MONITORING OF INFRASTRUCTURE OF TRANSPORT AND LOGISTICS COMPANIES

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ABSTRACT

The quality of services provided by transport organizations depends largely on the state of their logistics infrastructure. High differentiation of companies in the contract logistics market makes it difficult to select a partner, which may lead to a decrease in the level of order service. The subject of the analysis is the logistics infrastructure of transport companies performing logistics services. The objective of the study is to develop indicators for assessing the logistics infrastructure of transport companies as partners of focus companies, e.g. of JSC Russian Railways, in supply chains.

Following this purpose, the article proposes to introduce a process approach to assessing the logistics infrastructure of transport companies, starting by offering an approach to the notion of logistics infrastructure. It is assumed that the use of a suggested multilevel set of criteria for assessing the logistics infrastructure, simultaneously with the results of the logistics activities of partner companies, and monitoring of these data will solve the following tasks: automate the process of collecting and processing data on transport companies as participants in supply chains; reduce the time for analysis and selection of a partner in the supply chain, taking into account its infrastructure characteristics and performance in previous periods; in the future will allow to move to digitalization of the process of organizing the supply chain and increase the segment of high margin transportation, by reducing the delivery time and increasing the quality of logistics services. Study of proposed criteria was conducted at the example of Irkutsk region.

Keywords: logistics system, infrastructure, transport and logistics service, market, transport and logistics company, logistic process.

Background.
Justification of relevance

One of the features of development of the economic system of Russia is uneven development of the market of transport and logistics services. This market (TLS) is a set of subjects and objects of management, managing the material and related information, financial and service flows [1, p. 22]. In the study of TLS market, leading business consulting agencies identify the following segments of the company's activities: freight transportation and freight forwarding (transport services), their storage and processing (warehousing services), management logistics (supply chain management).

Focusing of attention on developments of TLS market is explained by global processes in the global economy: low rates of economic growth and international trade, high levels of competition in global and domestic markets, lower prices in the exchange sphere, sectoral and geographical redistribution of world capital.

The combination of adverse external and internal factors influencing the structure of TLS market, led to fulfillment of the pessimistic scenario of development of TLS market, which did not contribute to full-fledged competitive struggle and an increase in the quality of services. Table 1 shows the market indicators (2012–2017).

Under the influence of these factors, structural changes have occurred in TLS market. If according to a moderate scenario of market development, the share of the management logistics segment was supposed to be 2–3%, then according to the results of 2017, it was only 0,6%. Nevertheless, it should be noted here that the share of transport services in the composition of logistic activities has increased. Thus, the freight turnover of railway transport increased by 1,6%, of road transport – by 0,8%, transportation through pipelines – by 1,8%, by air – by 20,6%, by sea and inland water transport, respectively, by 7,6% and 3,4% [1, p. 27].

The data presented in Table 1 allows us to conclude that the dynamics of construction of high-quality commercial warehouses are declining and reflect a downward trend in investment in construction of warehouse infrastructure, which may be due to the desire of trade, transport and industrial companies to

Table 1

The state of the economy and the market of transport and logistics services in Russia in 2012–2017[1], %

Indicators' name	2012	2013	2014	2015	2016	2017[2]
GDP	103,4	101,3	100,5	95,2	98,0	101,5
Industrial production	102,6	100,4	101,7	90,6	101,1	101,1
Fixed investment	106,8	99,8	97,0	88,0	105,34	104,2
Retail turnover	106,3	103,9	101,9	97,5	94,8	101,2
Export of goods	102,3	99,2	96,7	86,8	83,0	125
Import of goods	105,4	102,1	91,3	76,7	98,63	103,6
Commercial freight turnover	104,4	98,6	102,8	92,6	101,8	106,4
Commercial freight transportation	102,7	98,2	96,4	83,0	107,9	114,6
Area of high-quality commercial warehouses	114,3	111,2	111,7	108,0	101,4	107,3

[1] Compiled according to the information agency RBC [Electronic resource]: http://www.rbc.ru/ for the year 2016.
[2] The calculation was carried out by the author independently on the basis of the press services.

Table 2

Scientific approaches to the definition of «logistics infrastructure»

Authors	Content
Object-functional approach	
Anikin B.A. [3, p. 18].	«The logistics infrastructure is the objects that ensure improvement of management of material and related information and financial flows».
Gadzhinsky A.M. [4, pp. 18–22].	«... the logistics infrastructure is the objects of implementation of the logistics functional areas of the logistics system (procurement, production distribution, transport and information)».
Sergeev V.I. [5, p.170]	«... these are terminal complexes, warehouses, transport communications, objects of transport and logistics services, telecommunications infrastructure».
Process approach	
Lukinsky V.S. [6]	«The logistics infrastructure is a comprehensive engineering and economic system, where, based on the effective use of vehicles and storage equipment, information technology, «the highest possible speed safe delivery of cargo from a consignor to a consignee is provided».
System approach	
Dmitriev A.V. [7]	«The logistics infrastructure is a complex of interrelated elements that ensure functioning of the procurement system, supply, storage and delivery of products to a consumer».
Lipichnik M.I., Lukinyh V. F., Shvalov P. G. [10, p. 13].	«... the logistics infrastructure is a subsystem that ensures functioning of all other subsystems of the region through optimization of logistics flows».
Nosov A.L. [11]	«The logistics infrastructure is a material and technical system designed to ensure production and social life of people».

reduce inventory. Meanwhile, the lack of high-quality commercial space can increase the risks of storage of material stocks.

In terms of researching the infrastructure of the transport and logistics services market entities, there is a problem associated with a variety of assessment methods, including those used at the macroeconomic level. At the same time, using of unified approaches to assess logistics infrastructure of transport companies, based on evaluating the results of their logistics activities, is currently not enough, which is due to fragmentation of TLS market itself. Thus, the participation of transport organizations as counterparties of supply chains, as well as in the system of providing integrated logistics services, should be associated with an assessment of their capabilities and the capacity of their logistics infrastructure.

Objective. *The objective of the author is to consider the system of monitoring of infrastructure of transport and logistics companies and to propose set of criteria there-of.*

Methods. *The author uses general scientific methods, economic analysis, comparative analysis, statistics analysis.*

Results.

Scientific aspects of the concept

The interpretation of the term «logistics infrastructure», according to the conceptual approaches of modern Russian scientists, is shown in Table 2.

Without denying the existing concepts and definitions of the logistics infrastructure, it is proposed to understand under logistics infrastructure the objects of transport, warehouse, information systems, functionally interconnected by the logistics activities of business entities [2, p. 33].

This definition differs from the existing ones in the following ways:

• is unified in terms of the scale of the logistics system (micro, macro and meso levels);

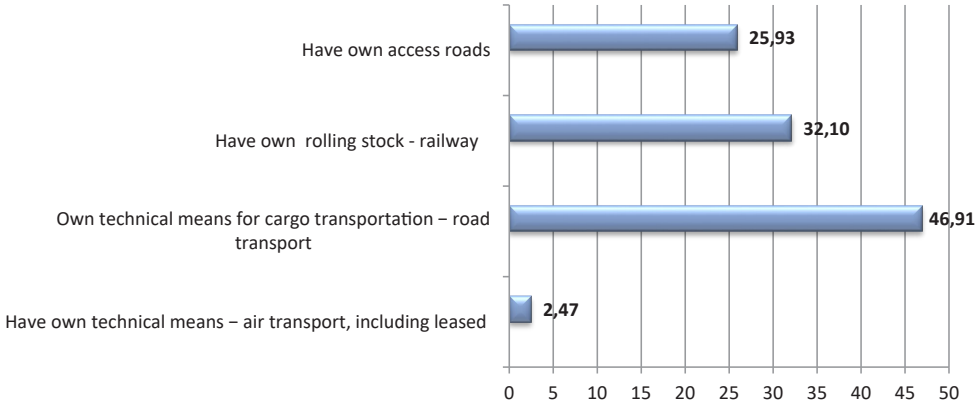
• is adapted for industry and regional logistics systems at the same time, that is, synthesizes their properties;

• reflects such a property of systems as «integrativity» with respect to elements of the infrastructure complex;

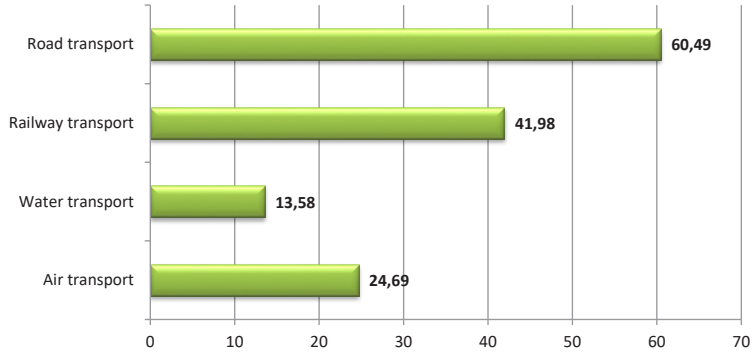
• allows further to offer methods for integrated assessment of the infrastructure of logistics systems of companies in terms of reliability of their work within a supply chain.

Most of the scientific papers presented in Table 2 are devoted to assessing the state of the transport and logistics infrastructure of the regions. However, assessment of the infrastructure of micro logistical systems formed at the level of supply chain partners has received insufficient attention. Meanwhile, development of methods for research and management of the logistics infrastructure of transport, trade and other organizations engaged in transport and storage activities, remains in real demand.

Consumer expectations expressed by shippers, according to the initiatively started researches [1, 2], focus on compliance with such parameters of the logistics service contract as delivery time, security of cargo delivery considering transshipment operations, delivery monitoring in transit, documentary and informational tracking of cargo. The task of improving quality of the above logistics services, set in the framework of the «Transport Strategy for Development of the Russian Federation to 2030», might be difficult if there is absence of necessary vehicles, information technologies and storage equipment for service providers. If in the area of improving the regional logistics infrastructure, responsibility is assumed by public or industry corporations, then at the level of transport and logistics organizations, the decision on the need to improve the logistics infrastructure complex lies with the business entities themselves. Accordingly, large carriers, with which the subjects of TLS market enter into partnership, need a more



Pic. 1. The state of the transport infrastructure of logistics companies of Irkutsk region in 2018, in %.



Pic. 2. Services for transportation of cargo of logistics operators of Irkutsk region in 2018, in %.

correct system for selecting partners in the supply chain, searching for the most competitive and reliable intermediaries.

To solve the problem of choosing a supplier at the focus company level or at the 4PL provider level, it seems effective to create information databases on the state of the transport and warehouse infrastructure of the counterparty partner in the supply chain. Creating an information base that includes the tasks of monitoring the infrastructure of existing and potential counterparties will help to make decisions not only about the need to invest information technologies that support organization of the product distribution process, but also to quickly and correctly select partners in supply chain management.

As objects of monitoring for organizations providing logistics services, it is proposed to allocate the following objects of observation:

1) transport infrastructure – vehicles of all types, transport mechanisms, elements of transport infrastructure (access roads);

2) warehouse infrastructure – warehouses of all types with an indication of their classification group, size, storage conditions for goods, etc.;

3) information infrastructure – telecommunications facilities and equipment, software for logistics processes, equipment, monitoring systems, etc.

The creation of such a database and monitoring system of the infrastructure of the counterparty will make it possible to make reasoned decisions in terms of organizing the supply chain by a focus company, e.g. JSC Russian Railways.

State of logistics infrastructure

In order to develop a passport of the counterparty organization in the period 2015–2017, pilot studies of companies in the market for TLS services of Irkutsk region were carried out, including a review assessment of their logistics infrastructure.

In general, the market of transport and logistics service providers is represented by more than 270 entities, based on the register of transport and transport and logistics companies in the region. For greater reliability of data from the registry, organizations that have been stably performing core activities for more than three years, namely, 81 companies, have been selected. The study of the logistics infrastructure was carried out on the basis of an object-functional approach and reflected the state of its basic elements.

Transport infrastructure refers to its own access roads, which contributes to the most comfortable conditions for loading and unloading operations, the availability of own rolling stock and vehicles, which reduces the search time and the preparatory stage of the cargo transportation transaction. For this reason, the study included an analysis of contracts by type of transport, provision of companies with vehicles and their own access roads.

The diagram in Pic. 1 shows the shares of companies that are able to quickly carry out transshipment and transportation services by various types of transport at the expense of their own or rented funds (in relation to air transport).

Table 3

Evaluation of the use of transport infrastructure of the company based on the analysis of the process of transportation

Indicator's name	Calculation method	Remark
Transit time on the route	$S_{\&}R = K_p/K_a$ (1)	$S_{\&}R$ – coefficient of conformity to the delivery schedule; K_p – the number of cases when the delivery schedule was observed; K_a – the number of cases when the delivery schedule was disrupted.
Index of delivery time	$I_{td} = \sum_{i=1,n} T_{ij1} / \sum_{i=1,n} T_{ij0}$ (2)	$\sum_{i=1,n} T_{ij1}$, $\sum_{i=1,n} T_{ij0}$ – accumulated time for the *i*-th kind of cargo on the *j*-th route during the current and base year, respectively; *td – time delivery* – delivery time.
Transaction cost index	$Itr = \frac{\sum_{i=1,n;\ j=1,m} C_{ij1}}{\sum_{i=1,n;\ j=1,m} C_{ij0}}$ (3)	C_{ij} – the cost of downtime on the *i*-th route of the *j*-th mode of transport in the reporting and base period, respectively; I_{tr} – cost index for idle time on the route.
Cost for transportation of cargo	$Ct_j = \sum_{j=1,m} X_j / n$ (4)	C*t* – transportation costs, arithmetic average value on the *j*-th route for each mode of transport; j – varies from «1» to «n».
Aggregate transportation performance indicator on the route	$E_T = \sum_{i=1,n} Pr_i / \sum_{i=1,n} Ct_i$ (5)	E_T – efficiency of the transportation process; $\sum_{i=1,n} Pr_i$ – the amount of profits from provision of transport services by various types of routes; $\sum_{i=1,n} Ct_i$ – the amount of costs from provision of transport services for various types of routes.

The diagram shows that the share of companies that organize road transportation is more than 46%. Freight transportation by rail is carried out by Russian Railways, and the logistics operator provides rolling stock and related logistics services. The share of such companies is 32,1%. There are only two or 2.47% of companies working on contracts for short- or medium-term lease of air transport.

At the same time, transport and logistics companies declare themselves as being able to execute services using various modes of transport, without being provided with the necessary transport infrastructure, which is proved by the histogram of Pic. 2. 20 companies, e.g., say about the opportunity to work under the contract of air transportation, that is ten times more than are able to do, considering transport vehicles in their possession. 26 companies have own or leased rolling stock, and 38 are claiming a rail carriage service. 38 have their own vehicles, and 46 companies provide road transportation services.

Based on the data from the study of the infrastructure of the subjects of TLS market [2], the following conclusions can be made:

• organization of cargo transportation services in such conditions might be accompanied by violations of the terms of their delivery due to the loss of time associated with the search for technical means of cargo transportation;

• due to the lack of own vehicles, companies are forced to rent them from their partners, which causes an increase in the cost of transport services and affects the final price of inventory items;

• companies are not responsible for the technical state of the leased vehicle, and so the shipper might be subject to unreasonable technical and technological or commercial risk, which significantly affects the quality of services provided.

In the process of researching the warehouse infrastructure of companies, information was collected and analyzed about the structure of warehouses based on attributed rank or class.

Only 48 companies (36%) have their own warehouses, while only 7% of their area is class A warehouse premises (6 units), 20% belong to class B, and 9% belong to class C and D.

The tendency to abandon maintenance of warehouse space is due to the desire of companies to reduce distribution costs, as well as to concentrate managerial impact on movement of material resources. Most of the premises of classes «A» and «B» belong to wholesale and retail companies, which in parallel provide transportation and storage of inventory at the level of the region and urban settlements. Network logistics companies that own warehouses in the cities of Irkutsk region, have an opportunity to place goods in other regions of the country and abroad. Those are totally eight companies of that type of the 81 included in the field of study, or 9,8%.

The study on information infrastructure assumed the study on the presence and dynamics of informatization of logistics processes in companies. Data for 2015–2017 showed:

• there is an annual decline in the share of information technologies being introduced;

• growth rate of investments in technological innovations was only 1,4%, including in logistics;

• the share of companies that have implemented information technology, in the region as a whole, increased by 1%;

• among the information technologies introduced in management of logistic processes, the document circulation prevails, which indicates the desire of companies to reduce transaction costs.

Table 4

Evaluation of the use of the logistics infrastructure of the counterparty based on the results of warehouse processes

Indicator's name	Calculation method	Remark
Coefficient of mechanization (automation, informatization) of warehouse operations	$K_i = I_u/I_p$ (6)	K_i – the level of informatization of warehouse processes (operations); I_u – volume of automatic warehouse operations; I_p – total volume of warehouse operations.
Safety coefficient for warehouse processes	$Ks_i = N_r/N_{lp}$ (7)	Ks(save–storage) – process safety coefficient; N_r – the number of risk situations in the process of implementation of warehouse operations of the i-th kind; N_{lpi} – the total number of warehouse operations of the i-th kind.
Average storage cycle time	$Tw_{av} = \sum T_i/n$ (8)	Tw_{av} – average cycle time of warehouse service; $\sum T_i$ – an aggregated measure of the time of the warehouse operations according to their kinds; n – the number of warehouse operations (processes).
Level of equipment of warehouses with technical means	$K_{tt} = Q_{tt} / Q_{CV}$ (9)	Q_{tt} – volume of material resources loaded using technical equipment; Q_{CV} (CV–cargo value) – total volume of warehouse freight turnover.
Level of equipment of a warehouse with auxiliary tools	$K_{ae} = Q_{ae} / Q_{CV}$ (10)	Q_{ae} (auxiliary equipment) –volume of material resources used in the service of auxiliary equipment (containers, pallets, etc.)

Table 5

Evaluation of the use of information infrastructure of the counterparty used in logistic processes

Indicator	Calculation method	Remark
Coefficient of use of information technology in logistic processes	$K_i = I_u/I_p$ (11)	Allows to determine the ability of the counterparty to cooperate in the supply chain. I_u – the number of implemented innovations; I_p – the number of available information technologies.
Dynamic indicator of the level of informatization on all types of logistics operations	$K_i = \sum_{j=1,m} I_{uj} / \sum_{j=1,m} I_{pj}$ (12)	Assessment of the dynamics and level of informatization of the process of providing logistics services.
Average time of logistic processes	$Tcp = \sum T_i/n$, (13)	Evaluation of the result of introduction of information technologies, where $\sum T_i$ – an aggregated indicator of the time the logistics operations (processes) are performed; n – the number of logistic operations (processes).

The situation on TLS market of Irkutsk region indicates that the existing information data is not enough for the effective management of goods flow both within the regional economic system and beyond it. We need more advanced approaches to organization of transport and logistics infrastructure, enabling companies to efficiently carry out logistics operations and to be a reliable partner in the supply chain.

Method based on the process approach

We believe that the basis for evaluating the infrastructure of companies should be a process approach that reflects the ability and quality of transport and logistics services provided by one or several contractors. With this approach, it is preferable if the research takes the form of monitoring, because it is precisely this method that determines the regularity and focus of indicators of monitoring the process. Only companies that are included in the monitoring system at the focus company level (we take for those territorial divisions of JSC Russian Railways), can apply for a deal. Information base is formed at the level of territorial (regional) or sectoral management. If the territorial body is the relevant public administration, then it is proposed to consider the focus transport company with a large share in freight traffic (particularly, a territorial division of JSC Russian Railways) as a branch organization.

One of the problematic issues of research and evaluation is the lack of information about the risks of logistics processes, that is, about the facts of violation of the conditions of storage and transportation of goods, non-compliance with the delivery schedule and so on. In addition, not all shippers report possible deviations in the performance of the contract, which does not allow to assess reliability of the counterparty performing the logistics service.

As a basis for application of the process approach, a method of evaluating the results of the counterparty's logistics activities was chosen. For convenience of consideration, the controlling parameters are differentiated in three areas of assessment of the logistics infrastructure complex and are shown in Tables 3–5.

Among the indicators presented in Table 3, there are indices, which are associated with the need to analyze the development trends of the transport and logistics company. The delivery time index reflects the trend and opportunities to reduce the time on the delivery route which the shipper inquires about, and the transaction cost index, which is the result of optimization of delivery time by eliminating downtime. The aggregate transportation performance indicator is not only an indicator of work on the route, but also an indicator of asset management.

With regard to Table 4, there is an obvious need to focus on selection of indicators for warehousing processes, given that the speed of service and the absence of risks for storing and processing cargo are most important for the warehouse service customer, depending on the provision of the used areas and technologies with specialized equipment. In this regard, five basic indicators were selected in the system of indicators of warehouse activity, reflecting both the level of equipment of the warehouse and the results of the management of warehouse processes.

Since modern warehousing and transportation management is based on the use of information technologies, indicators of development of information technology at various stages of supply chain organization are included in the indicators for development and management of the information infrastructure of companies (see Table 5).

The proposed method for assessing the infrastructure of logistics systems of transport companies may include a larger number of indicators. However, they should not be redundant, independent and collectively reflect both the result of logistics activities and the state of the logistics infrastructure complex. Taking into account that monitoring involves establishment of upper or lower boundaries of logistic processes indicators and indicators of the use of infrastructure of logistic systems, a considerable amount of time is ahead and detailed work is needed to determine the desired and possible control parameters.

Conclusion. *The development of TLS market in Russia, associated with the growing needs of shippers in organization of multimodal transportation, as well as provision of integrated logistics services, necessitated regular observations in this market. Thus, monitoring the market of transport and logistics companies for their reliability is an indispensable factor in choosing the «third party» of the transaction.*

A controversial issue for organizing monitoring of subjects of TLS market is the choice of a scientific approach to research from the point of view of the importance of collecting information on performance of companies or the state and dynamics of development of their infrastructure complex.

To improve the level of logistics services of transport companies, it is proposed to introduce a process approach to assess the logistics infrastructure of transport companies. It is assumed that the use of criteria for assessing the logistics infrastructure, simultaneously with the results of the logistics activities of partner companies, and monitoring of these data will solve the tasks:

• to automate the process of collecting and processing data on transport companies as participants in supply chains in the transportation system, e.g. of JSC Russian Railways;

• to reduce the time for analysis and selection of a partner in the supply chain, taking into account its infrastructure characteristics and performance in previous periods;

• in the future, will allow to advance in digitalization of the process of organizing the supply chain and to increase the segment of high margin transportation, by reducing the delivery time and increasing the quality of logistics services.

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