver of intelligent transport systems development

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Abstract. The paper discusses cutting-edge technologies for Industry 4.0 as the drivers of digitalization of transport and logistics ecosystems. It also analyzes these technologies in their practical implications for improving the efficiency of the industry and their alignment with intellectual priorities of digital economy development at both national and international levels. The article provides an analytical review of the current state and digital transformation of the transport and logistics industry, including the introduction of new digital technologies Industry 4.0, taking into account the existing geopolitical agenda.

1 Introduction

The beginning of the 21st century has become a period of intensification and deepening of globalization processes in the world. The growth in the level of integration of economies, both regional international unions aimed at creating and developing common economic spaces, and individual states, contributed to the development of the transport and logistics sector. One of the leading trends has been the globalization of international transportation routes and the logistics services market. The IV Industrial Revolution that took place, which led to the digitalization of all sectors of the economy, contributed to increasing the efficiency of national and international transport and logistics ecosystems, reducing costs and developing the sphere of multimodal transportation. At the current stage of development of the world economy and particularly of the transport and logistics ecosystem of Russia and other countries, digital transformation of all sectors is among the leading trends. This transformation implies implementation of a platform model, which in its turn means implementation of digital services and technologies in order to both create a new form of interaction between different players in the market and to obtain the means and ways of improving performance. The rapidly developing digital technologies of Industry 4.0 affect the development of all sectors of the economy, including the transport and logistics complex. Digital technologies, being one of the most important ways to increase the competitiveness of the economy, require legal regulation that creates conditions for their effective application.

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And cross-border integration processes that have changed the development paradigm due to the difficult global socio-economic situation require the creation of a single network of intelligent solutions in accordance with internationally established standards for the development of new technologies.

2 Materials and methods

Opensource materials on the Internet were used, as well as the Transport Strategy 2030, the strategy of digital transformation of the key sectors of the economy. In addition, the methodology of theoretical research, comparative analysis and system analysis are applied. The issues of the development of digitalization and the introduction of innovations in the Russian logistics ecosystem were considered in the works of Pokrovskaya O., Pokrovskaya O. and others [1-12].

3 Results and discussion

The transport industry plays an important role in the economy of any country, ensuring its territorial unity, the possibility of international interaction with partners in the global ecosystem. In the context of the process of digitalization of all spheres of the economy, the pace of digital transformation of the railway industry should meet the needs of other sectors of economic activity. One of the most important trends in the development of the transport and logistics industry has become its digitalization. Continuous automation of production processes and changing business models of the largest transport and logistics sectors require the creation of a whole layer of international legal legislation in this area to ensure effective interstate cooperation both within the SCO, the EAEU, and at the bilateral level. The development of large-scale machine-to-machine communication (M2M) and the Internet of things (IoT) in logistics has made it possible to significantly increase the efficiency of production processes, create an electronic document management system, increase the speed and accuracy of calculations due to the introduction of artificial intelligence, and improve operational work using digital technologies. In Russia, implementation of information and communications technologies and digital technologies is one of the strategic national priorities of economic development.

The paper attempts to elaborate a paradigm for the development of a system for intelligent management of the transport and logistics complex by designating hiatuses within the current socio-economic situation. This study is based on the results presented in several sources [2-8]. Digitalization of the transport and logistics sphere is one of the leading trends in the development of the industry.

Despite the high level of economic volatility today, the market of digital services for the logistics sector is rapidly developing. Thus, in 2020, its volume amounted to 89.4 billion rubles, and by the end of the decade it is expected to have grown 7 times to the amount of 627 billion rubles [2]. The expected effect of digitalization of the industry by 2030 implies an increase in its productivity by 20% [12].

In Russia, in 2021, the Ministry of Transport developed the Strategy for Digital Transformation of the Transport Industry until 2030 [13].
The leading digital technologies of Industry 4.0 are the following.

— Big Data, a technology of collecting and processing large amounts of data used both in predictive analytics and for decision-making processes which require complex computing;

— IoT, digital features of the Internet of Things allowing creation of personalized production sites relying on the use of cyberphysical systems which provide a connection between production processes and programming. Implementation of this technology allows remote equipment diagnostics, reduction of the service center costs, lifecycle diagnostics of railway cars and locomotives;

— artificial intelligence allowing the use of unmanned transport technologies;

— digital platforms which enable a new business model and reliance on network effect in the transport and logistics sphere.

Currently, the platform business model is being increasingly deployed in the field of logistics services management. Such services are created by both private companies and governments.

Russia is developing a common digital transport platform named Superservice 22. This platform embraces carrier registries, electronic consignments, waybills, transportation authorization documents, as well as electronic queue tickets for border crossing.
One of the rapidly developing spheres of digitalization of transport and logistics has been the implementation of cloud computing which is a technology of online user access provision to various data, services or applications.

SaaS (Software-as-a-Service) is an Internet application which users can access over the Internet. SaaS is a program that stores user files or is located on the World Wide Web. Its distinctive feature is the ability of its provider to fully administer (and, in fact, control) the use of SaaS.

A Russian company "Smart Logistics" has long been successfully developing SaaS services for logistics on the national market.

A significant hindrance for an effective implementation of Industry 4.0 technologies in the transport and logistics sphere is the absence of an elaborate legal regulatory system applicable to their use.

New geopolitical challenges related to the imposition of international sanctions on Russia in 2022 resulted in turbulent conditions for the development of many sectors of the economy, including the transport and logistics one. Strengthening technological sovereignty, which is
immediately dependent to the development of Russia's own digital technologies and services, has gained additional relevance in the new socio-economic conditions.

The disruption of logistics routes to European countries, the embargo on intellectual technologies supply to Russia, the closure of the access to foreign digital services and platforms, as well as the departure of major logistics companies from our market – all these require a change of the development paradigm of the national transport and logistics ecosystem.

Development and implementation of Russian digital services and platforms in transport industry should be the main task in the medium term, because digitalization is the main factor of the industry's competitiveness.

A ministerial grant program entitled "Digital Platform for the Transport Complex of the Russian Federation" [1] sets forth "automation and information and analytical support of the transport complex management" as the main goal.

In order to create an intelligent system of management for the transport and logistics ecosystem of Russia and its interconnection with digital services and platforms that provide transboundary cooperation, the following technologies must be implemented:

- AI (artificial intelligence);
- collection and processing of BigData;
- blockchain (distributed registry systems);
- VR and AR technologies;
- Spatial and information modeling technologies.

**Fig. 4.** Main Industry 4.0 technologies on Transport.

The areas of digital technologies application on transport:

- Predictive analytics;
- Electronic document flow (EDF) in the field of freight transportation, including EDF system operation in EAEU;
— Establishment of a unified management center for the transport and logistics complex;
— Implementation of smart contracts and blockchain technologies in logistics at all stages of signing and implementation of haulage contracts;
— Creating digital duplicates of the transport and logistics infrastructure;
— Modeling of traffic flows;
— Development of an intelligent system of accounting and planning of maintenance and development work on the transport and logistics infrastructure.

Digitalization of the transport and logistics complex involves digitalization of passenger and freight traffic, lifecycle monitoring of infrastructure and vehicles, transport management, and also ESG implementation in the transport industry, decarbonization.

The implementation of digital services should help to solve the following problems:
— reduction of the rate of accidents due to human factor;
— inefficiency of transportation by traditional modes of transport;
— low level of population mobility;
— opacity of cash payment of fares;
— low attractiveness of transport corridors due to the absence of EDFs;
— low utilization of the transit potential of the Russian Federation;
— lack of the ability of operational management of the transport complex from a single digital center;
— low coordination of the actions of public authorities and transportation actors in the field of transport security, including cybersecurity;
— lack of the ability to monitor the state of transport infrastructure objects at all the stages of their life cycle.

Fig. 5. Digital technologies in logistics chains. Source: https://mavink.com/post/56F478823E9900AB841FB9CF345B087AEDAM12B86D [3].

According to analysts, the main trends in the transport and logistics sphere development by 2025 would be the following:
• implementation of technologies aimed at reducing carbon emissions;
expansion of the scope of low-carbon transport, such as the bicycle and EV;  
- reduction of fossil fuel use and energy decarbonization, particularly in the transport industry;  
- investments in infrastructure and technologies aimed at environmentally responsible transformation of the transport sphere;  
- development of alternative environmentally friendly mobility options;  
- consolidation of the microtransit market;  
- implementation of machine learning technology in the business processes of companies [4].

However, the change of the international economic landscape in connection with the imposition of international sanctions on Russia, the disruption of logistics routes and the energy price rise has necessitated the correction of the forecasts of the transport and logistics industry development.

At the same time, the EAEU digital logistics project gains new relevance. Given the reorientation of logistics routes to the East, interfacing of the technical services of the EAEU platform and China’s logistics platform LOGINK for data exchange and functioning of the EDF system is a pressing task for both strengthening the transport sovereignty of the Russian Federation and increasing the competitiveness of the logistics sphere. It appears that the cohesion of the EAEU and China’s platforms could be one of the steps of implementation of the EAEU and Silk Road Economic Belt (EPSP) connection and creation of a common economic space with China.

The key trends in the development of the transport and logistics ecosystem are:
- development of regional cooperation;
- expanding the use of electronic services for paperless workflow;
- Creation and development of digital transport and logistics services and platform solutions for the 5th level logistics provider;
- development of international multimodal transportation;
- online formation of supply chains using the 5th level logistics provider;
- use of state support measures in the face of sanctions pressure;
- development of new niche markets in the Asia-Pacific region.

Summing up this study, it can be concluded that the main driver of transport and logistics ecosystem development are digital services which create network effect in the logistics industry. In the short term, digital logistics may probably be developing at great speeds due to its ability for scaling and collecting, analyzing and processing of large volumes of digital data.

The results of the study show that it is the level of implementation of digital services and digital connectivity between participants in the transport and logistics market that will be the determining factors in the process of increasing the competitiveness and efficiency of the transport industry. The results of the current stage of digital transformation of the industry are described, the concept of logistics development in the context of the current geopolitical agenda is presented.

4 Conclusions

Today, for all the sectors of the world economy including transport and logistics, data have become a new resource necessary for value creation and competitiveness within Industry 4.0. Given the current geopolitical situation, digital data control provides a significant strategic advantage by creating “digital intelligence”. It is likely that in the medium term there will take place a consolidation of the logistics market based on the dominance of regional digital platforms and services and their control over digital data. For Russia, one of the most
important tasks is to create competitive digital technologies for the transport and logistics ecosystem, which includes the possibility of interaction with strategic partner countries.

The IV industrial revolution has occurred. Under these conditions and to increase the competitiveness of her economy as a whole, Russia will have to be more actively involved in the establishment of the landscape of high-tech production by creating and implementing basic digital technologies which provide its functioning.

It can be deemed that further scaling up of the digital services utilization in transport and logistics ecosystems will secure transport and digital sovereignty of the Russian Federation in the context of the current geopolitical challenges and facilitate an increase in competitiveness of the Russian transport system for Industry 4.0.

References