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METHOD OF TRANSPORTATION SYSTEM CAPACITY DETERMINATION CONSIDERING CARGO FLOW FORECASTING

The method of cargo flow capacity forecasting considering the influence of state regulation mechanism of the cargo transportation process is working out in the article. The proposed method based on situational approach ensures a high level of the forecasts adequacy required for the analysis and solution of the tasks of the transportation system development.

Keywords*: state regulation, transportation system, cargo flow forecasting.*

У статті розроблено методику прогнозування обсягів вантажопотоку, враховуючу вплив механізму державного регулювання на процес перевезення вантажів. Запропонована методика заснована на ситуаційному підході, що забезпечує високий ступінь адекватності прогнозів, необхідних для аналізу і вирішення завдань розвитку транспортної системи.

Ключові слова: *державне регулювання, транспортна система, прогнозування вантажопотоку.*

В статье разработана методика прогнозирования объемов грузопотока, учитывающая влияние механизма государственного регулирования на процесс перевозки грузов. Предложенная методика основана на ситуационном подходе, что обеспечивает высокую степень адекватности прогнозов, необходимых для анализа и решения задач развития транспортной системы.

Ключевые слова: *государственное регулирование, транспортная система, прогнозирование грузопотока.*

Introduction. In the situation of active development of interstate integration processes, international trade globalization, as well as the need for ensuring the protection of economic interests, there arises the necessity to transform the role of state institutions and the essence of their tasks when performing control procedures.

The state development level depends on many factors, one of the most important places among them being occupied by the state of the transportation system. The process of international relations globalization leads to quantitative and qualitative increase of commodity, informational and financial flows worldwide.

Such methods as theories of transport processes and systems, mass servicing, investigation of operations, project management subject to their adaptation to contemporary conditions of authority control service functioning as

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the structure which ensures the protection of economical safety of the country allow effective management of temporal, cost-based and qualitative parameters, this is why it is appropriate to use them when carrying our reorganizational measures in the control authority sphere and can serve as the basis for solving the questions connected with working out optimal technology of performing control formalities.

Review of publications on the program. The forecasting problem has become particularly complex during the last decade as the result of rapid changes of the environment [1].

The prospects of further development of marine transportation complex of a country in modern situation are in the first place determined by the state of sea trade ports and the activity of control bodies [2].

The research in the sphere of state regulation of foreign trade activity has shifted from the determination of effective strategies of control authority development based on scientifically grounded instruments to the consideration of technological processes [3].

All methods assume the invariance of conditions during the period of prognostication, which does not conform to reality, are grounded on the paradigm "the past determines the future"; that is they suggest that the previous state of the system uniquely defines its next state.

Uncertainty, indistinctness of information used in such object domain as prognostication of cargo transportations are not taken into account [4].

In addition to obtaining possible future estimations of the parameters being studied, forecasting suggests the motivation to speculations on the suggestions of what may occur in the environment and what results may follow.

The majority of mathematical methods of forecasting based on the models of cargo transportations can be conditionally divided into the following classes: probabilistic, differential calculus, expert, etc.

All of them have multiple limitations and drawbacks which make there use for the prognostication of cargo transportations unproductive or inefficient at all.

From the mathematical point of view, the following should be marked: it is not always that adequate formalization of object domain is provided for when creating a forecast.

The aim of the study – working out the methods of forecasting of the transportation complex capacity subject to the influence of state control over the process of cargo transportations.

Main material of the study. Forecasting cargo flows is an example of a complex prognostication task which cannot be solved with the use of any single method. One of the main tasks of control bodies is the protection of economical interests of the state by way of tariff regulation of import and export duties rates, which influence the quantity of the cargo being transported and, consequently, on the workload of the cargo transportation process.

It is important to take into account connections in the system "traffic center-environment", as well as the availability of multiphase structural scheme of cargo flows passage. It is expedient to elaborate the method which allows forecasting the volumes of cargo flows – the fundamental basis for designing the development of transportation system.

Expert estimations formulated by specialist are based on the information collected at the stage of preliminary analysis and they take into account statistical data of the volumes of cargo flows of various goods, the capacity of potential market, the prospects of development of a certain sphere of economics inside the country, general demand, shares of goods of various brands on the market, level of accessibility of sales networks.

The effect of external factors in the model of forecasting cargo flows reveals itself through the influence on the current estimation of input characteristics of the model, which are formalized by membership functions of the corresponding fuzzy sets.

Active development of international transportation system demands taking new effective managerial solutions aimed at the formation of the system of control and transportation servicing of physical distribution able to make provisions for increasing cargo flows subject to maximal protection of the state interests.

The level of transportation system development is defined by its capacity to handle all available cargo flows.

It should be noted that the transportation system development is determined by the directions and the quantity of cargo flows.

This calls for the necessity of performing proper procedures of state control of the process of moving goods across the border, namely the realization of effective state control and registration of goods and transport means.

The system of transportation complex management should assist in reaching maximal effectiveness when using geopolitical position of the state, its participation in international transportation process, as well as in satisfying the needs of the economics in transportation service provided the influence of state control of the cargoes delivery.

The necessity of the transportation system integration in the international system of cargoes delivery is aimed at attracting additional volumes of carriages and currency inflows, lowering transportation expenses, approaching to the world standards of cargoes and passenger carriages, to ecological characteristics of the work, as well as to increasing the share of export potential on the international market of transportation services by way of competitive recovery of national carriers.

In its turn, this necessitates the use of rational technologies for prognosticating cargo flows with the purpose of effective use of existing transportation networks infrastructure, as well as for its prospective development.

The most often used regimes of moving cargo are: import, export and transit. The existence of other additional regimes, such as, for example, handling cargoes beyond the limits of state territory, re-export, re-import, should not

go unnoticed though their share in the total volume of moving cargoes is insignificant.

The following factors influence the formation of cargo flows: for import carriages: purchase requirement of population, the level of the national economic integration in the world economy, state tariff; for export carriages; competitive ability of enterprises in the world market, domestic demand, state tariffs; for transit carriages: the rate of handling cargoes, safety of transportation, control registration.

In all three cases, the state of authority regulations and control system influences the formation of cargo flow.

The methods of determining the capacity of transportation system required for the processing of the cargo flow includes the following stages (figure).
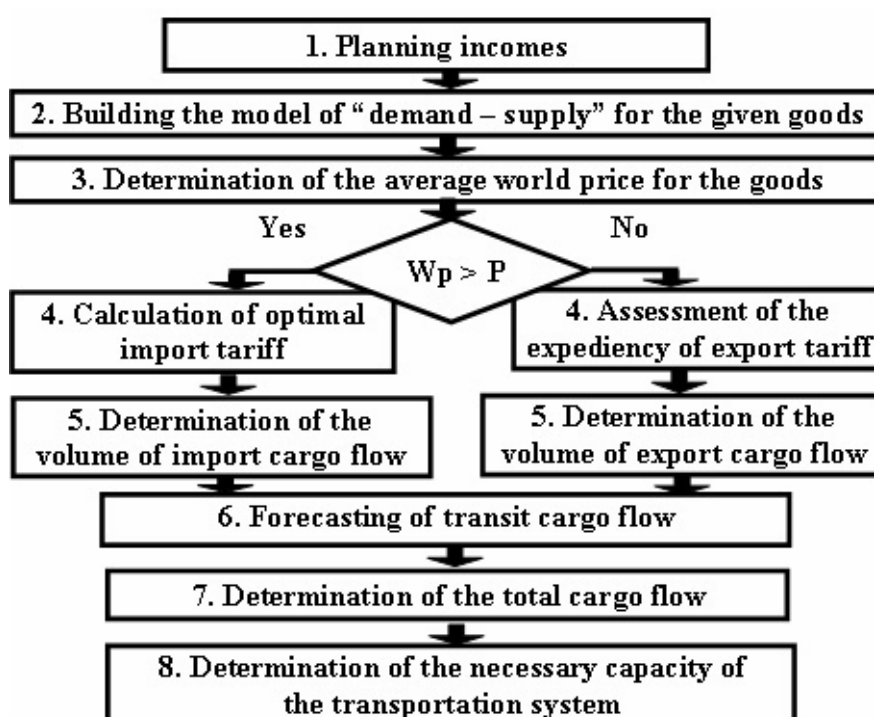

Fig. Method of determination of transportation system capacity

For the elaboration of the model of forecasting import cargo flow we shall introduce the following designations:

P_i − average world price of an i − goods unit, conventional units;

W_{Pi} − price of an i − goods unit on domestic market, c.u.;

C_i − duty rate for i − goods;

$Q_{Si}^{'}$ − total supply of i − goods in the absence of import tariff, units;

$Q_{Si}^{''}$ − total supply of i − goods at the introduction of import duty, units;

$Q_{Di}^{'}$ − total demand for i − goods at the introduction of import duty, units;

$Q_{Di}^{''}$ − total demand for i − goods in the absence of import tariffs, units;

Q_{DMAX} − maximal total demand for i − goods, units;

Z_i − prime cost of production of an i − goods unit, c.u.;

t − tax rate on the profit of enterprise;

$K_i^{'}$ − factor accounting for the dynamics of changing total demand for i − goods;

$K_i^{''}$ − factor accounting for the dynamics of changing total supply of i − goods.

There is secured the maximum income of the state budget (1)

$$R_i = \sum_{i=1}^{n} \left(\begin{pmatrix} Q_{DMAX} - K_i^{'} P_i - K_i^{'} P_i C_i \\ -K_i^{''} P_i - K_i^{''} P_i C_i + K_i^{''} Z_i \end{pmatrix} P_i C_i + \\ + \left(K_i^{''} P_i + K_i^{''} P_i C_i - K_i^{''} Z_i \right) P_i t \right) \rightarrow \max . \tag{1}$$

The optimal rate of import duty C_{OPT}, ensuring the maximal level of the national economic welfare must meet the structural limit of

$$0 \leq C_i \leq C_i^{GATT} ,$$

where C_i^{GATT} marginal tax rate for i − goods, specified by General agreement on tariffs and trade.

The volume of supply of i − goods shall be determined in the following way (2):

$$Q_{Si}^{''} = \begin{cases} 0, & if \ 0 \leq W_i \leq Z_i; \\ K_i^{''} (W_i - Z_i), & if \ Z_i \leq W_i \leq W_{P_i}; \\ Q_{Di}^{'}, & if \ W_i \geq W_{P_i}. \end{cases} \tag{2}$$

The value of the forecasting import cargo flow subject to state tariffs control of the process of moving cargoes across the border shall be calculated using the formula (3).

The forecast of transit cargo flows is realized in the form of interconnected modules, the interaction whereof suggesting logical realization of the results in the context of qualitative and quantitative characteristics subject to possible spectrum of events. Forecasting transit cargo flows assumes the interaction of two components: economic and transport.

$$
\begin{aligned}
Q_{IM_i} &= \sum_{i=1}^{n}\left(Q_{Di}{}' - Q_{Si}{}''\right) = \sum_{i=1}^{n}\left(\left(Q_{D_{MAX}} - K_i{}' W_i\right) - Q_{Si}{}''\right) = \\
&= \sum_{i=1}^{n}\left(\left(Q_{D_{MAX}} - K_i{}' P_i\left(1 + C_i\right)\right) - Q_{Si}{}''\right) = \\
&= \sum_{i=1}^{n}\left(Q_{D_{MAX}} - K_i{}' P_i - K_i{}' P_i C_{OPT} - K_i{}'' P_i - K_i{}'' P_i C_{OPT} + K_i{}'' Z_i\right).
\end{aligned}
$$

(3)

Economic component provides for forming the possibility of cargo flows emerging in the aspect of foreign economic activity of the country.

Transport component provides for the assessment of transit cargo flows possibility in the transportation network subject to its throughput.

To determine the traffic center facilities as the element of transportation system required for processing the cargo flow, the following actions should be performed:

- to determine the volume of import cargo flow subject to the calculation of optimal import tariff – while importing cargo;

- to estimate the expediency of export tariff and to determine the volume of export cargo flow – while exporting cargo;

- to forecast transit cargo flow – in case of transit cargo.

From the point of view of technology the following characteristics should be also taken into account:

- macroeconomic potential capacities of the countries in connection with import-export of goods;

- estimated cargo flow between the countries according to groups of goods in the aspect of transportation network;

- possibilities of transiting goods by international transport corridors;

- throughput of infrastructure of international transport corridors.

After obtaining the corresponding values of the above-mentioned characteristics the total cargo flow to be used for forecasting the necessary capacities of transportation system shall be calculated, including the number of units of transportation, transshipment means, as well as the warehouse areas required for processing the cargoes being moved.

Conclusions

1. Based on the study by the method of forecasting in the terms of the analysis of gross domestic product, as well as the forecasted model of demand and supply, the model of forecasting the volume of cargo flow subject to the influence of state control of the process of cargoes transportation was elaborated.

2. The workload of the transportation system depends on the volume of the existing cargo flow, which is influenced to a insignificant extent by the level of the duty rate depending on the direction of moving cargoes across the border.

3. The use of the above-mentioned complex of actions taking into account situational approach to prognostication shall ensure the high degree of the forecasts adequacy, which is necessary for the analysis and solution of the tasks of the state transportation system development.

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