Organization of flow processes in transport and logistics service ecosystems using digital technologies

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Abstract. The article is devoted to the problem of organizing the management of logistics flows in the ecosystems of transport and logistics services using modern means of digital transformation. The relevance of the chosen topic is confirmed by the importance and relevance of creating an established system of physical distribution of commodity and material values between suppliers and consumers, the basis of which, along with a developed logistics infrastructure in Russia and foreign economic activity, is transport and logistics services. The modern experience of developed economies shows that the market appeal of a product directly depends not only on its quality and cost but also on the speed of its movement through supply chains and the speed of delivery to the end consumer. The object of the study is material and information flows that correspond in digital ecosystems of transport and logistics services. The subject of the study is the economic and organizational and managerial relations associated with the formation and development of digital ecosystems of transport and logistics services. The main methods used in the study were the analysis and systematization of scientific publications on the topic, methods of designing management systems and operations research, and factor analysis. Outcomes: a list of the main digital technologies was identified; the effectiveness of their application area was analyzed. Further, the author built the scheme of the ecosystem of transport and logistics services and the scheme of interaction of its subjects. As a outcome of the analysis of the factors of influence on increasing the speed of promotion of logistics flows and goods in supply chains, the use of an integrated digital platform was recognized as the most effective. The author presented the mechanism of logistics flow management based on the creation of an integrated platform of transport and logistics services. Keywords: logistics flows, logistics, transport and logistics services, digital ecosystems, integration of digital systems.

1 Introduction

Theoretical and methodological foundations of transport and logistics services are quite thoroughly studied in the works of domestic and foreign authors. The main attention is paid

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to the concept and industry-specific features of the types of transport in the transportation of goods, the assessment of the influence of the environment, and external and internal factors on the efficiency of service in transport systems.

The development of the market of transport and logistics services is objectively conditioned by the formation of the business environment and the accelerated development of network production and trade and intermediary structures. The ecosystems of transport and logistics services themselves are complex engineering and economic flow-network formations consisting of transport, loading and unloading machines, mechanisms, terminals and warehousing, digital information systems, and technologies of logistics flow management.

Several works by modern academic economists confirm the need to apply the principles of logistics management in the distribution of transport flows in supply chains. It is also necessary to optimize transportation costs since their share in the total cost is high.

The evolution of scientific views reveals the diversity of the components of the logistics flow and the integrating mechanism of analog and digital platforms.

The classical school of logistics singles out the material flow as the main one; it is considered to be system-forming. In digital logistics, information flow is the key one, as the main processes and operations are performed as transactions in a virtual (electronic) environment. In analog systems, counter, return and duplicate cargo flows are likely to occur, while digital systems apply artificial intelligence to streamline flow processes and optimize transport costs.

Logistic integration is understood as the creation of an operational level, which streamlines individual logistics operations in the stages of procurement, storage, transportation, and sale of goods. At the present stage of the development of logistics, science integration is seen as the formation of a single information and communication space.

In Russia, the digital transformation of transport services is a technology of the future and is only possible after several logistical problems have been solved:

1) sectoral nature of the transport and logistics market, the lack of integration of logistics processes;
2) an imbalance of supply and demand for transportation services;
3) the difference in economic management in the regions and Russia compared to other countries;
4) mismatch between the characteristics of vehicles and customer requirements, which hinders the continuity and coherence of material flow in the supply chains of integrated commodity distribution channels.

2 Materials and Methods

To identify the existing mechanisms of distribution of logistics flows in the Russian market of transport services fundamental scientific works and applied works of both Russian and foreign scientists in the field of supply chain management, logistics, functioning of transport, and logistics systems have been collected and analyzed. The information base of the study also included international and national legal acts regulating the activities of enterprises in the field of transport and logistics services, and methodological materials of the Ministry of Transport of the Russian Federation. As a outcome of the analysis of literary sources, a list of the main digital technologies used in modern transport and logistics systems, their merits, and areas of application was identified.

In the process of researching operations and identifying relationships, and the flow of flows, the author has built a scheme of the ecosystem of transport and logistics services, the scheme of interaction of subjects of digital ecosystems.
As a result of the analysis of the factors of influence on increasing the speed of promotion of logistics flows and goods in supply chains, the use of an integrated digital platform was found to be the most effective. The author presented the mechanism of logistics flow management based on the creation of an integrated platform of transport and logistics services.

### 3 Outcomes and Discussion

The strategy for the scientific and technological development of the Russian Federation until 2035 and Presidential Decree No. 204 of 7.05.2018 "On National Goals and Strategic Development Objectives of the Russian Federation for the period until 2024" confirm the importance and relevance of creating an established distribution system of commodity flow along with a developed logistics infrastructure in Russia and foreign economic activity.

The following problems arising from the deepening of digitalization in transportation processes are currently being discussed:

1. the orientation of vehicles in space;
2. the need to accelerate and simplify the interaction of customers and suppliers on a global level;
3. the technical limitations of the introduction of unmanned transportation means and, therefore, the inability to reduce logistics costs [1].

![Digital technologies in transport and logistics service ecosystems and the effects of their implementation](image)

**Fig. 1.** Digital technologies in transport and logistics service ecosystems and the effects of their implementation. Source: compiled by the author.

To solve the problem of transport coordination, it is proposed to use a satellite map, which will display the route of the drone or robotic vehicle with minute details and information about obstacles (lights, poles, etc.). The vehicle will use sensors to scan the space and synchronize with the satellite map. By eliminating headlights, windshields, and other expenses, but useless parts for an unmanned vehicle, an additional economic effect (cost reduction) is achieved [2, 3].

For interaction between customers and suppliers of goods are created virtual transport exchanges, that is, a specialized Internet resource that allows you to get acquainted with the proposals of the transport market and direct contacts of transport companies without intermediate information links.

Web platforms are used for the implementation of virtual freight forwarding, which allows not only to select a carrier, calculate the rate, and find a passing cargo but also, thanks to special systems of cargo exchange, to track the movement of cargo from the point...
of departure to the destination. Without intermediaries, online, this possibility is available to all interested parties: the customer, the consumer, the carrier, and the owner of the goods [4].

The world's largest logistics system, EULogis, is available in 20 languages across Europe and tracks an average of 50,000 shipments and vehicles a day.

Virtual forwarding system Vird operates throughout the Russian Federation. It functions as a website, allows you to track freight shipments, ranks the regions, and displays the number of participants and offers.

The most popular system for shipping is the Internet resource SRC—the electronic freight exchange. Only registered participants-forwarding companies—get access, and they are provided with a client base, which is more extensive and convenient for searching for clients and additional services for the forwarder himself. In addition, the SRC system provides additional service-reference information on distances between seaports, search for the nearest container terminals, search for vehicles to organize "door-to-door" delivery, calculation of storage costs, calculation of delivery time and transit time, calculation of tariff [5].

As mentioned earlier, the third direction of digital technology development is the use of new transportation systems that perform standard functions, but belong to the medium price category, reducing costs by running autonomous vehicles (for example, Uber trucks). Projects involving robots that deliver goods directly to the customer's front door are also possible (Starship Technologies, South London). [6] The use of robots and robotic systems makes it possible to obtain cost savings compared to traditional technical means for warehousing goods and labor of workers.

The use of artificial intelligence systems makes it possible to avoid the following problems of the traditional logistics system:
1) excessive cost of transportation due to the cost of transport and logistics operations management,
2) reduced competitiveness in today's logistics services market,
3) finding ways to reduce the waiting time of cargo,
4) rapid response to changes in demand [7].

Autopilots are now widely used in air transport and cruise control in automobiles.

The strategy of scientific and technological development of Russia is aimed at applying tools for the digital transformation of the economy, including technologies of analysis and management of large information databases, artificial intelligence, and machine learning. The development of the construction industry, railway transport, energy and water supply, fire and police, social sphere, and logistics is quite successful [8].

Modern digital information and communication technologies make it possible to achieve better integration of business processes within supply chain management. Information, financial and commodity flows are integrated into a single management and control system, it is required to create new logistic systems of production, distribution of goods turnover, and cargo transportation, taking into account the increasing complexity of the sequence of logistic operations, obtaining added value, increasing competitiveness [9].

The imperfection of the current state of the global and Russian digital economy lies in the lack of integration of various digital systems due to different levels of software and hardware compatibility and insufficient security of data exchange. The regulatory and legal framework and restrictions on the implementation of digital technologies, and the pricing process are insufficiently developed [10].

The term "digital readiness" reflects the possibility of obtaining the economic effect of such technologies as blockchain, artificial intelligence, and robotization in the process of transportation and terminal and warehouse services. The degree of the digital readiness of a
country's economy is decisive in choosing a strategy for the formation and development of digital ecosystems of transport and logistics services.

The main properties and distinctive features of digital ecosystems of transport and logistics services:

1) flow processes are regulated in two spheres-material and virtual (material, information, and financial flows). In the virtual management environment, there is the processing and storage of information about the flows, the formation of transport and shipping documents in electronic form, the generation of signals for the management of flows in the physical sense;

2) suppliers and consumers of transport and logistics services interact with each other without intermediaries, using specialized digital platforms;

3) the association of subjects to share resources for the management of digital flows;

4) digital integration at the global level, simplification of access to the market of transport and logistics services, a greater degree of availability of information, resources, the openness of digital platforms;

5) a high degree of dependence of sustainable operation of the digital ecosystem on digital infrastructure (telecommunications networks, computer hardware, server hardware, software, etc.)

Shortly, the world is expecting a total digitalization of all spheres of life, and the transport and logistics sector is no exception. Logistics processes will be managed in physical and virtual environments, dominated by the Internet of Things [11] and augmented reality.

The country's pioneers of the introduction of digital technology revealed that the attractiveness of the product in the market for the buyer depends more on the speed of promotion of goods in the supply chain and the speed of delivery, rather than its quality and cost [12].

The introduction of augmented reality significantly accelerates the work with logistics chains and simplifies the solution of various applied tasks in logistics. This technology combines virtual and real objects and builds an optical track using markers or coordinates in space.

The advantages of augmented reality are easy object reference, versatile data, highly informative, easy to distribute and apply, high portability of installations-from tablets to video walls, realistic, virtual tangibility, and visibility.

The most effective uses of this technology are

1) in warehousing;

2) in transportation optimization;

3) last-mile delivery,

4) in advanced value-added logistics service.

The flow processes formed in transport and logistics service ecosystems are often uncertain and unpredictable. This is due to various problems that complicate the work of the logistics system: haphazard information for preparing the dispatch of cargo, which leads either to overloading of the system or to unproductive downtime. Acceptance of requests is probabilistic since not all shipments are made continuously, under long-term contracts. Because of the low level of solvency in the regions, delays in payment and the carrier's work on credit are not uncommon. Inaccuracies in processing accompanying and other documents for goods, changes in conditions or cancellation of requests for transportation during cargo delivery, and increased duration of rolling stock turnover through the fault of the forwarding company also complicate and reduce the efficiency of the built-up ecosystem of transport and logistics services.
Fig. 2. Diagram of the transport and logistics service ecosystem. Source: compiled by the author.
In digital ecosystems, the cargo owner does not have to control all the actors in the logistics system and all the links in the supply chain. The interaction of supply chain participants takes place centrally based on a digital platform.

Fig. 5. The process of implementing transport and logistics services. Source: compiled by the author.
The digital platform transforms supply chains into a fully integrated ecosystem, transparent for all participants (from suppliers of raw materials, components, and spare parts to finished products for customers).

It is necessary to use the achievements of modern IT technologies to minimize the harmful effects of external factors on the organization of logistics flows [13]. For example, digital information platforms based on a multifactor stochastic model are used to manage requests from customers who arrive irregularly. The object of analysis and construction of the model of interaction and distribution of flow processes is the digital transport and logistics service system itself or its elements. The elements of the digital ecosystem include the transport and logistics enterprise, the market of transport services, and flows created during the implementation of digital services transport and logistics services.

The choice of the carrier, mode of transport, and delivery route, in digital ecosystems, is carried out by solving a multi-criteria problem. The selection criteria may include the capacity and carrying capacity of the vehicle, the versatility of the rolling stock of the cargo transported, tariffs, the average speed of transportation, and the environmental component. However, most often the value of the costs associated with the transportation of goods becomes a decisive indicator. AXELOT TMS X4 transport and transportation management system, Maxoptra logistics management program, and others allow making such a choice.
Fig. 6. Scheme of interaction between actors in the ecosystems of transport and logistics services on a digital platform. Source: compiled by the author.

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Fig. 7. Logistics flow management based on the creation of an integrated platform of a digital ecosystem of transport and logistics services. Source: compiled by the author.

A digital platform serves as the core of the transport and logistics ecosystem; it integrates logistics flows and facilitates the interaction between service providers and consumers, as well as ensures the activities of the control and supervisory bodies of the ecosystem. There are three main types of platforms in transport and logistics digital ecosystems: instrumental (functional and technological), infrastructure, and application platforms.

The digital platform consists of three components:
1) customers (suppliers, consumers, intermediaries);
2) a server with connected client applications (search services, needs selection, transactions, transactions, delivery, tracking, payments, document management, certification, etc.)
3) database server, working with the application server and offering the implementation of digital technologies (working with "big data", "internet of people-things (everything)", distributed registries (blockchain), etc.)

The activity of transport enterprises in the integrated logistics market is an important aspect of their functioning. This activity includes the management of flow processes in digital ecosystems of transport and logistics services. In our opinion, the digital transformation of logistics services is a tool to guarantee an increase in the efficiency of the country's economy. By accelerating the turnover of goods, GDP and the profitability of investments in the digital ecosystem increase. The digital economy also provides for a quick return on investment, including international investment, and investment projects are characterized by sustainable revenues and the use of proven business models.

The digital transformation of transport and logistics service ecosystems implies the digitization of data at all levels of production and transport processes. This requires the creation of cloud transport networks and the introduction of transport robotization. The digitization of shipping documents and the digitalization of document management allows the system to expand the customer base, and to balance requests for transportation and offers of transportation services by freight forwarders.

The use of robotic systems makes it possible to reduce delivery costs by half at the current stage of scientific and technological progress; this is especially important at the "last mile" stage.
However, the main condition for the further development of logistics services is the abandonment of analog logistics systems and the transition to digital ecosystems, which are based on an integrated digital platform. In this case, the main regulator will not be the cargo flow, but information flows, the rate of circulation of which in a virtual environment or augmented reality is much higher.

Modern IT technologies and the application of multifactor mathematical models make it possible to minimize negative factors associated with the unevenness of applications, delays in payment, etc.

For greater success, it is necessary to take into account the interaction of logistics flows, as often the modeling of transport and logistics activities does not reach the possible level of optimization of flow processes. New paradigms of economic efficiency in the transport sector have been widely studied in the scientific works of N.A. Zhuravleva et al. [14] Consequently, such positive outcomes of the application of digitalization predetermine the necessity of implementing the flow concept in logistics management in the systems of goods movement. [15]

4 Conclusion

Digitalization is a catalyst for intra-industry competition, expansion of geographical and product boundaries of various markets, increasing the competitiveness of industries of individual countries in the processes of foreign trade movement, and the growth of national economies.

The activities of transport and logistics companies in the context of digitalization are carried out within digital ecosystems of the transport and logistics services and the logistics market, which is an integral part of the regional economy.

The most effective way to manage digital transport and logistics service ecosystems should be considered the platform concept, which is based on a digital integrator that coordinates the performance of logistics operations and ensures the sustainability of the digital supply chain. The use of a digital platform is by far the most effective way to manage digital transport and logistics service ecosystems. This integration allows for maximum coordination of all links and stages of logistic processes and a synergistic effect, which is especially important in the organization of inter- and multimodal transportation.

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