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ANALYSIS OF THE METHODS OF THE SELECTION OF MULTIMODAL TERMINALS DISLOCATION

Research is devoted to the analysis of the methods of the selection of the multimodal terminals dislocation. Multimodal cargoes transportation is one of the most important components of the transport concept of the world and national significance, which promotes the efficient cooperation of the enterprises of different kinds of transport, providing qualitative services of the modern format that enables to reduce the negative impact on the environment. Multimodal transportation enables to deliver the cargoes to any point of destination.

The important component of the multimodal transportation of the cargoes is multimodal terminal. Multimodal terminals are used in the process of multimodal transportation for the change of the type of transport, performing the operations of loading, unloading, storage of the cargo. Their efficient operation plays an important role in the growth of the volumes of the international cargo flows and increase the market competitiveness of Ukraine.

Imperfect choice of the multimodal terminal dislocation may lead to considerable losses and worsening of the quality of the multimodal transportation of cargoes, in this connection, there arises the need to study the methods of the selection of the multimodal terminals dislocation.

By the results of the research, carried out, it was determined that the following methods of the selection of multimodal terminals dislocation are used most frequently: exhaustive search, 'weight center', heuristic methods, multidimensional methods. Applying the method of the exhaustive search, the problem of the optimal dislocation is solved by the exhaustive search and assessment of all possible variants of multimodal terminals dislocation. Method of "weight center" provides the determination of one terminal dislocation, taking into account only the demand for the products, without taking into consideration the volume of goods delivery by the supplies and their location. Cluster analysis – is a variant of the multidimensional analysis, one of the directions of its usage is the economic substantiation of the conditions of the transport-logistics cluster formation in the region. Multimodal terminal can be located on its base. Heuristic methods, based on human experience and intuition, are based on Pareto principle, i.e., on the advanced denial from a great number of the obviously inadmissible variants. For the analyzed methods their advantages and disadvantages, which should be taken into consideration in the process of the selection of multimodal terminals dislocation are presented.

Key words: *multimodal transportation, multimodal terminal, dislocation, method, cargo.*

Problem set-up

Important component of the multimodal transportation of cargoes are multimodal terminals, their efficient operation plays an important role in the growth of the volume of the international freight transportation flows and increase of the market competitiveness of Ukraine. Construction of multimodal terminals is the long lasting and expensive process. Imperfect selection of the dislocation of multimodal terminals can lead to considerable expenses and worsening of the quality of multimodal freight transportation. Thus, the analysis of the methods of the selection of multimodal terminals dislocation is a challenging issue.

Analysis of the latest achievements and publications

Many foreign and Ukrainian scholars study the problems of the selection of the dislocation of the logistic infrastructure: I. V. Solomnikov, O. V. Boiko, O. M. Poliakova, G. L. Brodeskyi, N. V. Khalipova, P. A. Terentieva, John Peter Fesano, Feng Lee, O. A. Kopilova, N. K. Gorjaev, S. V. Kalanteev and others. However, nowadays there is no systematized analysis of the methods of selection of the multimodal terminals dislocation.

Aim of the paper

Analyze the essence, advantages and disadvantages of the methods of the selection of the multimodal terminals dislocation.

Presentation of the main material of the research

The market of multimodal transportation in Ukraine is at the initial stage of its development, in these conditions, the problem of efficient application of multimodal terminals becomes urgent. According to the Project of the Law of Ukraine "About multimodal transportation" multimodal terminal is production-loading complex of any form of property, which is used in the process of multimodal transportation for the change of the type of transport, performing the operations of loading, unloading, storage of goods, etc. [1].

Efficient operation of multimodal terminal directly depends on its dislocation.

Dislocation of multimodal terminal is labor-consuming process, for its realization rather complex economic-mathematical methods and models are required.

For the selection of the multimodal terminal dislocation such methods are widely used: exhaustive search, "weight center", heuristic method, multidimensional analysis method.

According to the method of the exhaustive search the task of the optimal dislocation is solved by the exhaustive search and assessment of all possible variants of multimodal terminals dislocation or is performed at the computer, applying the methods of mathematical modeling. However, in reality, in the conditions of the branched transport networks and numerous factors, this method may be useless, as the number of variants and labor intensity of the solutions increases exponentially [2].

Methods of multidimensional analysis is the most suitable quantitative tool for the investigation of social-economic processes, described by a great number of characteristics. They include cluster analysis, factor analysis, etc.

Cluster analysis reflects features of multidimensional analysis in the classification, and factor analysis reflects features of multidimensional analysis in the study of the connection. Cluster analysis mainly is intended for the division of the set of the studied objects and features into the uniform groups, that is, into clusters. This means, that the task of data classification is solved and corresponding structure is revealed [3].

Among the approaches, used for the solution of the problems of cluster analysis the following approaches are used most frequently: probabilistic, hierarchic, logic, theoretical-graphic and on the base of the systems of artificial intelligence, in particular, neural network systems. Main advantages of modeling on the base of neural networks is qualitative interpretation of the results, possibility to process variables of different types, allocate the most important factors of influence.

One of the variants of the neural network algorithms, performing the clusterization tasks are Self Organizing Maps – SOM. The characteristic feature of this neural network paradigm is that the method of teaching "without teacher" is used, i.e., the result depends only on the structure of the input data. That is why, cluster analysis on the base of SOM, unlike most mathematical-statistical methods practically does not impose limitations on the type of the investigated objects and allows to consider the set of the output data of practically random nature [4].

One of the direction of using cluster analysis is its application for the economic substantiation of the conditions of transport-logistic cluster formation in the region. On its base multimodal terminal can be located. Transport-logistic cluster (TLC) provides the joining of separate regionally functionally and economically connected logistic links: international transport corridors (ITC), transport nodes of the infrastructure, transport-distribution logistic centers, main regional and local communication routes in a single system of the transportation process, able to provide qualitative logistic service to the internal and external consumers at minimal total logistic costs [5].

Method of "weight center" provides the determination of the dislocation of one terminal. The drawback of this method is that the distance from the point of the material flow consumption to the

place of the terminal dislocation is calculated along the straight line. Also only the natural parameters (distance, mass, time) are taken into account, assuming that only these data influence the main expenses when the multimodal terminal dislocation is selected. At the same time, this method takes into consideration only production demand. Without taking into account the volume of the products delivery by the suppliers and their location.

Modern approach to the study of the problem of logistic infrastructure objects dislocation is the selection of the optimal dislocation with the account of not only transport expenses but economic usage of energy resources and reduction of the impact on the environment, such an approach is described by the foreign authors John Peter Fasano, Feng Lee. In the process of the selection of optimal dislocation of the objects of transport-logistic infrastructure, along with the conventional components of the transport costs, carbon dioxide emissions are suggested to take into account by means of determining the balance between the profit of the enterprise and different losses, connected with carbon dioxide emissions [8].

For studying the dislocation of multimodal terminal, nowadays simulation modeling is widely used. In [6], the authors developed the simulation model of the interaction of the logical chain participants during organization of the interregional transportations. This simulation model is constructed, using agent approach. The agents (independence autonomous objects) are shippers and carriers which interact with each other in accordance with different types of behavior [7]. Application of this approach enabled to study the dynamics of the demand and supply at the market of the freight transportation as a result of the behavioral changes of the separate participants at the market.

Unlike mathematical models, simulation models do not guarantee the obtaining of the optimal solution. However, simulation modeling is more flexible tool, which can be applied for the analysis of complex distribution systems [8].

Heuristic methods are rather efficient and less labour-consuming for the solution of large practical problems. They give the results, close to optimal at minor complication of the calculations. The name "heuristic" means that they are based on human experience and intuition (unlike the formal procedure, which is the base of the exhaustive search method). Thus, the method is based on the Pareto rule, i. e., on the advanced denial from a great number of obviously unacceptable variants.

Specialist-expert analyzes transport-logistic network of the region and variants, unacceptable, from his point of view, excludes from the task. Thus, the problem is reduced to the controlled size from the point of view of the alternatives which must be evaluated. Only disputable variants remain, the expert does not have the clear answer concerning them. For these variants, calculations using the computer, are performed [2].

For the dislocation of the multimodal terminal, the techniques, based on expert methods are widely used. This is connected with the fact that the dislocation of the multimodal terminals is influenced, besides the distances and volume of transportation, by the transport-infrastructure, economic, demographic, scientific-engineering and innovation factors which are interconnected. Application of the expert methods enables to take into account the impact of these factors while selection the dislocation of multimodal terminals.

Multimodal terminal is a large investment object, that is why, the companies in the process of the dislocation selection, take into consideration, mainly, the ratings of the investment attractiveness, which evaluate potential and risk component of the subject.

These ratings are formed, using expert methods (method of analytical hierarchy, counting points), that is why, they are of a subjective character, as they do not take into account the characteristic features of the transport branch: indices of the transport work of the region, dynamics of the transport infrastructure development. The advantages of the expert methods are that they are efficient for the solution of large practical tasks, however, they do not provide the determination of

the optimal solution. Such methods form the list of the alternative variants of dislocation, concerning which the experts do not have definite opinion, which of the variants is optimal and which must be assessed by the selected criteria [8].

Expert (heuristic) methods include method of analytical hierarchy. In general form problem set up is the following. The general aim (or aims) of the corresponding system functioning (problem solution) is set. M alternative solutions for achieving the corresponding aim and n criteria of the assessment of the available alternatives within the analyzed system are set. The best variant must be selected [9].

Method of analytical hierarchy, unlike many other methods of selection of multimodal terminals dislocation, allows to take into consideration the impact of various factors. Experts carry out the comparative assessment of the factors from the point of view of their importance, regarding the dislocation of multimodal terminal.

On the base of the expert methods the techniques of the selection of the logistic infrastructure objects are developed in the works of G. L. Brodetskyi, P. A. Terentiev, S. V. Kalentev [9, 10]. Authors determine the criteria, influencing their dislocation, they are assigned weight coefficients with further determination of the most attractive variants.

The drawbacks of these techniques are subjective character of the assessment of the factors (criteria) impact on the dislocation of the objects of the logistic infrastructure, based on the intuition and experience of the experts [8].

Conclusion

The analysis of the methods of the selection of multimodal terminals dislocation is performed. It was determined that the following methods are often used: exhaustive search, “weight center”, heuristic methods and methods of multidimensional analysis. The advantages and disadvantages of these methods which should be taken into consideration for the selection of the multimodal terminals dislocation are considered.

Results of analysis of the methods of selection of multimodal terminals dislocation are recommended to apply for further calculations in the process of the solution of the problem of rational dislocation of multimodal terminals.

Prospects for further research

Investigation and improvement of the methods for the selection of multimodal terminals dislocation.

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