MATHEMATICAL AND INSTRUMENTAL METHODS FOR TRANSPORTATION FORECASTING

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Annotation. *The basic principles and trends in the development of Internet logistics are considered based on the study of priority factors, methods of forecasting transportation and the possibility of enterprises working with clients without storing goods, it is also noted that the use of information and communication technologies in the field of logistics allows you to quickly find a potential client for the products offered by the manufacturer or services provided to them, and also leads to significant savings in material, financial and labor resources.*

Key words: *information and communication technologies, principles of Internet logistics, information flows, interactive services* **.**

Introduction. In industrialized countries, interest in the problems of Internet logistics development is associated with purely economic reasons. The prospects for the development of Internet logistics were determined by the following priority factors: increasing requirements for the quality characteristics of the process, the transition from a seller's market to a buyer's market. This transition was accompanied by significant changes in commodity distribution systems and production strategies. If previously the sales system was adjusted to production, then in conditions of market oversaturation, production programs are formed depending on the volumes and divisions of market demand. In conditions of intense competition, adapting to the interests of the clientele requires manufacturing companies to respond to incoming requests, which leads to an improvement in the quality of service, the competitiveness of products produced by factories, minimizing order execution time and strict adherence to the agreed delivery schedule. Time factors, together with price and quality of products, became decisive for the successful functioning of the enterprise. It is necessary to note the complication of the implementation problem with parallel interest in the quality of the distribution sphere. A similar reaction arose among manufacturing companies to their suppliers of resources, materials and services; as a result, a complex system of connections was formed between various market representatives, which required modification of existing models and methods of organization and forecasting of the transportation of goods in the field of supply and sales /1/.

Intensive development of mathematical and instrumental methods for forecasting transportation is carried out in conjunction with the development of the concept of transaction, logistics and its basic principles. Of utmost importance in the development and creation of mathematical and instrumental methods for forecasting transportation are the principles that determine the nature and essence of the entire coordination device, in general, and its individual aspects in particular. There are several of the most important mathematical and instrumental methods for forecasting transportation and principles that reflect the logistics approach to solving problems in production and economic activities.

Currently, a large number of methods for predicting scientific and technological changes and their implementation in socio- economic life are used in practice. The purpose of forecasting cargo transportation on a regional scale is to provide an objective picture of transport development, taking

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into account the rational distribution of containers.

The main task that economic forecasting in transport solves is to assess the prospects for the development of transport enterprises and the industry as a whole, as well as their rational distribution, taking into account regional characteristics. Forecast is probabilistic assessment of the possible state of the forecast object in the future, in order to reduce losses and achieve maximum effect from the operation of railway vehicles and containers.

In the socio-economic transport system, there are three main groups of forecasting methods: expert (intuitive), formalized and combined [1,2].

Expert (intuitive) methods are based on the study and disclosure of previously unknown properties of an object. Intuitive methods are used when quantitative information about the forecast object is limited or absent. Therefore, intuitive methods are used when information about the forecast object is mainly qualitative in nature and the influence of factors cannot be described mathematically.

"Expert" in Latin means "experienced." The forecast is based on the opinion of a specialist or a team of specialists, based on professional, scientific and practical experience.

Expert methods are used in the following cases: if the object of study is extremely simple or, conversely, when the object of forecasting is extremely complex, its novelty, the uncertainty of the formation of some essential features, insufficient completeness of information and the impossibility of complete mathematical formalization of the process of solving the problem.

Expert (intuitive) forecasting methods are divided into individual and collective expert assessments. The main principle underlying the methods of individual expert assessments is the maximum opportunity to use the individual abilities of the expert. However, individual expert methods are of little use for predicting the most general development strategies due to the limited knowledge of one expert in all areas of economics, science, technology and other related areas of theory and practice.

Formalized methods are based on the logical analysis of facts, statistical data, and forecast estimates using mathematical models. Formalized methods are used when information about the forecast object is mainly quantitative in nature and the influence of factors can be described using mathematical formulas.

From the point of view of practical feasibility, the advantage of using formalized methods over experts is to increase the share of objectivity of the forecast and automate the forecasting process itself through the use of mathematical models, which allows saving a large amount of resources.

Usually in practice, formalized methods are divided according to the general principle of operation into four groups: extrapolation (statistical) methods; system-structural methods and models; associative methods; advanced information methods.

As a rule, the choice of a forecasting method depends on a number of circumstances, a significant part of which is directly related to the availability of information about the forecasted object. The forecast object may be completely new; accordingly, the absence of patterns in the development of the object in the past will not allow us to predict similar trends in the development of the object in the future. Also, information about the past may constitute a trade secret and therefore be inaccessible to the researcher. Another circumstance may be the absence of any patterns in the development of the object in the past, instability, a high degree of variability depending on the location of the region, their characteristics and seasonality.

In all the above cases, the researcher needs to use expert methods to predict the future. An important feature of these methods is the use of personal opinions of experts as sources of information. The personal opinion of experts is based on their abilities, knowledge, intuition, and experience. Therefore, it is very important for the researcher to involve highly qualified specialists

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who are not personally interested in a certain outcome of events to develop a forecast. If the forecast object has existed for a long time, sufficient information has accumulated about it, which is available to the researcher and allows us to talk about the stable development of the object, the presence of patterns in its behavior, then the researcher can use formalized forecasting methods.

Thus, the choice of one or another forecasting method is determined by the stage of forecasting and analytical work, the availability of available information, and the lead time of forecasts.

In the framework of this work, it seems appropriate to consider the problem of forecasting transportation only in that part that is associated with purely quantitative indicators of expected demand or requests for transportation.

Let us briefly look at the analysis of the main methods of forecasting transportation. Regression analysis. The term "regression" is used in mathematical statistics to refer to the process of finding the best, single curve that can be drawn through a given set of points. Using regression analysis methods, elasticity coefficients can be calculated. The most common explanation of the elasticity coefficient is given by F. Fully [3].

Let the volume of transportation on the railway transport system be expressed by a dependence of the form:

$$y = ax^{B}.$$

When business activity *x* (production volume) increases by Δx, the volume of cargo transportation increases by Δy. Then "the degree of change *in x* will be characterized by the ratio Δ *x / x* , and "the degree of change in y" - by the ratio Δ y / y . Elasticity £ - ratio Δ y / y : Δ *x / x* in differential form:

$$£ = dy / dx * x / y ,$$
$$dy /dx = Bax^{b-1} ,$$
$$x/y = x/ ax^{b} ,$$
$$£ = B\, ax^{b-1}\, x / ax^{B} = B .$$

The elasticity coefficient shows whether transportation is growing at the same rate as business activity (£ = I), faster (£ > I), slower (£ < I).

"Input-output" method. In foreign literary sources this method is called Input - Output Analysis . The output of an enterprise or industry in question (Output) is a function of consumed raw materials and supplies (Input). In relation to transport, the output of industrial sectors and agriculture forms the overwhelming majority of cargo flows.

Empirical models have become widespread mainly in foreign literature. In K.J. Kansky "Structure of the transport network", the transport network is presented in the form of a graph, which allows, using empirical models, to approximately estimate the volume of transport between large industrial centers in a regional context.

The LILL model, often used in the transport system (Lills ' travel model) is based on the use of the Newtonian gravitational formula for the interaction of bodies:

$$T_{1.2} = k(j_1 * j_{2)} / d\, n_{1.2}$$

where $T_{1,2}$ - cargo exchange between industrial centers of region 1 and 2;

J_1 and J_2 - population size in the corresponding regions ;

d is the distance between the terminals of the region;

k, *n* are empirical constants.

The NAVIG model (Nyvigs ' model) is used to distribute freight turnover by mode of transport:

$$W_A = k * 1/ F * 1/ H * S ,$$

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where W_A is the share in the freight turnover of a given type of transport A ; F is a function that determines the costs (fees) for transportation; H – time taken for cargo delivery; S - flight departure frequency.

Bjorkmans model model) is used to forecast freight and passenger turnover. According to this model, the traffic growth rate *(dT)* is the product of the following parameters:

$$dT = dP * dJ * dS^2 ,$$

where *dP , dJ , dS* are the growth rates of the population, its purchasing power and improvement in the quality of transport services, respectively.

The predicted exchange of $T_{1.2}$ between industrial centers of region 1 and 2 in the future is determined by the condition:

$$T_{1,2} = t_{1.2} * dT ,$$

where $t_{1.2}$ is the existing exchange (number of trips, tons transported); *dT* is the growth rate of freight turnover for the transport system as a whole.

Holt method and the forecasting method using additive and multiplicative components were used in constructing a methodology for forecasting demand for container transportation, taking into account the seasonality of production and consumption of containerized cargo. Assessing the competitive position of a transport company in the transport services market, thus, allows timely preparation and implementation of measures aimed at maintaining or increasing the level of its competitiveness. The strategy for managing the development of a transport company is to ensure that the planned activities bring the company as close as possible to its target state according to a system of private indicators, which should also include a competitiveness indicator.

In conclusion, it should be noted that information flows characterizing decisions in the distribution system can be divided into those characterizing the temporary reasons for operations in the distribution network and reflecting the accuracy and reliability of the data. Information that reduces the uncertainty of distribution timing combines order fulfillment data. Temporary parameters of transportation are associated with the choice of delivery scheme, route, etc. The cycle of receiving an order and its duration include information about the time of cargo delivery, destination, time of loading and unloading, and documentation. Information flows associated with reducing the uncertainty of other parameters take into account delivery conditions, reliability and accuracy of information when managing inventories. The considered information flow for one function of logistics management gives an idea of the complexity and variety of information flows in the logistics system.

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