Modeling the seamless cargo logistics development

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Abstract. The key direction of the development of the transport industry is the development of multimodal transportation using information technology. The most pressing issues are the development of transport logistics systems. They have acquired crucial strategic importance for ensuring competitiveness and a new level of development of the cargo containerization sphere using logistics approaches and management tools. Seamless cargo logistics is a strategic goal of the transport sector. The paper presents a theoretical justification for the use of modeling strategies for the development of a transport logistics system. The rationale for the expediency of using simulation modeling is presented. This simulation model creates conditions for the study of the transport logistics system of the region and the formation and implementation of the transport services market.
Keywords: system, transport, transportation, logistics, strategy, model, simulation

1 Introduction

International trade is a complex and dynamic process that covers various spheres of society, including the international system of commodity circulation, transport and logistics. The most noticeable processes can be observed in the field of transport and logistics activities, when the movement of goods covers the territories of different states, which requires the formation of a single space in which conditions are created for the integrated exchange of information, goods and services. The key factors contributing to this convergence of various participants in the commodity distribution system include the increasing role of transnational corporations, the rapid growth of digital information and communication technologies, electronic commerce and Internet services, international supply chains of goods and transportation. It is impossible not to note the role of the COVID-19 pandemic, which has made a negative contribution to the overall picture of the development of world economic processes [2, 3]. The invasion of digital multinational corporations in all spheres of life, including transport activities, further monopolization of capital, significant political factors have led to a global crisis of logistics chains, the destruction of previously existing schemes

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for the delivery of goods and cargo. And, of course, one of the main catalysts of change and the superiority of the "digital champions" is flexibility in the workplace, which determines the role of mobility [4]. The possibilities of working anywhere in the world with any digital device with Internet access have expanded.

Changes based on the application of innovative methods of managing the processes of intermodal cargo transportation are one of the urgent problems in the field of logistics technologies that affect the efficiency of transport systems development. The problems of scientific and methodological study of the impact of intellectual mobility and system compatibility, including in the transformation of cargo transportation processes, should cover all stages of the life cycle of commodity movement systems and intermodal transport logistics systems [14] and to solve the strategic task of ensuring seamless cargo logistics, which is provided for in the passport of the Digital Transformation Strategy of the transport Industry of the Russian Federation [11].

The purpose of the study is to select and build a simulation model for the development of seamless cargo logistics and the formation of the transport logistics services market.

This research topic attracted the attention of domestic and foreign scientists. Thus, the development of the theoretical foundations of modeling such systems is devoted to the work of domestic researchers: Borisov A.N., Krumberg O.A., Fedorov I.P., Diligensky N.V., Dymovoy L.G., Sevastyanov P.V., P.V. Nedosekin A.O., as well as a number of foreign scientists Adams G., Williams C., Bader J., Biegun S., Eydeland A., Wolyniec K. [10].

Along with the development of digitalization processes, other systemic factors that influence the stability and sustainability of the functioning of the transport logistics system are becoming increasingly important. The transition to a new technological order is associated with the "formation of new principles, models and architecture of enterprise engineering", as evidenced by a number of scientific articles by Nekrasov A.G., Sokolov Yu.I., Macheret D.A., Sinitsyn A.S. This is associated with the justification of highly efficient systems of transportation and logistics services of goods, providing a new quality of transformation of the system as a single the whole [14].

At the same time, the issues of modeling the development strategy of multimodal transportation and seamless logistics have not been studied in the scientific literature.

2 Materials and Methods

Currently, the development of digitalization processes in the field of transport and logistics are part of modern business processes. This is due not only to the increase in system performance, but also to the intelligent mobility and sustainability of transport logistics systems [1, 2, 5].

Of course, the transport logistics system has all the features of a complex system, since it is hierarchical and includes interconnected subsystems. When conducting a study, a specialist chooses a simulation method to study a complex system for several reasons.

Table 1. Justification for the adoption of simulation modeling of the system.

№	The reason for the choice	Tasks solved by building a simulation model
1	It is not possible to create a specific list of research tasks.	Each group of developers of a complex system model chooses its object for research as a set of basic elements. Each uses different assumptions about the type of interaction between elements, different quality criteria describing the functioning of the model, and sets a different goal for modeling. All this is connected with the power of simulation modeling as a tool for creating a model.

2	The complexity and complexity of the analytical apparatus.	There are a huge variety of mathematical tools for describing various elements of the simulated system. Among them are the theory of queuing, finite-difference schemes, Boolean algebra, graph theory. But when modeling, too many input source values are received as input data, which does not allow us to unambiguously consider the final solution satisfactory.
3	The complexity of observing the dynamics of components in the system.	The specialist often lacks average estimates of the characteristics of the functioning of a complex system. He is also interested in studying the time sequence of the occurrence of model vulnerabilities, their effective closure, making changes to the operation of the system, etc.
4	The lack of economic feasibility of staging field experiments.	Any research and manipulation of the system leads to economic costs and are expensive activities. If a change in the operation of a real-life facility turns out to be unsuccessful, it can lead to damage to the owner of the facility, social tension, and economic losses. Designing a new system will also lead to high costs. In order to avoid them, they use the already accumulated experience of specialists in this field, avoiding cooperation with research teams. They also use simulation in order to conduct a preliminary check of a new strategy before its immediate implementation.
5	There is a need for an accurate representation of the functioning of the system components.	Due to the presence of many factors unknown to the specialist, the study of the operation of the system for a certain time period will need a certain analytical model. It is possible to solve such a simulation problem by preserving and restoring the intermediate state of the system Due to the presence of many factors unknown to the specialist, the study of the operation of the system for a certain time period will need a certain analytical model. It is possible to solve such a simulation problem by preserving and restoring the intermediate state of the system «backup».
6	Using a simulation model as a simulator.	The training program for decision-making specialists should include a part aimed at acquiring new knowledge and skills in the management of the simulated system.

The strategy for the development of seamless cargo logistics ensures uninterrupted, uniform operation of various modes of transport, allows you to synchronize the work of carriers and transport logistics terminals [6].

The model of seamless cargo logistics development for finding a compromise solution takes into account the results of cargo movement monitoring, forecast and application of control actions, coordination of service system parameters in the supply chain, delivery time, infrastructure capabilities of terminals.

Methods of building simulation models help to find compromise solutions (Fig.1).

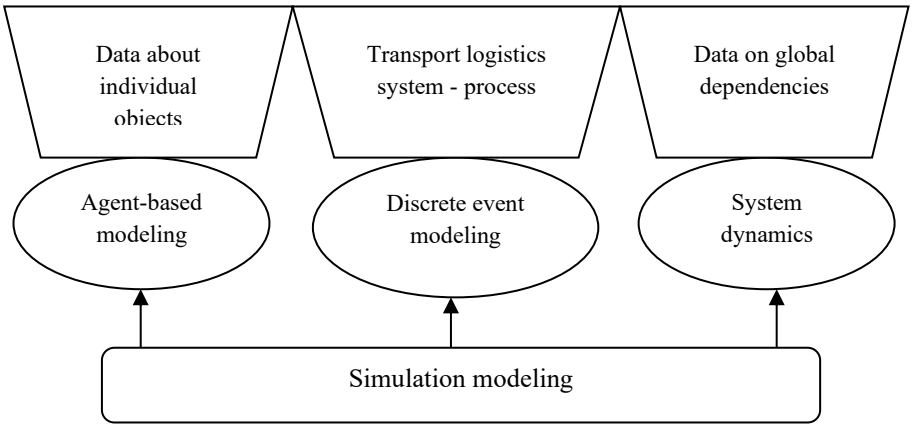

Fig. 1. The system of multi-pass simulation.

Such methods are considered: agent modeling, if data on individual objects are located; discrete-event modeling, if the transport logistics system can be described as a process; system dynamics, if there is information only about global dependencies. The use of all three methods is considered to be multi-approach simulation modeling [13].

To model the development strategy of seamless cargo logistics, the most relevant method is system dynamics. Dynamic models simulate the behavior of the system over time and allow you to investigate the operation of the system in a given time range or predict its operation in the future. This type of modeling helps to understand the essence of the ongoing identification of cause-and-effect relationships between objects and phenomena. At the same time, the following scheme for developing a simulation model is common [7]:

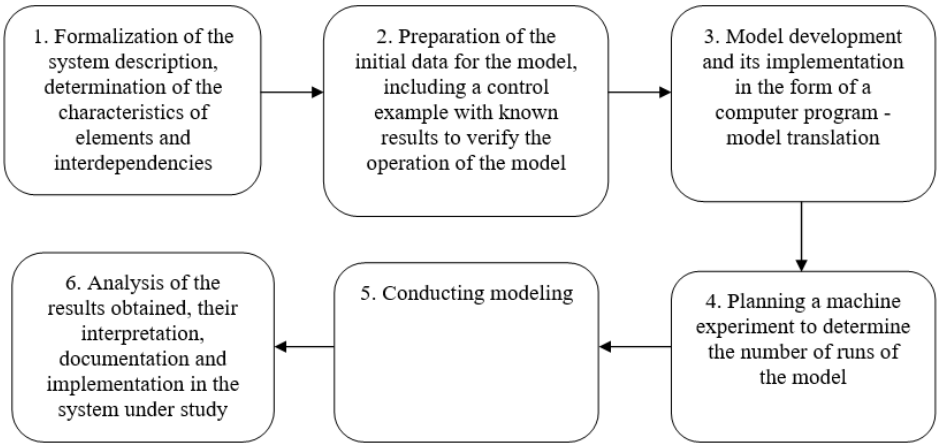

Fig. 2. Simulation model development scheme.

To build a model, you need to follow a certain algorithm. Figure 3 shows the algorithm for building a prototype model for the development of seamless cargo logistics. In order to simplify the modeling process and understand the stages and components, the design should be broken down into blocks, each of which corresponds to a particular key area of modeling of the transport logistics system or reflects the most important indicators necessary for the analysis of the model [8].

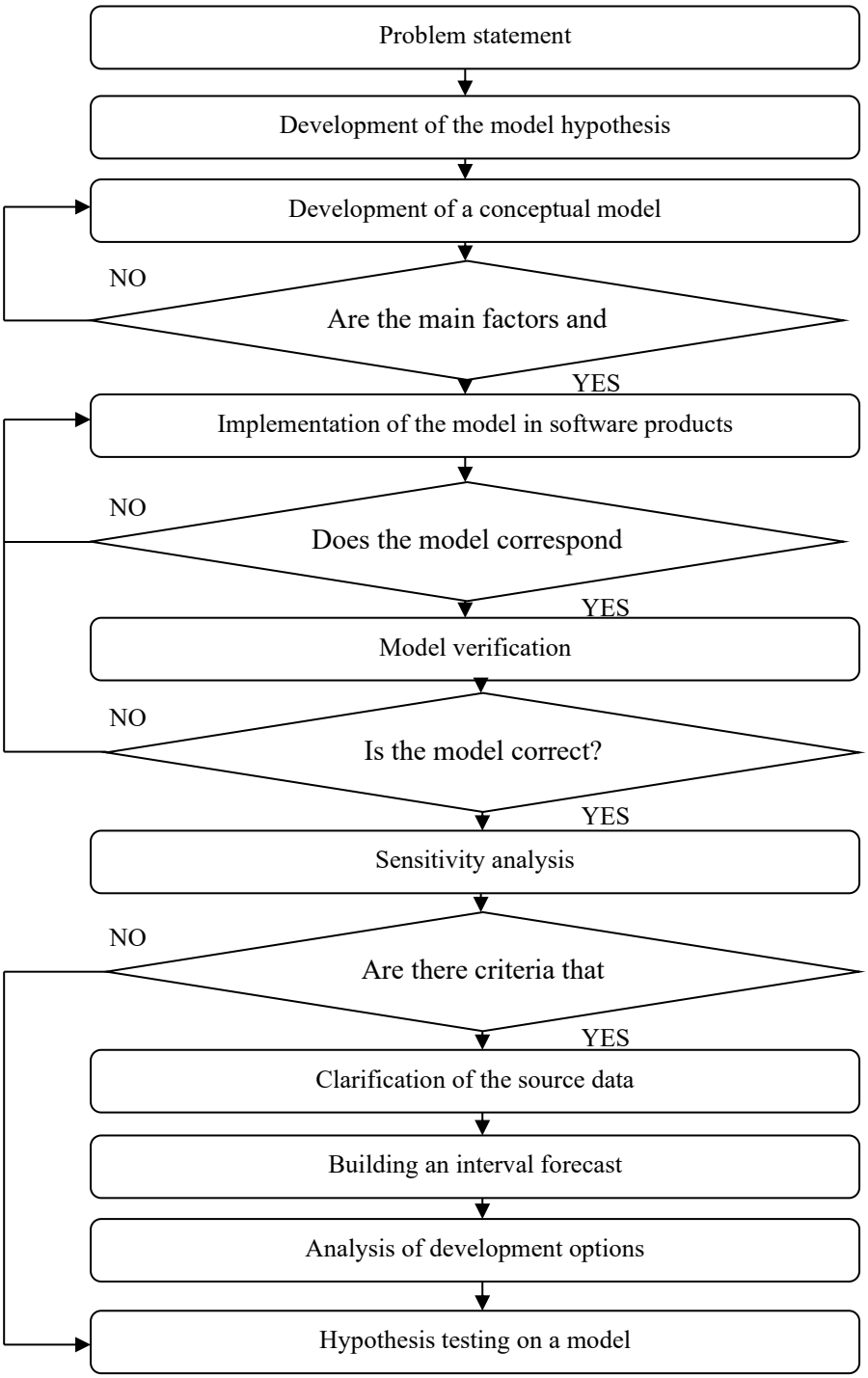

Fig. 3. Algorithm for constructing a simulation prototype of the model.

To build a model of the transport and logistics system is most effective in the context of the whole region. The main parameters of the transport logistics system from the point of

view of the development of the region are: the state of transport, warehouse, road, customs, information and financial infrastructures [15].

For the development of multimodal transportation and seamless logistics, first of all, it is necessary to form an infrastructure framework that will connect all types of transport in a single network in a separate region, synchronize infrastructure modernization work.

The transport infrastructure includes capacities that allow transportation between the objects of the region, allowing for the movement of material flows of the region. The unevenness in the territorial distribution of transport networks and transport infrastructure facilities, the interdependence and interaction of individual modes of transport, the congestion of major highways and urban agglomerations affects the economic development of the region as a whole.

The warehouse infrastructure provides storage and transshipment of goods, ensures the redistribution of material flows between directions.

The road infrastructure characterizes the capacity of the region in terms of road transport, as well as the maximum possible speed of movement of material flows within it.

The customs infrastructure allows for the import and export of the relevant material flows of the region [10].

The division by type of material flows, the reflection of material flows in monetary form, profits, losses, tax and other deductions, the understanding of all this is engaged in the financial infrastructure.

Information infrastructure currently occupies key positions. This issue is regulated by the provisions of the Transport Development Strategy until 2030. One of the conditions for increasing the speed of multimodal transportation by 4 times is the digitalization of cargo flow management and the transition to electronic document management [11]. It is also worth noting such digital technologies as the introduction of a cargo tracking system using electronic navigation seals, the development of a digital platform for the transport complex, the formation of a system for the end-to-end exchange of electronic transportation documents and a national digital logistics circuit, as well as the practice of introducing electronic platforms for ordering cargo transportation and logistics services. The introduction of intelligent operational management of the system ensures its functioning [13].

Based on the simulation model construction algorithm (Fig. 3), we will build a conceptual model of the transport logistics system development strategy (Fig. 4).

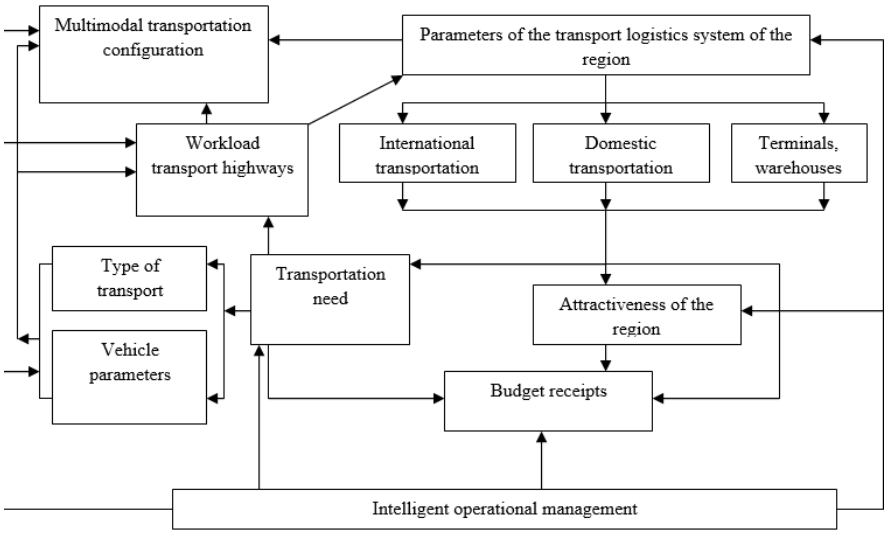

Fig. 4. Conceptual model of the transport logistics system development strategy.

For the most efficient functioning and competitive variants of the transport logistics system infrastructure, it is necessary to develop methodology and organizational and methodological approaches. The conceptual model of the strategy for the development of the transport logistics system (Fig.4) is presented in a general form and reflects the interaction and interrelationships of the main subsystems of the structure [15]. It is important to note that when using information and computer technologies on the example of the transport logistics infrastructure of a particular region, it is possible to identify the key factors of each subsystem. Based on the results of the implementation of these factors, it is possible to obtain a detailed model of the transport logistics system of a particular region.

3 Conclusions

The Ministry of Transport of Russia has started work on the implementation of the digital transformation strategy. The introduction of seamless cargo logistics as part of the digital transformation of the transport industry requires new management approaches. The formulated model allows for the elaboration of investment program options when creating a transport logistics system. A very important aspect is that the model of a transport logistics system, which uses a simulation software package, allows you to create and adjust data arrays reflecting possible options for organizing vehicle routes, to obtain information that is most adequate to real-time conditions.

Thus, in relation to the activities of the entire industry, a systematic approach is implemented and the integration of the business model and IT systems, which until now have been considered as separate subsystems, is ensured [14].

The next stage in the transformation of such a model may be the transformation into a system whose subject area would be focused on the development of the transport industry or the economy of a particular region.

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