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Empirical Analysis of the Interaction Participants of Regional Transport and Logistics Systems

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***Abstract*—Integration processes in economy suggest an increase in the importance of logistics in solving national economic problems. One of the topical scientific directions in logistics and supply chain management (SCM), which are of practical importance, is a comprehensive study of the problems of territorial organization of flows and their management based on the analysis of the interaction of participants in transport and logistics systems.**

Keywords—logistics, transport and logistics systems, flow processes, supply chains, integration processes, logistics centers.

I. INTRODUCTION

The integral paradigm of logistics, on the basis of which the modern methodology for studying flow processes is built, evolves towards a broader concept - the integration of interaction between market actors in the supply chain at the meso, macro and micro level. In this context, the strategic tasks of organizational and economic interaction acquire a radical character:

- Regional logistics policy;

- Rational use of logistics resources;

- Integration processes that form regional logistic systems of different types and scales, as well as logistic links.

Among many factors relating to logistics performance, it was found that fixed broadband Internet availability is the most important target area for improvement related to sustainable logistics policy [1]. The modern development of the territories poses new tasks for logistic. A new logistical understanding of the ongoing processes caused by globalization, the transition from command and distribution to market mechanisms of management is required. This applies primarily to such fundamental concepts as the unified logistics space of Russia and the common economic space of the countries participating in integration associations. For a market economy, the analysis and classification of factors taken into account when creating transport and logistics systems, as well as the organizational and economic rationale for the composition and structure of supply chains.

Traditionally, the solution of these problems is connected with the development of an entrepreneurial strategy or reconstruction, the expansion of existing enterprises integrated into the supply chain. The main attention is paid to the study of the dynamics of demand and supply of products, services as the basis for the implementation of entrepreneurial ideas in the field of transport and logistics services for the goods flow.

The dynamics of traffic volumes will follow the following statistics. The volume of domestic freight road transport in Russia in 2018 amounted to 5 billion 544 million tons. This is 1.8% more than in 2017. The relevant information is provided in the information and statistical bulletin “Transport of Russia. January – December 2018, prepared by the Ministry of Transport of the country.

It is worth noting that the growth index recorded in the motor transport sector turned out to be one of the highest in the industry as a whole. Only pipeline (+ 2.7%) and railway (+ 2.0%) modes of transport showed the best dynamics for the previous year. The overall growth in freight traffic, noted in 2018 in the transport industry, as well as in the auto transport sector, was 1.8%. At the same time, according to the Ministry of Transport, according to the Ministry of Transport, the volume of commercial road freight traffic amounted to 1 billion 630.7 million tons. As compared to 2017, it increased by 1.6%, that is, the growth index was even less than in the motor sector as a whole.

From the data of the relevant ministry it can be concluded that the share of commercial traffic accounted for less than a third (namely, 29.4%) of all domestic road haulage carried out in the country. Accordingly, about 70% of traffic accounted for the transportation of own cargo. Using the automotive industry as an example, process sequences of the overseas supply like transportation, storing or handling are parameterized regarding their respective flexibility range as well as the time- and cost-related implications of their adjustment [2].

The current problem of transportation in supply chains is insufficient research on streaming processes in the territory where this type of business will be implemented. The creation of transport and logistics systems and logistics centers in a certain area requires a different approach to choosing the location of such systems. In an environment of high external and demand structure, the Supply Chains Management requires a change in the configuration (reengineering) of the network structure based on the use of combined modeling techniques [3]. Current and emerging manufacturing and logistics systems are posing new challenges and opportunities for the automation and control community [4]. The basis of this approach should be logging flows into and out of the area that is flowing to this center, as well as factors affecting their provision. This is necessary in the feasibility study of investment projects in the creation and development of transport and logistics systems.

II. METHODS AND MATERIALS

In this case, the conceptual and conceptual framework is used, on which the theory of the placement of logistics centers should be built, coordinating the interaction of participants in transport and logistics systems.

The practical tasks of locating logistics centers stimulated theoretical searches. However, in reality, the creation of logistics centers without sufficient theoretical and methodological substantiations is observed, as a result of which there remain many territories that are not covered by logistics services. Often, alternatives to organizing logistics centers in certain areas are not considered, the multiplicative effect of logistics centers placement is not taken into account, the reverse effect of concentration of logistics services on the volumes and placement of industrial and other types of consumer products is not calculated.

Undoubtedly, logistics centers serve, depending on their location, as important subsystems of regional economic systems. Therefore, when studying them, one should take into account the entire set of elements, which may include any industry, activity, enterprise or institution that plays its part in the development of a given territory. Each logistics center can serve a small area within its own country, have a regional or national significance, and participate in domestic and foreign trade. It depends largely on the validity of the location of logistics centers in the economic and geographical space and their participation in modern global economic processes.

The main task of the theory of location is as follows: to determine the leading factors of the placement of logistics centers and to establish the patterns by which these factors act. Within the framework of one article it is not possible, due to the limited scope, to fully disclose these factors and to give an exhaustive picture of their action on the decision on placement. Therefore, we confine ourselves in this case to some aspects of the theory of location and consider it in relation to logistics centers.

According to the methodological position of A. Weber (he introduced a new concept of "standard port", which described not the real, but the proposed optimal placement of production), placement factors are the economic benefit of placing production in a given place. This benefit is the result of a reduction in the relative costs of the production of this product, its sales and the availability of fixed assets. It is obvious that the patterns of placement of logistics centers can be based only on factors common to all regions without exception.

Special factors are associated with the peculiarities of the technology of logistics processes of individual logistics centers specializing in certain types of logistics services. All factors - general and special - should be divided into regional, determining the location of logistics centers in certain places, and agglomeration, contributing to the concentration of logistics services in some of these places.

To build a general theory of accommodation, according to Weber, it is necessary and sufficient knowledge of only general factors of a regional nature. We will study some of the issues of justifying the location of logistics centers using the theory of A. Weber and regional factors.

The dominance of road haulage in freight transport is an important issue of public comment [5]. The materials for empirical analysis used common regional factors of location, in particular, the costs of raw materials and fuel, labor and transport. Transport costs, as one of the most important factors affecting the provision of logistic flows, are determined, in turn, by only two factors: the weight of the transported goods and the distance of transportation. All other factors boil down to these two. For example, a change in tariff rates, depending on certain reasons, is reduced either to a change in the weight of the goods transported or to a change in the distance of transportation. When calculating transport costs, the costs of transporting materials to the production sites and then finished products to the places of consumption are taken into account.

In order to find the best in terms of transport costs, «standard» (location of the logistics center), consider the ratio of costs for localized materials mediated by the logistics center and for finished products sent to the consumption site (inside or outside the region).

The ratio of the weight of localized materials to the weight of the product is called the material index. The total weight of goods transported from the «material warehouses» to the place of production and from this place to the places of consumption of goods is called «standard weight».

If, for example, for the production of 100 tons of a product, 300 tons of one localized material and 200 tons of another localized material are required, then the material index of this production (industry) will be (300 + 200): 100 = 5. Based on the same values, the standard weight in general will be equal to 600, and per unit of production = 6. Taking these indicators into account, the search for a «stand» developed by A. Weber in the framework of a standardized figure (triangle, hexagon, etc.) is carried out. These techniques are presented in the liter-

ature on regional studies and socio-economic geography and their main provisions can be used when deciding on the location of a logistics center.

When studying the potential locations of logistics centers in a particular area, different approaches are used, depending on the goals of the organizational structure being created. So, a multi-level approach can be used to justify the location of the center: the choice of region (macro level), location within the region (medium level) and the specific location of the logistics center in a given territory (micro level). This approach is based on the study of factors affecting the efficiency of the center, as well as on the requirements for the region, the territory of deployment.

Let us dwell on some of the features of this approach. First, a qualitative selection should be made of the indicators needed to assess the territory (for example, the area of the territory, the number of people employed, including by industry, the volume of production, the density of the transport network per unit of territory, the volume of traffic and others). Then, based on the values of the selected natural indicators (criteria) and expert assessment, the generalized ranks of the regions (ranking process) are determined according to the selected criteria.

For the application of the system of assessing regions by ranks, compiled calculation programs on a computer can be used when making decisions at the average level and at the micro level. The program also makes it possible to determine the coefficients for agreeing the opinions of experts. The more the assessment of the matching coefficients approaches 100%, the more objective will be the decision made regarding the location of the logistics center.

When choosing criteria for assessing the location of the center at the middle level, it is necessary, on the one hand, to investigate the existing transport infrastructure for each type of transport in the region and in the specific territory where the logistics center is supposed to be located (for example, in large cities with which the logistics center can interact). On the other hand, potential clients should be included in the analysis (the most important industrial, commercial and other business structures), which will establish business relations with the logistics center and which should be taken into account when justifying its location.

Multi-criteria assessment of the location of the logistics center requires adequate information, the formation of which necessitates a specific data collection system. Taking this into account, we note that the creation of a logistics center is advisable only in the case when the expected volumes of cargo processing ensure its profitable activity and the corresponding capacity utilization. Also should be taken into account the predicted values of the volume of freight traffic of the studied areas and factors affecting the involvement of large entrepreneurs in the circle of users of logistics services, their needs for logistics services in the future.

For the collection of data needed by experts in the process of ranking and selecting the region where the logistics center is located, it is necessary to develop forms that are filled in with transport or other business structures operating in a given space, as well as with existing centers providing logistic services of a certain type. Data on the wishes of potential consumers of the services of the logistics center being created (what services, when, in what way, the volume of services) can be entered into this form.

In the process of deciding on the location of the logistics center at the micro level (the choice of location in the studied area of placement), the following basic data should be summarized according to the chosen evaluation criteria:

- Main technical, economic and financial indicators of the enterprises available in the territory under study;

- Indicators characterizing transport communications in the territory, for each type of transport;

- Level of equipment of the territory by means of mining and machinery;

- Provision of equipment for warehousing and other logistic operations in the territory;

- Available in the territory under study infrastructural objects.

For the collection and processing of these and other data necessary for expert evaluation, it makes sense to draw up tables for clarity.

Creating a logistics center is one of the possibilities to meet the requirements of a modern market economy in logistics services through a timely, short-cycle disposition, fulfillment of specified volumes of production, supply and marketing according to the «just in time» principle. In addition, the formation of logistics centers can help to manage cargo flows, as well as improve the situation on the Russian business market. At the same time, one of the issues is loss in effect of the risk factor of non-execution of agreements which is especially, topical for production and supply of the high-priced finished products in the necessary quantity and in time [6].

Thus, the study of the creation of a logistics center in certain regions, along with the collection and analysis of data on transport infrastructure and freight traffic, requires the development of such methods for preparing and making decisions on the placement of logistics centers that make it possible to more accurately justify their location based on complex surveys with numerous parameters necessary to select a region, determine a location in a selected area, distinguish between in the region of logistics services.

A paradigm shift, e.g., novel organizing principles and methods, is needed for supporting the interoperability of dynamic alliances of agile and networked systems. Several solution proposals argue that the future of manufacturing and logistics lies in network-like, dynamic, open and reconfigurable systems of cooperative autonomous entities [7].

The information used to implement the method proposed in this article, based on a three-tier support for choosing the location of the logistics center, also helps in the development of planned strategic decisions about future centers and the performance of logistic functions.

Modern information technologies as a tool to support logistics processes make it possible to use the potential of logistics in regional and international markets. However, the realization of this potential is impossible without the formation of communication networks, which integrate logistics centers and entrepreneurs of various sectors of the economy as consumers of the services created by the logistical organizational structures that operate on the principles of commercial calculation.

III. RESULTS

The end of the XX - the beginning of the XXI centuries was marked by the formation of logistic centers in various countries and regions, whose value goes beyond the national borders. There were processes of concentration in them of logistic functions, volumes of logistic services. The international (global) logistics centers are created.

A new network quality is a product-oriented production network. Production networks of this type are characterized by the fact that network participants jointly resolve issues relating to the idea of a product, its development, manufacture and supply. To do this, combine their competencies and production capabilities. The production network integrates the core competencies of the network partners into synergistic cooperation. Objective conditions of transport infrastructure should be taken into account, as a basis for wider and effective cooperation [8]. The incentive for the network is the «burning» market needs for a new product. Such a regional production network is created for a certain time and changes according to customer needs. This causes new requirements for a dynamic production system and its structure.

In the formation of flexible network structures, simple technical system solutions should be made that ensure optimal costs and quality, and a high level of integration. They differ from previously used automated flexible production systems in that they combine strong, well-equipped, autonomous production structures that correspond to the purpose of the network. Not only the concept of «flexibility», but also the competence of the solution for autonomous structures should be redefined for the conditions of the network.

Of particular relevance in determining an integrated network focused on the product and the process, acquire the conditions for the formation of a network union of work structuring taking into account the new business space, and other responsibilities and professional competence. The inclusion of tasks related to the implementation of work planning, quality assurance, production management, material supply, transportation, and recycling repair functions in the process of creating a networked production structure becomes crucial. The new use of machinery and equipment within the network influences the functions of individual production structures (entrepreneurs) and the cooperative network as a whole. This applies to such functions as the conclusion and execution of contracts, management of network structures, the integration of logistic material flows.

Thus, in the period of development and restructuring of entrepreneurship, qualitatively new structures capable of effective interaction with the market should be created, ensuring the introduction of innovative ideas into the logistics of interacting entrepreneurs.

- expanding the possibilities of applying a system-theoretical approach to raising and solving scientific and economic issues both at the national and at the international (international) level;

- strong changes in the intensity and situation in competition in many industries and between different entrepreneurs, as well as within the framework of an integrated European Union;

- Increasing global trend of saturation of the most important markets, this results in the emergence of buyers' markets;

- Significantly reducing the product life cycle and, accordingly, the product development time;

- Intensification of the development of measures to use the potential of rationalization and cost reduction in the production and management processes;

- Possibility of continuous improvement (improvement) of computer-based information planning and communication systems.

For the interference-free flow optimization process in logistically interconnected enterprises, it is important to change the application of logistic principles in terms of both supply systems and the number and structure of sub-suppliers. At various levels of observation, the following trends occur.

The efforts to reduce the depth of processing and the procurement of parts first lead to an increase in sub-suppliers. This development further leads to a transition from multi-source support to single supply with supply of certain parts synchronous with production, and it adheres to the principle of «just in time». Under the depth of processing understand the creation of enterprise value, distributed to the total value of the product.

Technical and economic problems and legal restrictions arising in the formation of a single transport space (common transport space) affect the amount of transport work and quality indicators of the transport process, the competitiveness of companies participating in the distribution process among the participants of transport corridors [9].

As part of the international business strategy for cost reduction, reducing the depth of processing instead of or as an addition to a single supply is a global European or international supply policy.

Increasing transaction costs with a very large number of sub-suppliers, as well as logistical organizational problems when using the «just in time» principle, lead to the fact that global support is complemented by modular software. This principle means that the demand for products (results of sub-suppliers) extends to a greater degree not to individual components, but to all previously assembled groups (modules) that are offered by system suppliers.

The modules for installation can be made by employees of the sub-supplier of the entrepreneurs of customers. This reduces the number of direct sub-suppliers with modular provisioning. However, in this case, the entrepreneurs offering the delivery of modules depend, in turn, on a large number of sub-suppliers of individual components. Educated employee (15.61%) is the most important indicator for the competitiveness of logistics companies [10].

The result of the study is the rationalization of transportation technology in the transport and logistics system. Transport and logistics systems are an expression of the highest level of cooperation between the participants in the distribution, close interaction of transport carriers with each other and with transport customers. Transport and logistics systems are transformed into logistics transport chains. The concept of the logistic transport chain (LTC) reflects the new approach to the transportation of customers. The through transport chain improves the quality of transport services due to the coordination of transport and the production process in enterprises.

When organizing business relations, participants in the logistics transport chain are called upon to proceed from the fact that the shipment must undergo as few trans-shipments as possible. If this is not possible, then handling should be rationalized, for example, by mechanization. The need to comply with this requirement is due to the fact that in some cases, forwarding or transport companies artificially overestimate the volume of transshipments, since each of them is associated with the formation of value added and brings profit. One of the significant aspects of most supply chains is the organization of operational logistic activities, in particular transportation [11].

To the greatest degree of compliance with this requirement corresponds to the logistics transport chain, which is formed during container transportation. However, for other types of transport problems arise due to the specifics of the goods. For trucks, the task is to ensure that the links of this chain (as participants in the process of changing the location of cargo) are located in the most rational way. This means the achievement of optimal coordination of railway technology (with the presence of this link in the transport chain) and schedules of routes for freight vehicles. The purpose of such coordination is the daily readiness to ensure the movement of goods from shippers and consignees and minimum empty runs (for example, without containers). Achieving this goal is achieved by increasing the turnover of containers (in some cases it can be 95%).

Bulk cargo transportation requires a different logistic transport chain. Its formation is based on the same principles as in container transportation; however, the technology here is much more complicated. This is due to the large number of types of cargo, shipping quantities, transportation distances, that is, the various elements of the cargo flow (material flow). The task of rationalization here may be the concentration of cargo traffic, but at the same time there is an increasing concentration of intermediate storage time and, accordingly, an increase in the total shipment transportation time. The concentration of cargo traffic elements leads to a rationalization effect for transport industries.

If the time to ensure a single shipment in the transport process is high enough, then a noticeable improvement can be achieved in the initial links of the cooperative chain, when the transition from combined bulk transport to transporting them by road takes place. This results from saving time as a result of the elimination of overloads and intermediate storage. We present the corresponding scheme (Fig. 1), while allowing for the simplification that the freight cars on the railway are intended for the transport of bulk cargoes.

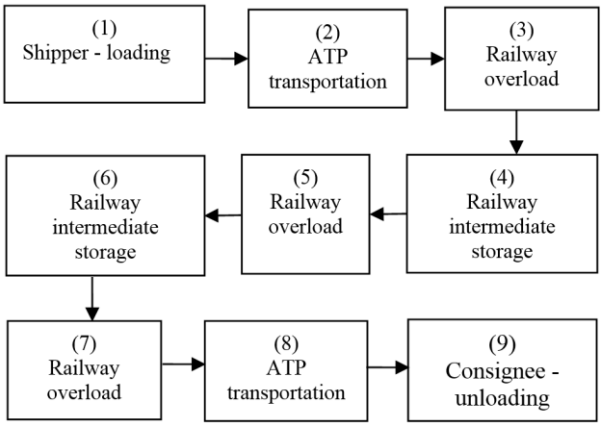

Fig 1. Logistic transport chain diagram for combined bulk transportation

Intermediate storage in Figure 1 is characterized by a concentrated element of cargo traffic. When transporting bulk goods by road, direct transport is used. Therefore, in the LTC scheme (Fig. 2), instead of the railway, there would be ATP-1, ATP-2, and there were no links related to logistics activities 3 and 4 or activities 6 and 7. A prerequisite for such transfers is a significant load that ensures optimal vehicle load. In favorable, but not common cases, it is possible to carry out transportation in a single-stage process, for example, when it is necessary to deliver several shipments of piece goods from one sender to one recipient. Then, in the LTC scheme (Fig. 2), there would be no activities of 3, 4, 5, 6, 7, and the carriage of goods by the auto enterprise received signs of delivery. In this case, minimizing the time costs for customers is the most important criterion for improving the quality of service and can be viewed as the effect of streamlining transportation technology.

Combined transport is of great importance for transport-oriented customer service. Consider the process of formation and operation of LTC on the example of cement transportation

for housing construction organizations. At the same time, possible options for transportation by direct transport from the cement plant and transport for «cement elevators» (let's call them «buffer capacity»), belonging to organizations providing construction materials with the participation of the railway. The diagram (Fig. 2) shows the formation of this technologically complex logistics transport chain, including «cement elevators».

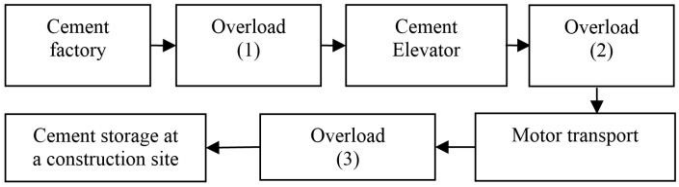

Fig 2. Scheme of the formation of the logistic transport chain in the delivery of cement with three overloads

Reducing the number of overloads is possible if we use specialized railway vehicles - cement trucks in the process of cement delivery. The formation of the logistic chain in this case occurs as follows (Fig. 3).

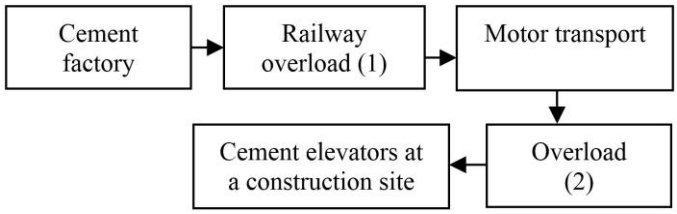

Fig 3. Scheme of the formation of the logistics transport chain for the transport of cement with two overloads

The Figure 3 shows that, in contrast to the logistic transport chain shown in Figure 2, there is a direct overload from the railways to vehicles. Comparing the schemes, it can be argued that in the case of direct transport the logistics transport chain is shortened by two links.

The formation of a rational logistic transport chain requires the creation of the necessary technical, technological and organizational prerequisites, for example, the use of specialized vehicles, tanks, mechanized devices for concentrating overloads, determining the optimal values of technical and operational indicators.

IV. CONCLUSION

1. Logistic transport chains are formed for certain types of goods based on a study of the processes of joint activities of transport enterprises and enterprises of other sectors of the economy participating in such chains.

2. The main criteria for the development of LTC are the reduction of total costs, the release of labor and the improvement of labor in the overall logistics process of transportation, handling and storage.

3. The use of LTC requires solving a number of technical problems. One of the technical problems associated with measuring the degree of filling cement truck. To solve this problem, various devices can be used, for example, acoustic signals in the driver's cabin. Another problem is the organization of overloads, especially for the variant with direct overload on vehicles with the continuous stay of cement trucks. The solution to this problem requires the coordination of the necessary carrying capacity of road transport enterprises and transshipment points so that the contractual volume of goods corresponds to the production rates of cement trucks.

For example, to ensure compliance with the standard idle time for loading cement with the continuous supply of cement trucks, «buffer capacity» is required, which take cement at those fixed times when road transport cannot transport. «Cement elevators» serve as cargo storage, used when the flow of cement trucks increases and exceeds the capacity of a given ATP (in this case, cement trucks of other auto enterprises are used). «Buffer capacities» can be determined taking into account such indicators as the degree of continuity of supply of cement trucks; the probability of exceeding the rate of release of cars (compared to the contract); the likelihood that the range of cement produced is not immediately required by the construction site volume of transportation in tons for a certain period.

The estimate of the buffer capacity calculated in this way shows how much cement should be overloaded through the «cement elevator». Based on this, it is easy to determine the necessary «buffer capacity» of cement elevators for individual loading points and taking into account the indicators that are different for them (for example, overload time or frequency of overloads).

4. The economic effect during the formation of LTC is due to a significant reduction in the capacity of cement elevators in warehousing, production or storage, reducing losses during reloading, reducing vehicle downtime as a result of coordinating the ATP work schedule and customers, as well as simplifying commercial clearance. And, finally, the organization of such logistics transport chains contributes to an increase in labor productivity in road transport and in the clientele.

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