ANALYSIS OF MODERN METHODS OF TRAFFIC FLOW MANAGEMENT

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In the context of the globalized global economy and the rapid growth of transportation volumes, transport systems play a key role in ensuring the sustainable functioning of logistics chains. The efficiency of traffic flow management directly affects the speed of cargo delivery, the level of transportation costs and the competitiveness of the national economy [1].

The purpose of the study is to analyze and evaluate modern methods of traffic flow management in order to improve the efficiency of transport systems and optimize logistics processes.

The relevance of the topic is due to the growing volume of traffic and the increasing complexity of traffic flows in modern logistics systems. Existing problems such as infrastructure congestion, delivery delays, and uneven flow distribution require the introduction of more effective management methods.

The thesis sets out the following tasks:

1. To study the theoretical foundations of traffic flow management.
2. Analyze the existing methods and models of traffic flow management.
3. Evaluate the effectiveness of modern technologies, including mathematical modeling and artificial intelligence.
4. Identify the main problems and limitations in traffic flow management.
5. To propose ways to improve traffic flow management methods.

A traffic flow is a collection of moving objects (goods, vehicles) interacting within the framework of the transport network infrastructure. The main task of management is to optimize the flow of flows in order to minimize the cost of time, resources and increase the reliability of delivery [3].

One of the key directions is the application of mathematical modeling and optimization methods. For example, the task of minimizing total transportation costs can be represented as a function: $Z = \sum_{i,j} c_{ij} \cdot x_{ij} \rightarrow min$, where, c_{ij} – the cost of transportation between the nodes, x_{ij} – flow volume.

However, classical optimization models do not take into account the uncertainty and stochastic nature of transport processes.

Based on this, probabilistic and simulation methods are currently being developed that allow us to take into account uncertain random factors such as delays, fluctuations in demand, and weather conditions.

The current stage of development is characterized by the introduction of artificial transport systems (ITS), which combine information technologies, telecommunications and automatic control systems [5]. Artificial transportation systems provide real-time data collection and processing, which allows for rapid response to changes in the situation in real time. The key elements of such a system are transport monitoring systems (GPS/GLONASS), automated traffic control systems and data analysis platforms.

However, methods based on artificial intelligence and machine learning occupy a special place. For example, demand forecasting can be represented as a function: $D_t = f(X_t)$, where, D_t – projected demand, X_t – set of input factors (time, seasonality, economic indicators).

The integration of such models with optimization algorithms makes it possible to form adaptive traffic flow management systems. Figure 1 shows a diagram of modern methods of traffic flow management. This picture describes the concept of intelligent transport systems, which transforms the data received from sensors and GPS into precise management decisions using mathematical models and neural networks. The scheme builds a logical chain from operational monitoring "here and now" to long-term strategic infrastructure planning, combining technological and economic goals into a single feedback loop.

In the course of the research, this thesis analyzed modern methods of traffic flow management, including classical optimization models, simulation methods, and intelligent systems. It has been established that complex approaches based on the integration of mathematical modeling and artificial intelligence technology demonstrate the greatest effectiveness. It has been revealed that the use of digital platforms and real-time monitoring systems can significantly improve planning accuracy and reduce transportation costs. The thesis also identifies the main problems of existing control systems related to limited adaptability and insufficient coordination of participants in the transportation process. The directions of improving traffic flow management are proposed, including the introduction of predictive analytics, automation of decision-making and the development of intelligent transport systems.

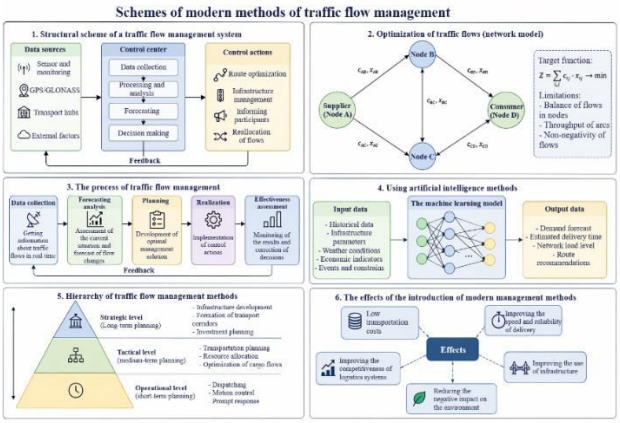


Figure 1. Diagrams of modern methods of traffic flow management

In conclusion, it can be said that the effectiveness of traffic flow management largely depends on the use of modern methods based on the integration of mathematical modeling, digital technologies and artificial intelligence. It is shown that traditional approaches provide the necessary flexibility and adaptability in a dynamically changing transport environment. Thus, further development of traffic flow management methods should be aimed at their digitalization and integration into a single information environment.

List of used literature.

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