Logistics centres in the region: the Russian Far East

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Abstract. The area of the Russian Far East is 6.9 million square kilometers. This is the largest region in the country. All types of transport are operating in the Far East. Some sections of the state border between Russia and Asian countries pass through the region. In particular, the length of the border with China exceeds 4000 km. The transport complex of the region is involved in servicing transportation in the following directions: across the Far East, between the east and west of Russia, as well as transit, export, and import traffic. The creation of a system of logistics centers in the Far East will make it possible to more effectively organize the entire process of transporting various goods. This article contains proposals on the organization of a system of logistics centers in the Far East. The following indicators (official statistics) for 2013-2018 were used for calculations: volume of freight traffic by mode of transport, the density of the transport network, volume of production, population, gross regional product. The estimates using econometric methods made it possible to single out twelve locations for organizing the logistics centers in the Far East. The logistic system will include logistics centers of three levels: federal, regional and territorial. The levels are divided depending on the scale and significance of the transport and logistics work.

1. Introduction

The study of transport at the present stage includes an analysis of the logistics system of the Territory. Not only the level and quality of transport infrastructure (roads, railways, seaport terminals, airports, etc.), but also the availability of associated logistics facilities, is important for an efficient transport process. Good logistics services reduce trade costs. The efficiency of building a logistics system is evident in how supply chains link firms to domestic and international markets.

The process of changing the logistics systems of various countries is the subject of monitoring. Every two years, the World Bank has published the Logistics Performance Index (LPI) since 2007. The LPI analyzes countries through six indicators:

1. The efficiency of customs and border management clearance.
2. The quality of trade- and transport-related infrastructure.
3. The ease of arranging competitively priced international shipments.
4. The competence and quality of logistics services.
5. The ability to track and trace consignments.
6. The frequency with which shipments reach consignees within the scheduled or expected delivery time.

At the end of 2018, Russia ranked 85th in the LPI rating (2.68 points) out of 167 countries represented [1]. Estimates for individual sectors were: customs – 131st place, infrastructure – 73,
international shipments – 105, logistics quality and competence – 73, tracking and tracing – 88, timeliness – 74. In 2010, Russia ranked 94th in the LPI (2.61 points). Estimates for individual sectors were: customs – 115th place, infrastructure – 83rd place, international shipments – 96, logistics quality and competence – 88, tracking and tracing - 97, timeliness – 88 [2]. Thus, during the period 2010-2018, in Russia, the quality of customs, international transport, tracking, and logistics services has decreased according to experts.

Also, transport and logistics are considered as one of the components of the indicator of the competitiveness of the national economy. The World Economic Forum evaluates the competitiveness level of 137 countries by the Global Competitiveness Index (GCI) annually. According to the results of 2019, Russia was in 43rd place out of 141 countries under review. In the “infrastructure” block, Russia occupied the 50th place. Estimates for the blocks of logistics services: the efficiency of air transport services – 52, liner shipping connectivity – 43, the efficiency of seaport services – 47, efficiency of train services – 17 [3]. In 2010, Russia occupied the 47th place out of 139 countries under the “infrastructure” block [4].

The presented indices (LPI and GCI) provide an opportunity to compare the level of development of logistics in different countries. An analysis of the methodology for calculating indices, as well as the possibilities of their application, is given in some scientific publications. So, O. Kabak, S.O. Ekici and F. Ulengin [5] study relations between logistics performance and the competitiveness of a country using statistical methods based on LPI and GCI. The authors use Bayesian Networks and Partial Least Square to highlight the competitiveness pillars that are more critical in contributing to countries’ logistics performance.

In another study, S.O. Ekici, O. Kabak, F. Ulengin [6] develop a roadmap for different countries’ governments, to assist in the development of strategies for constructive actions towards improving the logistics performance of their countries. Using LPI and GCI, researchers showed that countries should increase awareness regarding digitalization and supply chain analytics to differentiate their logistics performance from that of other countries.

In their work, R. Beysenbaev, Y. Dus suggest supplementing the methodology for calculating LPI with estimates based on official statistics [7]. According to the authors, this will increase the informative nature of the index and allow it to be used as a tool for developing managerial decisions in the field of logistics.

Despite the widespread use of the logistic approach, at present, there is no single universally accepted definition of logistics. Moreover, it is recognized that logistics itself is developing, its content is changing. So, in the literature there are four main stages in the development of logistics [8]:

- Logistics operations are fragmentary, logistics sections are not integrated, neither are they based on a single concept. Logistics included purchase and supply, storage, distribution (until the 1950s).

- Integrated logistics systems included physical distribution and materials management (1950-1970).

- IT solutions are used like automatic identification, Just in Time system, Material Resource Planning system and so on (1980-1990).

- Logistics goes beyond individual companies. The logistics develop basing on information systems, local area networks, wide area networks, Internet and Intranet (from 1990 to the present).

In scientific publications, there are various interpretations of the term "logistics". Thus, in the work of World Bank specialists, logistics is understood to be "a network of services that support the physical movement of goods, trade across borders, and commerce within borders" [9]. In our work, we will understand logistics as Logistics is the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from the point of departure to the point of consumption to meet customer requirements.

In our work, we mean by the logistics center nodal points of modal logistics network. Depending on the time of formation, classification, purpose and strategy "nodal points" would be called: storage center; logistic services center; distribution center; logistics park; logistics hub and so on [10, 11]. A logistics center is the hub of a specific area where all the activities (transport, logistics, and goods
distribution) are carried out by various operators. The logistics center provides transportation, reception, storage, distribution and distribution of goods, as well as related services.

The location of the logistics centers is their important feature. Logistics centers are most efficiently located:

• Outside the city territory, for example, in the suburban areas of large cities, transport hubs.
• Near major transport routes or within international transport corridors.

The following specializations of logistics centers are distinguished: universal, transport, warehouse, distribution, transport and distribution, with customs clearance and complex [12].

A lot of work is devoted to the problems of logistics and the development of logistics networks in the scientific literature. There are studies of the evolution of theoretical concepts of logistics with the identification of stages of its development, classifications of the functions performed, consider the relationship between logistics and the economic development of the territory.

In their article L. Gafurov, M. Panasyuk and E. Pudovik [13] explores the relationship of changes in the organization of transport environment of region and increase of efficiency of its economy by increasing budget revenues as a result of the performance of large-scale logistics center and constructing on this basis new service industries are investigated.

An analysis of the logistics systems of various countries is presented in J.H. Havenga, I.E. Witthöft and Z.P. Simpson [14], J.C. Perez-Mesa, E. Galdeano-Gómez, J.A.S. Andujar [15], Y. Gao, D. Chang, T. Fang, T. Luo [16], et al. The authors study the features of building national logistics systems, consider various options for the formation of their configuration, and evaluate the economic effects of functioning. Topical issues of logistics at the present stage are considered. For example, C. Altuntas and O. Tuna [17] explore the challenges of "green logistics" based on environmentally friendly transportation and storage technologies.

Some works are aimed at finding optimal locations for logistics centers in the territory. In this case, the authors use various methods and models for searching for an effective point of location of the center. Some authors use the two-stage procedure resulting in the selection of the most desirable location of the logistics centers based on the findings of logisticians by applying a hybrid of the fuzzy method [18] and the technique for order of preference by similarity to an ideal solution [19, 20] and other methods [21].

Logistics is an important part of effective market transactions. Currently, the development of logistics in the regions of Russia is at a different level. In the western and central regions, the transport and logistics system is quite good. In the eastern regions of the country, the transport and logistics system is poorly developed. Features of the Far East, affecting the development of transport and logistics functions:

• Significant area (6.95 million km square, 40.6% of the territory of Russia).
• Low density of transport networks (road and rail).
• Low population density.
• Localization of economic activity.
• Regional transport system acting as an intermediate link for transport to Northeast Asia countries.
• The border location of the region.

Effective organization of transport processes and the creation of logistics centers network is an urgent issue for the Far East. The purpose of this study is to determine the effective location of the transport and logistics centers in the Russian Far East.

The object of research is the transport and logistics complex of the Russian Far East. The Far East is considered within the borders of the Far Eastern Federal District as of the beginning of 2020. The district includes 11 subjects of the federation: the Republic of Buryatia, the Republic of Sakha (Yakutia), Trans-Baikal Territory, Kamchatka Territory, Primorsky Territory, Khabarovsk Territory, Amur Region, Magadan Region, Sakhalin Region, Jewish Autonomous Region, and Chukotka Autonomous Region. In 2018, the composition of the Far Eastern Federal District was changed; the Trans-Baikal Territory and the Republic of Buryatia were added to the Far East.
2. Materials and Methods

In Russia, large logistics centers are concentrated in the central regions of the country. There are practically no logistics centers in the east of the country. This has led to imbalances in the distribution of logistics infrastructure.

World experience shows that the economic feasibility of locating logistics centers determines proximity to transport and production centers. The most important factors include the location of the logistics centers near large industrial objects of a national/regional level, main national transportation routes, international transport corridors, shipping lanes, and major seaports.

All modes of transport operate in the Far East of Russia. Intra-regional, intra-Russian, international (including transit, export, import) transportations are carried out. The Far East is a near-border region. There are sections of the state border of the Russian Federation with China (land border and river sections), North Korea (river border), Japan (sea border), and the USA (sea border). The border position of the Far East and the significant scale of freight traffic (transit, export, import) determine the relevance of creating an effective network of logistics centers in the region.

The formation of transport and logistics networks and centers in the eastern regions of Russia was considered in the works of Russian and foreign scientists. In the work of Z. Lihua [22], the logistics networks that have developed between Russia and China are examined, the main problems of logistics are highlighted: a low level of management, a lack of infrastructure, an imbalance in cargo flows, and so on. In the study of V.M. Samuilova, K.D. Serova and T.A. Kargapol'tseva [23] analyzed the logistics potential of the Northern Sea Route and the prospects for increasing the efficiency of its use.

The general logic of the study:

1. The formation of an array of statistical data on the volume of cargo flows in the municipalities of the Far Eastern Federal District. The data of all existing modes of transport are used: automobile, railway, and water.

2. Determining the number of transport and logistics centers for the Far East. The calculation is based on the concentration index (Herfindahl-Hirschman).

   \[ HHI = S_i^2 + S_2^2 + \ldots + S_n^2 \]  

   where \( S_i \) – is the share of freight traffic of the corresponding municipality, \( n \) – is the number of municipalities in the sample.

   Initially, the number of logistics centers is taken approximately equal to the number, mutually inverse of the calculated index. In our case, it is proposed to place 12 logistics centers in the region. Further, the choice of the number of created logistics centers will be confirmed by calculations.

3. The specific locations of the logistics centers are determined. To do this, a ranking of the allocated municipalities by the specific gravity of the cargo flow is carried out. The concentration of cargo flows in each municipality is determined.

   The study uses official statistics (from Rosstat). The initial data set includes indicators in the context of 224 municipalities (lower-level territorial units) of all administrative subjects of the Russian Federation on the territory of the Far East Federal District. The data for the period 2013-2018 were used.

   The data set includes indicators for each municipality (taking into account the characteristics of the territory) such as volume of road transport, volume of rail transport, volume of inland water transport, road density, and rail network density, number of seaports, number of river ports, population, and gross output. For cities (also related to municipalities) data on industrial production and trade turnover are included.

3. Results

In the first stage, municipalities (224) were ranked by the volume of freight traffic.

In the second stage, an adjustment was made taking into account the density of the road network. For adjustment, a correction factor was adopted taking into account the correlation between the volume of traffic and the density of the automobile and railway networks from 0.9 to 1.1 in increments.
of 0.02. Of the 224 municipalities, 40 municipalities with the highest rating were accepted for further calculations.

In the third stage, to correlate the localization of logistics centers, correlation and regression analysis is used. Regression analysis revealed the most significant factors for the placement of logistics centers. The main criterion for creating a logistics center in a particular territory is the demand for cargo handling. Demand depends on the volume of industrial production, retail and wholesale trade, transit traffic.

As a result of the analysis, it was revealed that the largest correlation coefficient was accounted for by the volume of shipped goods of own production, performed works and services on their own (0.61), retail turnover (0.55), and population (0.59). Investments in fixed assets, the volume of exports and imports were less significant and were excluded from the further calculation. As a fictitious variable, the analysis considered the presence of a functioning cargo (cargo-passenger) checkpoint across the state border of the Russian Federation, however, this factor turned out to be statistically insignificant.

The equations of paired regressions are checked in order to assess the influence of each factor. The use of these factors in a multiple regression model creates the effect of multicollinearity. The resulting regression models are statistically significant. The obtained estimates of the coefficients and statistics of their significance are given in Table 1.

| Regression equation | R   | R²  | F-test | t-statistic |
|---------------------|-----|-----|--------|-------------|
| y = 1275.4 + 7.61x₁ | 0.58| 0.34| 13.6   | 3.9         |
| y = 1570 + 56.7x₂  | 0.55| 0.30| 11.7   | 3.4         |
| y = 1389.2 + 76.3x₃ | 0.61| 0.38| 16.25  | 4.0         |

The following notations are in Table 1:
y – the freight traffic volume,
x₁ – population,
x₂ – the trade turnover,
x₃ – the volume of goods production.

At the fourth stage, an integrated indicator of the municipality's attractiveness for the location of the transport and logistics center was calculated. The indicator was defined as the weighted average of individual factors for each municipality. The calculation of individual factors for a municipality is carried out as the ratio of the actual value of the factor and the maximum value of this factor for the entire aggregate of municipalities.

\[ t_{ij} = \frac{x_{ij}}{x_{\text{max}}} \]  \hspace{1cm} (2)

where \( t_{ij} \) – individual indicator for the j-th region by the i-th factor,
\( x_{ij} \) – the actual value of the i-th factor for the j-th municipality;
\( x_{\text{max}} \) – the largest value of the i-th factor in the entire set of municipalities.

At the fifth stage, the calculated integrated indicators for municipalities were adjusted taking into account weighting coefficients. Weighting coefficients are determined based on the determination coefficients of the corresponding paired regression equation.

A higher value of the calculated integrated indicator shows more favorable conditions for the placement of a logistics center in this municipality. The values of the twelve best-integrated indicators of municipalities are presented in Table 2.
Table 2. Integrated indicators of the attractiveness of municipalities to create logistics centers.

| Municipality          | The constituent entities of the Russian Federation | Integrated indicator value |
|-----------------------|---------------------------------------------------|-----------------------------|
| Vladivostok           | Primorye Territory                                | 0.179                       |
| Khabarovsk            | Khabarovsk Territory                              | 0.166                       |
| Komsomolsk-on-Amur    | Khabarovsk Territory                              | 0.160                       |
| Ulan-Ude              | Republic of Buryatia                              | 0.064                       |
| Blagoveshchensk       | Amur Region                                       | 0.063                       |
| Yakutsk               | Republic of Sakha (Yakutia)                       | 0.062                       |
| Chita                 | Trans-Baikal Territory                            | 0.049                       |
| Yuzhno-Sakhalinsk     | Sakhalin Region                                   | 0.041                       |
| Ussuriysk             | Primorye Territory                                | 0.037                       |
| Nahodka               | Primorye Territory                                | 0.027                       |
| Artyom                | Primorye Territory                                | 0.018                       |
| Svobodniy             | Amur Region                                       | 0.013                       |

The number of logistics centers proposed for creation (12) corresponds to the initially determined number of transport and logistics centers (see the second stage of the methodology). The adequacy of the choice of the total number of logistics centers in the Far East is confirmed by the estimates obtained.

The total value of integrated indices for the municipalities presented in Table 2 is 0.879, i.e. they account for about 90% of the volume of transport processes in the region. This verifies the importance of creating logistics centers at these points and confirms the optimality of their initially determined number.

4. Discussion

The Russian Far East is a border region. The transportation from Siberia and the central regions of Russia to Asian countries (the PRC, the Republic of Korea, and Japan) is carried out through its territory. Also, the regional transport complex is involved in servicing export and import cargo flows [24]. Under these conditions, the creation of a system of logistics centers in the Far East will allow the more efficient organization of the transportation process.

The calculation method used in this work does not take into account transit freight flows. However, further transit flows may be included in the analysis. In this case, the list of potential locations for logistics centers in the Far East will change. Transport hubs focused on servicing international (export-import) traffic may be considered. Of the considered municipalities, an important hub for servicing transit and export-import flows is Zabaykalsk (Trans-Baikal Territory). In this node, the processed internal freight flows are insignificant, which is explained by the small population and low level of economic development of the territory. At the same time, the volume of processed export-import cargo is significant, which shows the importance of creating a logistics center focused on international freight flows.

Birobidzhan municipality (Jewish Autonomous Region) also possesses the potential for locating logistics centers for servicing international cargoes (the cargo flow of the Jewish Autonomous Region is accumulated here, as well as cargoes passing through the state border checkpoints in the PRC), Nikolaevsk-on-Amur (Khabarovsk Territory; river-sea export-import transportation services), Vanino
(Khabarovsk Territory; service of export-import shipping). Transport hubs of these municipalities have the prospect of future growth in served freight traffic. Orientation to servicing export flows increases the dependence of the development of transport hubs on the external markets of NEA countries. Therefore, at present, there is a high degree of uncertainty in the development of these points for the creation of logistics centers.

5. Conclusions

According to the results of the study, places for the accommodation of transport and logistics centers in the territory of the Far East of Russia have been determined.

Logistic centers being created in the region will differ in the scale and significance of transport and logistics work. In this regard, they can be divided into three levels: 1) centers of the federal level will be located in the cities of Vladivostok and Khabarovsk; 2) regional centers will be located in the cities of Yakutsk, Komsomolsk-on-Amur, Ussuriysk, Nakhodka, Yuzhno-Sakhalinsk, Ulan-Ude, Chita, Blagoveshchensk; 3) the territorial logistics centers are effectively located in the cities of Primorsky Krai: Svobodny and Artem.

The cities of Birobidzhan, Magadan, and Nikolaevsk-on-Amur also have the potential to locate logistics centers in the Far East in the event of an increase in the formed or absorbed cargo flow.

The locations of transport and logistics centers determined as a result of the study correspond to the priorities of modern state policy for the development of the Far East. Implementation of projects within the framework of new forms of economic development of the Far East: territories of advanced economic development and the free port of Vladivostok will lead to an increase in freight traffic. This will positively affect the loading of the region’s logistics infrastructure and will add additional positive dynamics to the development of the logistics system.

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