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Development of Multimodal Transport Network in the Region

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Abstract: In a market economy, the stability of an enterprise determined not only by its production costs, but also by optimizing its delivery to domestic and foreign markets and reducing their cost. This requires the development of transport and logistics. The key factor in the development of transport and logistics is the optimal use of the transport network, types and means of the region.

The article discusses the issue of multimodal transportation of goods in the region, i.e. the effective use of road and rail transport and network, as well as their development in line with future growth of freight flows.

Keywords: transport, multimodal, automobile, railway, network, multispectral, development, road scheme, optimal, cost, freight flow.

One of the important tasks is further improve the system of organization of transport services, to create a competitive environment and favorable conditions for carriers of all forms of ownership and to identify measures to increase the transport and transit potential of the country.

Transport companies need to further improve their commercial and production activities, and focus on studying, analyzing and meeting the needs and requirements of consumers. Transportation activities aimed at meeting the needs of organizations in two different directions – the seller and the buyer, i.e. the sender and receiver. It understood that the process of selling a product considered complete only when it delivered to the consumer. In a market economy, the stability of an enterprise determined not only by its production costs, but also by its ability to sell its goods on the market, that is, to sell them to buyers. After enterprises and organizations sell their goods, there is a problem of delivery of the product to the buyer. Because in a market economy, in addition to the market of products and goods, the market of transport services formed, there is competition between transport enterprises [1].

Such an infrastructure for the modern development of the transport services market is a multimodal transport network [2].

Multimodal transportation is domestic transportation with at least two modes of transport [1].

According to experts, the low level of competitiveness of products produced in the Russian Federation is primarily due to the high cost of freight forwarding. This situation is the result of shortcomings in the transport operations and inventory management system for the delivery of goods.

Transportation considered the most important for the country's economy. The state of the transport system, which provides communication between each region of the region, closely linked to the sustainable development of the national economy. Reliable and high-tech transport infrastructure will allow meeting the growing demand of society for freight and passenger transportation. According to many authors [2], such an infrastructure for the modern development of the transport services market is a multimodal transport network, taking into account international transport corridors.

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The main problems of the multimodal transport network project are described [3,4,5,6]:

- Interaction of different objects in the transport infrastructure;
- Differences in the technical condition of transport infrastructure and their capacity, quality and availability are not adequate in the required conditions;
- Non-coordination of transport infrastructure projects of different types of transport implemented without a common strategy;
- Insufficient funds to eliminate "gaps" or build new infrastructure;
- Diversity of ownership and management structure, i.e. the expression of personal interests in solving the problems of transport infrastructure and their development.

The main characteristic of the transport system is its provision. Provision determined by the geographical advantage of the area (district, city or corridor) over all regions [7].

The definition of a low-cost transport network based on graph theory. The multimodal transport network presented in the form of graphs, i.e. presented as multiple nodes and arcs (Figure 1). This method based on the optimization of freight flows in the transport network [8,12].

The article discusses the issue of optimizing freight flows in the multimodal transport network.

The problem is expressed in the following form there is: a transport network area consisting of n nodes and arcs m with the characteristics of each arc connecting the points S, so i, j characteristics of each arc connecting points - C_{ij} – specific cost and d_{ij} – the parameters of the capacity of the existing line [9].

According to the plan of the future period of transportation, the inter-node loading and receiving interstate flows $\{X_{ij}\}$ are described in the form of a freight schedule.

Construction of new lines and maintenance of existing ones will require the creation of an optimal option for the development of the network, which will allow to master the volume of transport work in the future with minimal costs. At the same time, the minimum cost of fixed assets, including capital expenditures on fixed and current assets and current transportation costs, serves as a criterion for the optimality of this plan. The problem is a nonlinear functional problem of the cost of mastering the transport in the network.

The authors proposed a method of finding the nearest optimal option for the development of the transport network based on the idea of heuristic programming [6,7,8,11]. The problem solved in the order of several consecutive approaches to the real situation. The development of each existing line in a given area identifies possible options for reconstruction (reconstruction) and new construction. The required level of line development determines the load flow, capacity requirement, which in turn depends on the load flow volume. Therefore, it is necessary to create a multi-network $S^{\bullet}$, unlike the existing network in the field S. A multi-network constructed as follows: two adjacent nodes i, j connected by several arcs, rather than by two connecting arcs provided in a typical network. Additional arcs conducted in parallel with the existing arc should adequately reflect the level of technical equipment of the site (Figure 1).

Instead of the capacity of each arc of the existing plots in the network, the difference in the level of development compared to its predecessor d_{ij} is written, that is

$$d_{ij} = D_{ij}^{p} - D_{ij}^{p-1}, \qquad (1)$$

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Where p – is the level of development of the plot (stage order). The values of the multi-network ij arcs (C_{ij}) are taken as the differential cost of transporting the freight across that section.

A necessary condition for solving the problem by this method is that depending on the amount of cargo flow, the cost of transporting goods should change not linearly, but in the order in which the growth of this function does not decrease i.e.

$$C_{ij}^{o} < C_{ij}^{1} < C_{ij}^{2} < ... < C_{ij}^{p-1} < C_{ij}^{p} \qquad (2)$$

1 2

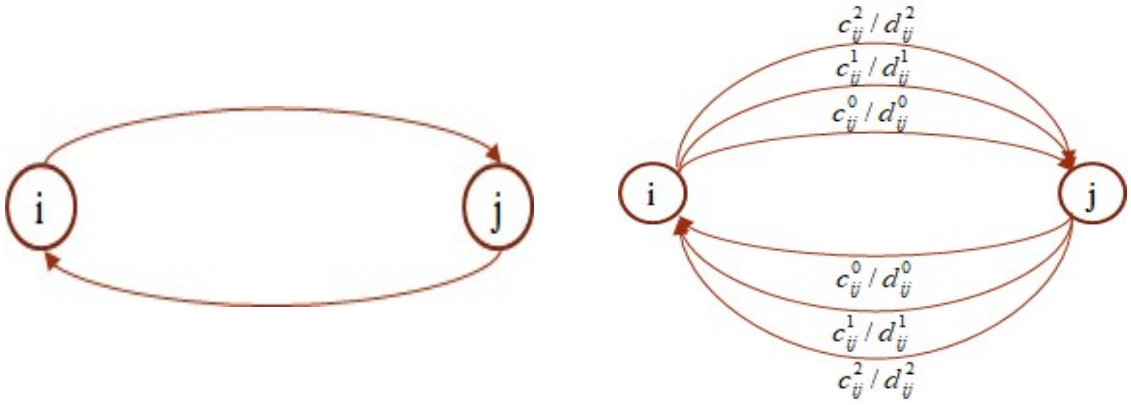

Figure 1. Multi-network view of the site

1- simple network;

2- multicenter C_{ij} - comparative cost;

d_{ij} - line capacity.

Calculations on the development of the railway network [10] showed that the condition (2) maintained for the differential costs calculated in the variants corresponding to the level of freight flow in the individual stages of single-track line development. Then the structured multisector and its arcs evaluated and the loads redistributed. The solution to this problem done in an approximate way. In this case, in accordance with the condition (2), first, at each section, the arc load current corresponding to the existing level of technical equipment is satisfied. Then the arcs corresponding to the first stage of reconstruction (reconstruction) filled with load current, and then the second, and so on steps will be consider.

Because of the distribution of load flows in the multi-network arcs, the sum of the carrying capacity for all types of cargo is determined.

After each iteration, the use of the arc's current-carrying capacity analyzed. Depending on the level of utilization of cargo flow capacity, a recalculation of the cost of transportation performed.

As mentioned above, the option of developing the transport network for the planned traffic volume at the exact time moment considered. It is possible to determine the dynamics of the development of the network by solving a number of static problems for different stages of freight growth over time.

The article recommends the organization of transportation in the transport network, which includes three types of transport. Therefore, the optimization of cargo flow is carried out in an extended single surface transport multitask. A single transport multinational network differs from a normal network in that it has several transport sections and additional (fictitious) nodes. It is create in the following order.

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The available points of each type of transport (in terms of sending, receiving, economic-technical, capacity and other indicators) shown as nodes of the graph.

Addresses where different modes of transport are connected, i.e. points where it is possible to reload from one mode of transport to another, are represented in the form of several addresses, respectively, which more fully takes into account transportation costs for door-to-door transmission (Figures 2 and 3).

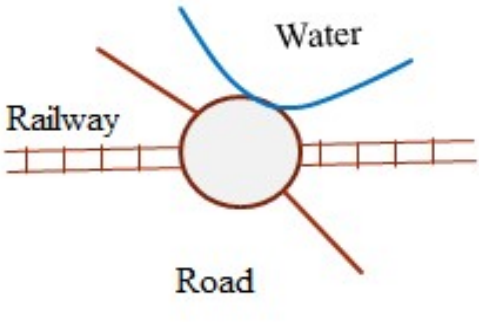

Figure 2. View of the transport network

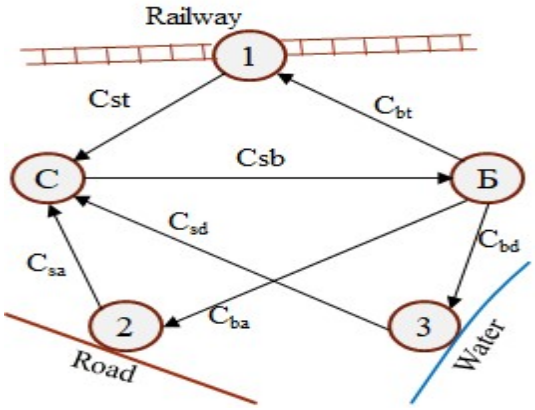

Figure 3. Multi-network view

The real point where the different modes of transport are connected is divided into *B*-sender, *C*-receiver conditional and neutral 1,2,3 links. The oriented arc between the conditional links reflects the costs of the initial-final operation of the respective modes of transport, as well as the costs of reloading from one mode of transport to another. Therefore, $C_{БА}$ and $C_{СА}$ – determine the cost of initial and final operations on road transport, $C_{БТ}$ and $C_{СТ}$ – railway, $C_{БД}$ and $C_{СД}$ – on river transport, and $C_{СБ}$ – indicate the additional costs of cargo storage (Figure 1). It will be possible to add other modes of transport (air) to the network. Because the supply of flows in the study economic zone is mainly used road and rail transport, land transport considered in this regard.

Conclusion.

In the multimodal transport network, the problem of optimal distribution of freight flows in the region by type of transport and network solved. This cannot be achieve in a simple expert way. The peculiarity of this option is that the optimal plan was obtain with the joint and mutually coordinated participation of the modes of transport. At the same time, an optimal plan for the development of modes of transport and networks has been develop.

In the final stage of solving the problem based on the optimization of freight flow in the multimodal transport network, the areas where the capacity of the highway should be increase have been identify and the funds needed for the implementation of measures to develop the road network will be identified.

According to the results of the study, the following conclusions drawn on the development of the road network in the region: II_{TE}-I_{TK}-115 km, III_{TE}-I_{TK}-67 km, III_{TE}-II_{TK}-39 km, $III_{ўT}$-III_{TE}-72 km, IV_{TE}-III_{TE}-23 km, $IV_{ўT}$-IV_{TE}-24 km.

The development of the transport network mainly based on the operational condition of the roads. This will allow for the rational distribution of capital funds allocated for the development of the transport network in the region.

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The use of the results of this research will provide a great opportunity to plan and design the future development of the freight network in road and rail transport. In our opinion, the development of the transport network in the region more clearly and comprehensively justified. This saves significantly on the transportation costs of the productive forces. This, in turn, will increase the competitiveness of our products and our economy as a whole.

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