

Interorganizational Logistics Entities: Categorization of Forms and Quantitative Evaluation

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Abstract

The paper explores and categorizes interorganizational logistics entities. Based on the expert survey data and the analysis of aggregate indicators of the intersystem logistics entities, the most integrated intersystem logistics entities were identified. The results indicate that the most integrated intersystem logistics entities in the Russian Federation are integrated corporate-level logistics systems and strategic alliances. In conclusion, when the level of interorganizational logistics integration was used as a measurement, the most significant relationships turned out to be the ones between strategically integrated corporations — strategic alliances and intercorporate logistical systems.

Keywords: Logistics Integration, Intersystem Entities, Interorganizational.

Entidades logísticas interorganizacionales: Categorización de formularios y evaluación cuantitativa

Resumen

El artículo explora y clasifica entidades logísticas interorganizacionales. Sobre la base de los datos de la encuesta de expertos y el análisis de los indicadores agregados de las entidades de logística intersistema, se identificaron las entidades de logística intersistema más integradas. Los resultados indican que las entidades logísticas entre sistemas más integradas en la Federación de Rusia son los sistemas logísticos y alianzas estratégicas integradas a nivel corporativo. En conclusión, cuando el nivel de integración de la logística interorganizacional se usó como una medida, las relaciones más

significativas resultaron ser las que existían entre corporaciones estratégicamente integradas: alianzas estratégicas y sistemas logísticos intercorporativos.

Palabras clave: Integración Logística, Entidades Intersistema, Interorganizacional.

1. Introduction

Changes in the social and economic conditions for business inevitably affect the choice of organizational forms that are most adapted to the dynamic external environment, consumer behavior, regulatory changes and other factors. Fulfillment of these conditions currently requires the potential of organizational forms that appeal to the mechanisms of integration and collaboration. The development of logistics management is related to the concept of logistics integration, which a priori determines advanced corresponding management tools; meanwhile, the continuous development of logistics integration within the innovative logistics paradigm leads to the emergence of new forms of relationships between business units and, therefore, the search for new mechanisms and management methods. Nowadays, the challenge to the theory and methodology of logistics management of integrated structures is related to digitalization in logistics, which determined the content of this research.

2. Literature review and formulation of hypotheses

The search for methods to improve the competitiveness of business units in present-day markets, their sustainability and flexibility in responding to changes in demand led to the interest in new forms of relationships between enterprises and companies based on the integration principles. In particular, the basic principles of the theory of cooperation, collaboration, integration between business units have been studied by Gray (1989), Wood and Gray (1991), Bengtsson and Kock (2000; 2014), Rajaguru and Matandrea (2009), Schoenherr and Swink (2012), Ovchinnikova (2014); specific features of developing and functioning of various types of intersystem entities are explored by Whipple and Frankel (2000), Buckley (2011), Spekman et al. (1998); matters of interorganizational and intercorporate relationships were studied by Ring and Vandeven (1994), Smith et al. (1995), Harrison (2001), Noteboom (2004), Levie (2006), Gnyawali et al. (2016) and others.

In turn, the development and functioning of modern logistics systems is based on the logistics integration concept, which is viewed as the combination of activities, the comprehensive actualization of functions and managerial interactions, the relationships of participants in the process of product distribution (including the seller and the buyer), the availability of the collective information and communication system, establishing the organizational relations (including the rationalization of the system structure), and the process of involving, engaging new elements, areas of activity or individual functions (Morash and Clinton, 1998; Frolich and Westbrook, 2001;

Prokofyeva and Sergeev, 2011; Shulzhenko et al., 2017). As logistics evolve and logistics systems integrate, brings about various types of logistics integration.

The development of supply chains as intersystem logistics entities and development of the corresponding tools of interorganizational logistics integration in the process of managing them are typical for the initial stage of the innovative logistics paradigm, which was explored by researchers, in particular, Stevens (1989), Stank et al. (2001), Parfenov (2001), Simatipang and Sridharan (2002), Klein et al. (2007) and others. The cluster forms of logistics integration are sufficiently studied, in particular by Delangen (2004), Sheffi (2012), Rivera and Sheffi (2014), Rivera et al. (2016), Gviliya (2016), as well as strategic alliances that were explored by Luo (2008), Solskaya and Freidman (2016) and others. However, the publications and other sources available to the authors did not contain the results of a comprehensive analysis of the forms of intersystem logistics entities that develop under the influence of the evolutionary factor of logistics integration.

H1 Hypothesis: The emergence of new forms of intercorporate relationships is determined by the logic of logistics integration development

The study of the factors that determine the need to develop new forms of logistics integration of corporate entities enables to describe the specific role of the following forms: globalization, search for new tools to improve competitiveness, and market transformation. Contemporary studies of the practice of the logistics integration allow identifying the development of intersystem logistics that involve entities in various fields, in particular, manufacturing enterprises and corporations, logistics companies, retail chains, which leads to a conclusion that the form of an intersystem logistics entity depends on the business area of its constituent entities. For example, Adamczak et al. (2016) studied aspects of the development of integration relationships between manufacturing and logistics systems and the external environment, Mortansen and Lemoine (2008) explore systemic integration relationships between manufacturers and 3PL logistics companies.

When solving this problem, the question definitely becomes relevant regarding the measuring the level of integration relationships between the elements of the intersystem logistics entity, the methods of which are currently insufficiently studied and require further research. For example, Cyplik et al. (2014) suggest an approach to measuring the level of integration in supply chains by ranking the local integration levels during the actualization of integrated processes in the supply chain; Wong et al. (2011) look into the principles of informational integration of supply chains elements. The orientation of the presented results (despite they are methodologically fragmented) to the supply chains, which are viewed as a form of intersystem logistics entities, suggests that similar assessment can be performed for other identified forms of interorganizational relationships, and levels of their typical logistics integration will widely vary.

H2 Hypothesis: The choice of the form of the intercorporate logistics entity depends on the type and field of its constituent entities

H2.1: The level of interorganizational logistics integration is determined by the form of interorganizational relationships

H2.2: Strategically integrated intercorporate entities have the highest level of interorganizational logistics integration

Digital technologies, including those in the logistics management, allow to create tools to improve the efficiency of both individual entities and the intersystem entities they constitute; and it

should be noted that in the latter, the management digitalization through increasing their stability (Kayikci, 2018) and flexibility Industry (2016) is typical in the greatest extent. At the same time, an unlimited increase in the management digitalization level seems economically unviable, since there is a limit to the effectiveness of digitalized management, which, in turn, is determined by the nature of the interorganizational logistics entity.

H3 Hypothesis: The required level of logistics management digitalization depends on the level of interorganizational logistics integration

3. Research methods

3.1. Collecting the baseline data

The indicators under study, that are included in the baseline data, constitute the following groups:

Group 1 — indicators of the estimated level of logistics integration that constitute a group of factor indicators in further research;

Group 2 — indicators of the digitalization level of the management corporate-level logistical intersystem entities that serve as the indicators under study.

Let us consider the indicators of the Group 1, a comprehensive analysis of which allows assessing the integration level within individual logistics intersystem entities and their types, based on the analysis of various flows (in particular, material, information and financial flows) that unite the constituent entities of the integration entity. Table 1 overviews the indicators to assess the level of integration relationships when performing the logistics functions within intercorporate systemic entities.

Indicator	Notation	Analytical expression	Explanation
Analytical indicators of the intensity of mutual relationships			
Significance of mutual material flows	TFT	$TFT = \frac{FT_{if}}{FT_{\Sigma}}$	FT_{if} — the total supply turnover between the participants of the logistics intersystem entity; FT_{Σ} — the total supply turnover of the participants of the logistics intersystem entity.
Significance of mutual financial flows	TI	$TI = \frac{I_{if}}{I_{\Sigma}}$	I_{if} — the total investments between the participants of the logistics intersystem entity; I_{Σ} — the total investment in the economy by the participants of the logistics intersystem entity?
An indicator of the significance of mutual information flows	TInf	$TInf = \frac{Inf_{if}}{Inf_{\Sigma}}$	Inf_{if} — the total intensity of the information flow between the participants of the logistics intersystem entity; Inf_{Σ} — the total intensity of the information flows of the participants of the logistics intersystem entity.
Significance of mutual information resources	TRInf	$TRInf = \frac{Rinf_{if}}{Rinf_{\Sigma}}$	$Rinf_{if}$ — the volume of the joint database of participants of the logistics intersystem entity; $Rinf_{\Sigma}$ — the total volume of information resources of the participants of the logistics intersystem entity.
Openness	TO	$TO = \frac{TA_{\Sigma}}{D_{\Sigma}}$	TA_{Σ} — the total value of transactions between the participants of the logistics intersystem entity; D_{Σ} — the total income of the participants of the

Diversification of activity (sectoral analysis)	GL	GL = 1 $= \frac{\sum_i \sum_j X_{i,j} - M_{i,j} }{\sum_i \sum_j X_{i,j} + \sum_j M_j}$	logistics intersystem entity. $X_{i,j}$ — supply volumes from the participants within the logistics intersystem entity; $M_{i,j}$ — supply volumes to participants of the logistics intersystem entity; i — business area; j — participants of the logistics intersystem entity.
Analytical indicators of the closeness of mutual relationships			
Traditional statistical indicators: mean-square deviation, linear and quadratic variation coefficients, correlation coefficient			
Indicators of quantitative analysis of secondary factors			
The secondary factors include: stage of the life cycle of individual participants, the level of initial economic development of the participants			

Table 1. Measuring the Level of Integration Relationships in Corporate-Level Logistic Intersystem Entities

The preferred indicators for assessing the digitalization level are the Digital Transformation Index (DTI) and the McKinsey Digital Quotient. However, accumulating a complete empirical foundation for determining those indicators is problematic. In the study, individual indicators within DTI are used.

3.2. Data Analysis Toolkit

The authors believe that each type of logistics intersystem entities is characterized by value ranges of the indicators, which together constitute the integration level. Evaluation of how the required level of management digitalization within intersystem logistics entity at the corporate level is affected by the integration level was performed based on the study of the correlations between the indicators under study. Since the sample was small ($n < 30$), the Spearman's rank correlation coefficient was used to identify the correlation between the indicators under study.

$$r_s = 1 - \frac{6D^2}{n(n^2-1)},$$

Where n — the number of ranked attributes; D — the difference between the ranks by two variables.

The evaluation tools were chosen due to the attribution of the Spearman coefficient to the class of nonparametric measures of the relationships between the variables that are measured in the rank scale, or quantitative variables where the Pearson's coefficient does not apply. In addition, the use of the coefficient does not imply a study of how the attributes under study are distributed.

4. Results and discussion

4.1. The concept of logistics intersystem entities

The authors of the paper believe that logistics intersystem entities can be characterized as organizational and economic forms of establishing and actualization of economic ties within certain macro-logistics systems. They normally develop into micrologistics systems that are sufficiently resilient to changes in the external environment and highly stable in their target and functional purpose. At the same time, it should be taken into account that, on the one hand, intersystem entities determine the lines of development of micrologistics systems, and on the other hand, they depend on the purpose of creation of the latter and the specific features of their operation. Using the

analysis and synthesis method to study them and design an efficient operating mechanism, logistics intersystem entities can be regarded as subsidiary logistics systems integrated in a certain way with the parent macrologistics systems. Such intersystem entities in logistics include, above all, logistics chains, logistics networks and logistics alliances.

4.2. Categorization of forms of intercorporate logistics entities

Logistics integration as a core concept of the modern logistics theory is currently being transformed by multiple factors. The integration level of logistics is continuously increasing as the logistics develop and the ideology of supply chain management is actualized in advanced businesses. The following factors determined the rapid pace of logistics integration: markets globalization, an increased role of customers, development of integrated systems and technologies, increased customer requirements to the quality of products and services, a growing potential of the supply chain. The logistics integration in the Russian Federation evolves at a time of significant changes in the social and economic environment for business in various markets, which inevitably affected the choice of production and logistics concepts and logistics integration forms that comply with market requirements (Figure 1). The analysis of the elements of intersystem entities in modern business practices in Russia makes it possible to single out the following essential attributes when categorizing types and forms of interorganizational logistics integration:

1. The core business area: production (P), trade (T), transport and logistics (TL) corporations as the core economic entities that initiate the integrated processes at various management levels;
2. Level of process integration: operational, tactical, and strategic.

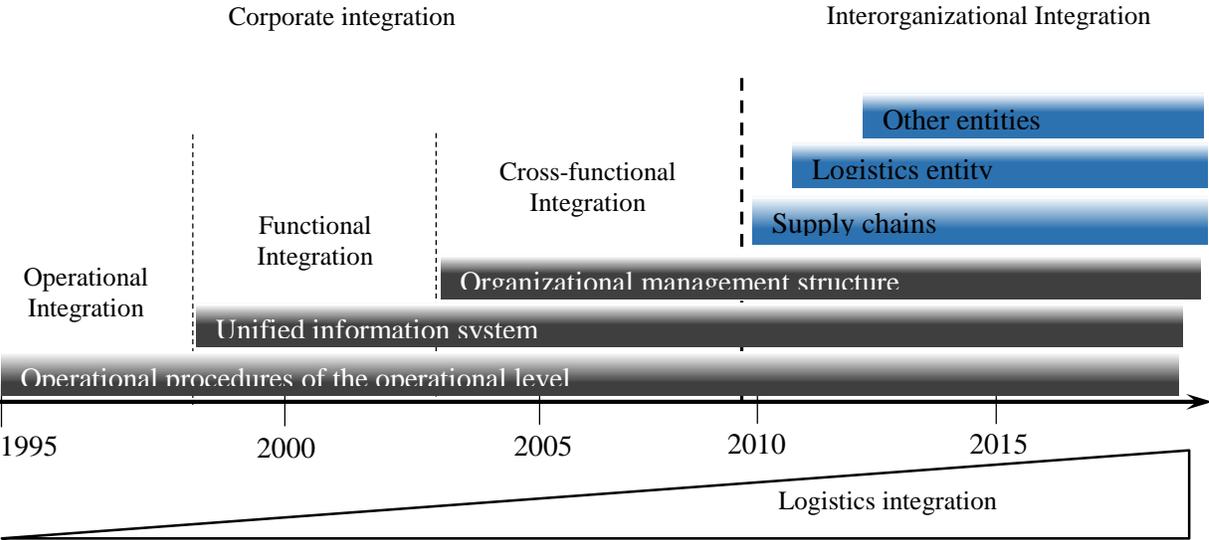


Figure 1. Evolution of methods and forms of logistics integration in Russia

A variational combination of the presented categorization attributes made it possible to identify the core forms of intersystem logistics entities (Table 2).

		Level of integration of logistics processes			
		Operational	Tactical	Strategic	
Business area	P-TL-P				
	P-TL-T	Supply chains			
	TL-T				
	P-TL	Virtual enterprises			
	TL-TL	Transportation and logistics clusters			
	P-P			Strategic alliances	
		Production clusters			
Integrated corporate-level logistics systems (suprasystemic entities)					

Table 2. Core Forms of Logistics Intersystem Entities

Note: Corporate-level integrated logistics systems (CLILS) (suprasystemic entities) are defined as the logistics systems that emerged as a result of the union and integration of the logistic systems processes of corporations.

It should be noted that as the logistics integration evolved, the main types of intersystem logistics entities developed in Russian environment (Table 3).

The form of the logistics intersystem entity	Examples of the logistics intersystem entities
Strategic alliances	Global Ports company is an operator of container terminals and oil product transshipment terminals, 20% of shares are listed at stock exchanges. The company owns five container terminals in Russia (Petrolsport, First Container Terminal, Ust-Luga Container Terminal and Moby Dick on the Baltic Sea, Vostochnaya Stevedoring Company in the Far East) and two container terminals in Finland (Multi-Link Terminals Helsinki and Multi-Link Terminals Kotka). It also owns the internal container terminals Yanino Logistics Park and Logistika-Terminal located outside of St. Petersburg, and 50% of the large AS Vopak E.O.S. oil products terminal in Estonia, which consists of four terminals. The company says it controls 30% of Russian container turnover and 28% of fuel oil export. Global Ports is developing within the strategic partnership of N-Trans Group and APM Terminals company, which is a part of A.P.Moller-Maersk.
Suprasystemic entities (CLILS)	Prospective forms of intersystem logistics entities that emerged as a result of the union and integration of the logistic systems processes of corporations. Given a high proportion of natural monopolies in Russian economy (including in the transportation sector), emergence of such entities is possible during the integration of the logistics processes of corporations of different types of transport, for example, OAO Russian Railways and PAO Transneft.
Production clusters	In Europe, all the manufacturing enterprises is located near the ports, because the water transportation is the cheapest. Rotterdam and Hamburg are examples of such industrial zones. However, in Russia, most of the manufacturing enterprises are located inland, in the center of the country. Nowadays this situation is beginning to change. Several companies recently announced such projects in Ust-Luga or near a port. Eurochem is currently designing an ammonia plant in Kingisepp (40 km from the port) at a cost of \$1 billion. The production is scheduled for 2018. Another example is NGSK, the engineering and construction company in the Alekseevskaya industrial zone (40 km from Ust-Luga), which is constructing a methanol plant that is to start production by 2019. Its capacity is 1.65 million tons per year. BalticGas Chemical Company plans to build a methanol plant in the port itself by 2019. Its capacity will be 1.7 million tons per year and the cost — \$1–1.3 billion. Therefore, a petrochemical cluster may soon emerge in the area of Ust-Luga.
Transportation and logistics clusters	Transport and logistics entities often develop due to the integration of transport and logistics assets of transport and logistics companies in a certain territory. For example, the logistics system of the St. Petersburg transport hub, the Big Port St. Petersburg, Port

	Bronka, Port of Vysotsk, Ust-Luga Port, Primorsk Port, Vyborg Port, with the appropriate railway and automobile infrastructure.
Supply chains	Gazprom is building a large liquefied natural gas plant in the Leningrad Region. The project of the large-scale Baltic LNG plant in the area of Ust-Luga port is carried out as scheduled. The plant's capacity will amount to 10 million tons of liquefied gas per year. The opportunities of Ust-Luga port will enable to ship the products to consumers in the Atlantic region, Middle East, and South Asia. The estimated investments in the project are 660 billion rubles. The commissioning of the Baltic LNG is scheduled for 2022–2023. The main idea of building LNG plants is to have the production closer to the port infrastructure and reduce, therefore, the transportation costs. In addition, liquefied gas can be shipped by sea over long distances and to any ports, while non-liquefied gas can only be transported through very expensive pipelines.

Table 3. Examples of Logistics Intersystem Entities (Russian Environment)

These forms of intersystem logistics entities widely vary in their structural and geographic characteristics and the level of interorganizational logistics integration. The level of interorganizational logistics integration is viewed as a complex characteristic of logistics intersystem entities, and it is suggested that the quantitative assessment includes various aspects of the concept (Figure 2).

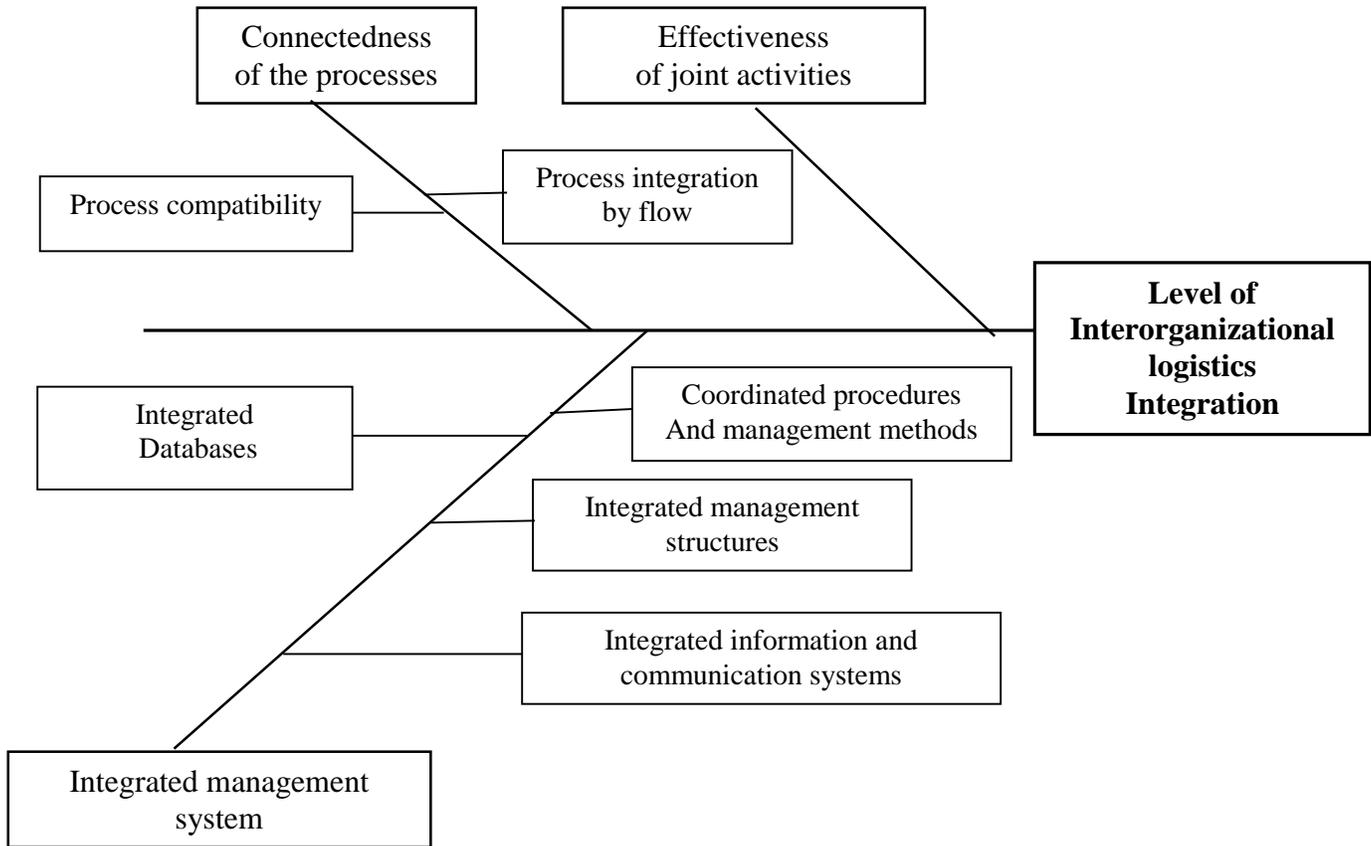


Figure 2. The subject matter model of the level of interorganizational logistics integration concept

Table 1 summarizes the measurements of the level of integration relationships in corporate-level intersystem logistics entities that were used to preliminarily assess the attribute under study. The results (Fig. 3) obtained through an expert survey and the analysis of aggregate indicators of

logistics intersystem entities in the Russian Federation, make it possible to identify the most integrated intersystem logistics entities, which include integrated corporate-level logistics systems and strategic alliances.

The form of the logistics intersystem entity	Final level	TFT	TI	Tinf	TRInf	TO	GL
Strategic alliances	High	High	High	High	Medium	High	High
Suprasystemic entities (CLILS)	High	High	Medium	High	High	High	High
Production clusters	Medium	High	Medium	Medium	Medium	High	Low
Virtual enterprises	Medium	High	Low	High	High	Medium	Low
Transportation and logistics clusters	Medium	Medium	Low	Medium	High	Medium	Medium
Supply chains	Low	Medium	Low	High	Medium	Medium	Medium

Attribute level: low  high

Figure 3. The level of interorganizational logistics integration for different forms of logistics intersystem entities (Russian environment)

The presented attribute of logistics intersystem entities can be used for a number of theoretical and practical problems, in particular, to assess the current state of interorganizational logistics integration in an entity under study, to describe the of evolution and prospective forms of logistics intersystem entities, to develop tools to improve the management of corporate-level logistics entities.

4.3. Digitalization of management in corporate-level intersystem logistics entities

The problem being solved (choosing a rational level of digitalization of corporate-level intersystem logistics entities) includes three components:

- 1) Choosing an indicator of management digitalization;
- 2) Drafting a model that would characterize the dependence of the required digitalization level on the level of integration of individual forms of corporate-level intersystem logistics entities;
- 3) Producing recommendations on introducing digital technologies in certain types of corporate-type intersystem logistics entities using a scale of the digitalization level.

Figure 4 shows the results of a preliminary survey of the digitalization level in intercorporate logistics entities that operate in the Russian Federation. The survey method was the Digital Transformation Index that was proposed by Little (2015) and adapted to the Russian environment.

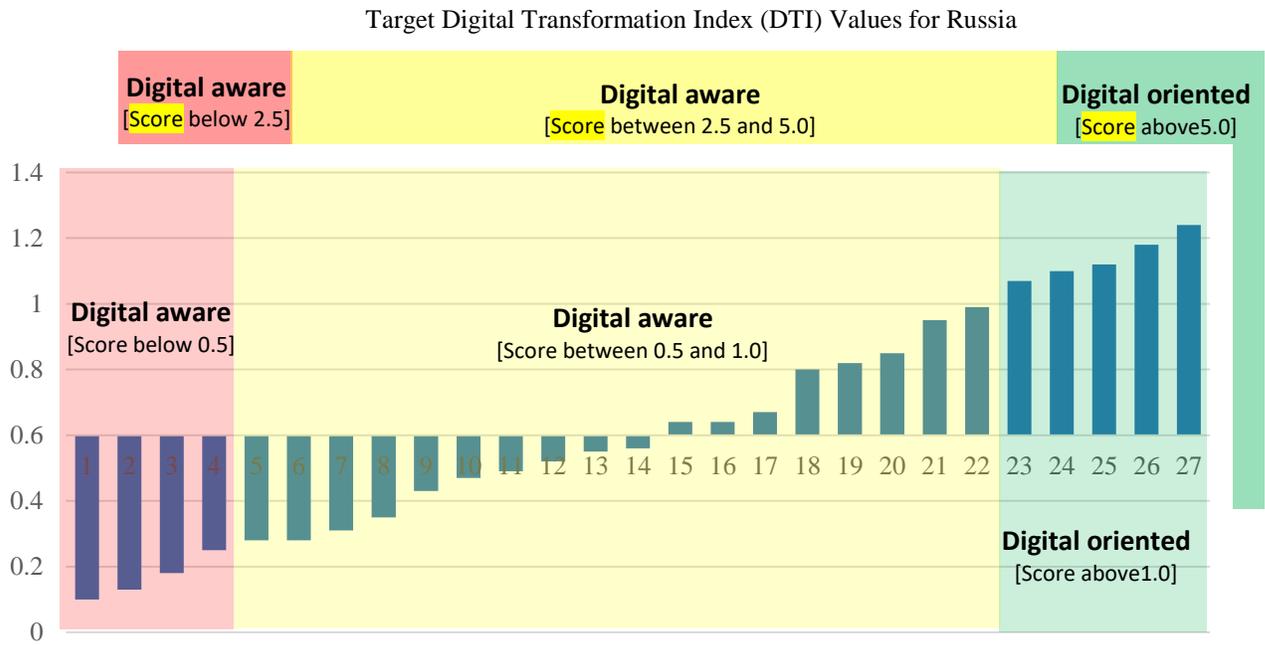


Figure 4. Results of the survey of the digitalization level intercorporate logistics entities (Russian environment)

The analysis of the results shows an inverse correlation between the level of logistics integration and the level of digitalization of intercorporate logistics entities. In particular, the highest values of the digitalization level are currently typical by supply chains and virtual enterprises, which, in the author's opinion, caused by the relative simplicity of management digitalization at the operational, and partially, at the tactical levels. A significantly higher potential for operational management digitalization is typical of intercorporate logistics entities with higher levels of logistics integration, which determines the areas of further prospective research related to the assessment and actualization of this potential.

5. Conclusions and areas of further research

The study established a correlation between the level of logistics integration and the form of intercorporate logistics entities in the Russian Federation. In particular, when the level of interorganizational logistics integration was used as a measurement, the most significant relationships turned out to be the ones between strategically integrated corporations — strategic alliances and intercorporate logistical systems. It is recommended to use this indicator for choosing management tools for individual forms of intercorporate logistics entities, including those based on digital technologies. The development of the presented approach requires further research, possible areas of which are determined by the need to solve the following problems:

- To specify the indicators to be included in the baseline data for assessing the level of integration in corporate-level intersystem logistics entities;

- To develop comprehensive methods for collecting and analyzing the baseline data for the indicators under study on the basis of the existing systems of accounting, management accounting and statistical corporate reporting; to continue developing the baseline data;
- To produce recommendations for assessing the management digitalization level of intersystem logistics entities;
- To substantiate the prospective forms of intersystem logistics entities in the Russian business practice based on further studies of the evolution of logistics integration and collaboration tools.

6. Acknowledgments

The paper was prepared as part of the research carried out with the financial support of the Saint Petersburg State University of Economics.

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