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STUDY OF THE TYPOLOGY OF LOGISTIC ENTITIES USING FUNCTIONAL AND LOGISTIC APPROACH

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Abstract

The work is an attempt to integrate the cluster and synergistic approaches to the determination of a logistic entity's stage of development, which constitutes scientific novelty in the conducted study of the typology of logistic entities with the use of a functional and logistical approach. Implemented methodology includes logistics, synergetic, classification, transport geography, cluster and systems analyses. The urgency of creating a new classification and hierarchy of logistics facilities is determined by the lack of complexity in the existing ones, as well as the lack of a unified approach to the typology of logistics facilities, the number of which is growing in modern supply chains. The goal of this study is to propose a classification system and a hierarchy of logistic entities as the key elements of the terminal and warehouse infrastructure, based on a new, functional and logistic approach. We developed a functional and logistic approach to the classification and hierarchy of logistic entities, which is distinguished by the synthesis of the cluster and synergistic approaches, while taking into account the stages of evolutionary development, functional characteristics and comprehensiveness of service. This approach is a part of the theory of terminology, which we propose to be included in the practice of transport science. Our new approach implements a comprehensive assessment of the functional stage of development of a logistics entity using the criteria of sustainability, structure, and development of infrastructure and services.

Keywords: Logistic object, universal classification, identification, evolution, functional and logistic approach.

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1. Introduction

The rapid growth of the transportation and logistics services industry, the globalization of logistics chains and the increasing role of logistics terminal-warehouse infrastructure facilities (logistic entities), in cargo delivery systems brings up the problem of developing a unified classification and hierarchy of the numerous types of such entities. The complexity in identifying the type of logistics facility that is suitable for the needs of a business, as well as the choice of such a logistics facility, which needs to be relevant to the functional tasks of the logistic chains being built, is associated with an abundance of similar, interchangeable terms in a non-specific terminology framework used by the participants in the transportation process.

In turn, the multitude of definitions for logistic entities (hereinafter LE) is determined by the multidimensionality of their essence, complexity and range of services that they provide. This situation objectively requires transport and logistics science to formulate the necessary theoretical basis that will ensure a consistent coordinated terminological approach to their systematization and identification by type.

2. Problem Statement

The existing classifications of logistics facilities are either detailed, or are overexpanded, or duplicate cost estimation classifications of the warehouse logistics industry. All classifications have floating criteria with minor differences. As a result, the same entity can simultaneously exist in several classes when referring to different classification systems.

In addition to this, the well-studied sciences of logistics are deeply tied with specific areas of logistics industries – such as warehousing or transportation - and often do not include the full range of these functions.

The development of the classification and hierarchy of LEs was carried out by such Russian scientists: based on the design characteristics and structure of the transportation node (Apatsev & Efimenko, 2014), based on the combination of technical and technological features as they relate to the type and design of a warehouse building (Malikov, 2014), based on the functional role in the logistics chain (Dybskaya, 2018) and others (Martin et al., 2018). Internationally, the development of an approach to the classification of LE types, was devoted to the following topics: a description of the typology of logistic systems (Bowersox & Klos, 2017), the study of the spatial configuration of transportation and logistics systems (Higgins & Ferguson, 2011), research and classification of logistic centers (Akhavan, 2017), analysis of the typology and geographical configuration of transport systems, and others (Rodrigue, 2017).

The first attempts to systematize the types and development of an LE hierarchy (the term “logistics center” was used in the original works) were made back in the 1990s by the following groups:

1) the Commission on Transport and Logistics of the European Union - classification of LEs by status, considering their location;

2) Networking Logistics Centres in the Baltic Sea Region (NeLoC) – on the interaction of LEs in the Baltic region;

3) The European Association of Freight Villages "Europlatforms" based on the analysis of terminal networks investigated the nature and characteristics of European LEs;

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4) The United Nations Economic Commission for Europe (UNECE) investigated the role of LEs in intermodal transport (Erkayman, Gundogar, & Yilmaz, 2012).

Organizations such as the Economic and Social Commission for Asia and the Pacific proposed their classifications; The Institute of Logistics and Supply Chain Management (ILSCM, Australia) with their gradations of: cargo village, inland port, cargo hub, logistic city. According to the most common approach in the European Union, there are:

1) transport terminals (concentration points);
2) logistics centers;
3) freight villages with a wide range of services;
4) logistics hubs (gateways, sea and air ports).

In a similar field of research, a classification approach was developed by Rodrigue (2017). According to his approach, LEs are divided according to their location and functions. Later a new hierarchy was proposed: a cargo terminal, a cargo hub, a logistic village, a logistic city, and an interregional logistics cluster. It should be noted that LEs of a large territorial size and scale of operations are often called logistic clusters in non-Russian literature, which differ in size, number of cores, and design. Rodrigue J.-P. based his 3-level LE hierarchy on the zoning of intermodal freight traffic. The 3-level hierarchy of Les is also widespread in the work of Higgins K. and Ferguson M., in which the type of LE is determined by its distance from the sea (Higgins & Ferguson, 2011).

Russian transport science classifies LEs by the nature of their operation (Apatsev & Efimenko, 2014), technology of cargo processing (Malikov, 2014), geographical location (Prokofieva, 2015), type of logistic services (Dybskaya, 2018), geometric outline and control system. In domestic and foreign approaches to classification, it is common to clearly distinguish two key approaches to the characterization of LEs - the physical representation (cargo terminal) as the lowest stage of their development (dominant in Russia), and the virtual (information center) as their highest form of development (dominates abroad).

Knight Frank was the first company to attempt the unification of logistic entity classification systems by classifying such companies as Swiss Realty Group, Jones Lang LaSalle, Penny Lane, and others, based on technical (construction-planning) parameters of their areas, including line engineering, divided into classes “A”, “B”, “C”, and “D”. These parameters are important for commercial assessments and consequent transactions, but do not directly affect the technology of cargo handling and do not give information about the functional logistic arsenal of the entity. Such classifications are primarily for the use of: LE assessment from a commercial standpoint; from a real estate standpoint (LE as a construction project); in terms of trade (LE as a storage warehouse).

The development of the modern transport and logistics services industry has long been put before the science and the practice of creating a unified approach to the typology of LEs, whose format and range of services is changing and expanding. Consequently, the theory is lagging far behind such a rapid development of the logistic terminal and warehouse business. The situation is complicated by the fact that a large portion of work in modern logistics chains is done by its participants - customers, freight forwarders, logistics providers, warehouse and transport operators, as well as carriers.

At the same time, each group of participants has its own slang, its own approach to the structure of each LE, which makes it difficult to find a “common language” in the delivery process. There is certain

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one-sidedness when representing the variety of types of LEs. This is largely due to how all of the various participants in the logistics chain specifically understand the essence and functional role of the each LE. The objective requirements of time and customer-oriented service, requirements in understanding how logistic technologies work, centralized customer service, and the presentation of seamless end-to-end service – all of these requirements must also be met by the LE classification system.

Thus, a single informational field is required to facilitate the interaction of all the participants in the transportation process that is "in the same language", which simultaneously satisfies the interests of all participants equally. The condition of informational field unity can be met by a unified classification of LEs and serve as an alternative to the existing ones.

3. Research Questions

Taking the gaps in existing scientific literature and the problems of the modern transport and logistics services industry into account, we formulated the key questions for this research:

- How do we integrate the principles of complexity, the focus on customers and service availability into the study of logistic entities?
- Which applicable tools, in the conditions of multi-field integration, can transportation science offer, for a comprehensive and integrated study of logistic entities?
- How should we systematize the stages of development of logistics entities with regard to quantitative and qualitative parameters?

How do logistic entities of different functional type relate to each other?

4. Purpose of the Study

The questions listed above have defined the goal of this work - to create an alternative, integrated system of classification and hierarchy of LEs in the framework of a new functional and logistical approach. Such an approach to classification will focus on the most common characteristics of LEs and integrate technical, technological, economic, and other aspects.

5. Research Methods

The analysis of domestic and foreign classifications and its results helped us form the methodological basis for the alternative classification and the hierarchy of LEs. We used methods of logistics, synergetics, transport geography, cluster and system analysis, and classification.

In order to achieve our goal in this research, a number of original terms have been analyzed that reflect the authors' LE typology. While analyzing the literature, we have found that most authors refer to LEs as territorial entities, located at the nodal points of transport system, that transform freight flows, which often identifies the concepts of different LE types. New terminology is necessary for theoretical support of a unified approach to the definition of the hierarchical positions of LEs, as well as their classification and functions.

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In order to establish the conceptual aspect of the new classification system, we developed a functional-logistic approach. The new approach integrates all of the existing approaches while focusing on the functionality of each type of LE.

While developing this approach, we performed a thorough analysis of scientific literature in the field of transport, logistics and economics. It showed that today's scientific trends show mutual distribution, or integration of scientific research, that is to say that the research has an interdisciplinary nature.

6. Findings

We have developed original terminology as pertaining to LEs, which is a unified theoretical classification support that allows for the identification of a specific LE functionality type. The introduced theoretical concepts of "LE evolution", "the stages of functional and logistic development" open up new fields for the study of the origin, functionality and evolution of LEs.

Our research team has also established that transport hubs, warehouse infrastructure, a network of support stations, and logistic centers are all, in essence, logistic entities of various functional specializations and various levels. Since all these entities are included in the logistics chain and have a system-forming, nodal character, all of them should be combined into a single group of logistics entities and be considered as a whole.

6.1. Proposed terminology

At the analysis stage of the study, we established that LEs exist and can be considered as: open and self-organizing systems, transport and logistics clusters and logistic systems. We also concluded that, on one hand, we had to use a systematic, logistic and synergistic approach, while on the other hand, we must structure them into a single methodological approach.

The results of the methodological foundations of LE classification study are presented in Figure 1. Four areas represent the essence of well-known LE classifications – economic/logistic (provided services and geographical location), transport, technical (engineering), commercial (market estimation).

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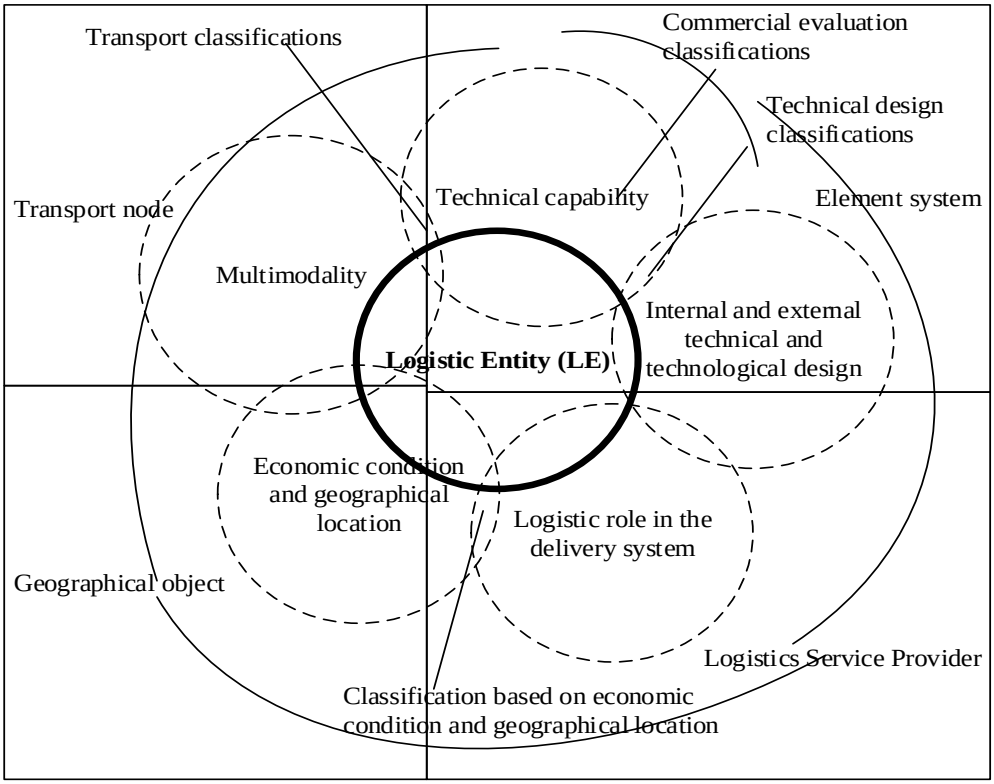

Figure 01. LE classification comparison

LE as a whole is the proposed name of the whole group of entities of the logistic terminal-warehouse infrastructure, physically implementing transport and warehouse service that is concentrated in a spatially defined area.

Type of LE is a set of functional, technical, technological and organizational features inherent in the LE and the factor that determines the format of its work:

1. The simplest components that are based on the types of LO (basic service package: transportation + loading-unloading + storage):

Warehouse site is an elementary part of the LE, equipped for processing, transshipment, loading/unloading and storage of goods that also allow open storage, and may be a separate cargo front.

Warehouse is the simplest node element of the cargo delivery system, which is a combination of buildings, structures and machinery designed and equipped to efficiently convert cargo traffic as well as the minimum level of service, necessary for initial processing, inventory, loading and unloading and storage of goods during the transportation process.

Logistics terminal and warehouse complex is a set of specialized technologically interconnected warehouse sites and warehouses with developed engineering, administrative and transport infrastructure.

2. Integrated and coordinated components of the transport and logistics system in the cargo delivery process (advanced logistics service package: basic service + additional near-transport services):

Transport terminal is the simplest LE with a the “center” format, located at the initial, final or intermediate point in the highway transport system, representing a territorially united and spatially localized collection of warehouses that ensures the effective interaction between modes of transport.

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Distribution center is a large transport terminal with enhanced, coordination functions that manage cargo flows at the breakpoint of the transport network, providing customers with a wide range of terminal-warehouse and logistics services in multimodal transportation.

Logistics center is a group of independent companies engaged in freight transportation and related services, including at least one transport terminal.

3. Large network components in the transport and logistics system of cargo delivery, which are the infrastructure basis for the formation of logistic regions (maximum logistic service package):

Transport node is a LE located at the junction point of several types of transport, including railway stations, sea and river ports, airports, warehousing, maintenance and auxiliary facilities.

Transport and logistics node is a compact, spatially localized association of independently specialized enterprises, with a high concentration of added-value services.

Multimodal Transport and Logistics Center is a large transport and logistics hub that integrates the multimodal, terminal and logistical infrastructure of independent market participants, with a single multimodal transport operator with direct access to transport corridors.

6.2. Functional and logistic approach to LE classification

Our proposed approach synthesizes methods of logistics, synergy, general systems theory, cluster and systematic approach. Using **cluster approach**, we will understand the set of principles according to which LEs are considered transport and logistics clusters. The **systematic approach** will help us understand as LEs as a complex, open, nonlinear, nonequilibrium technical-economic systems. Using the **synergistic approach**, we will understand the set of principles that govern the classification of LEs as self-organizing systems.

The approach is based on the classification of the stages of LO development, taking into account the range and complexity of the implemented logistics service.

Stage of development (evolution) of a LE is the period of time during which the LE has moved to another level of quality through the process of role evolution in the logistic system of cargo delivery, taking into account the range, orientation and complexity of the logistic functions that are performed. The format of its activity and the variety of solutions for its optimization depend on the LE stage of development.

LE evolution is the path of a LE in the course of its changes in functionality and state parameters, which together transfer the LE into a qualitatively different type (according to the authors' classification and hierarchy) or the stability of state parameters with the constant preservation of type and place in the hierarchy.

LE State is a set of parameters that identify the LE in the general hierarchical system (determining its type) and characterize its work as a whole.

6.3. Application of the new approach to LE classification

The functional and logistic approach is distinguished by an assessment of the functional development stage of the LEs logistics service, based on the criteria of sustainability, level of structure, level of infrastructure development and the range of services provided. Our proposed approach solves the problem of a lacking comprehensive assessment of LEs service and functionality development stage, based

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on the criteria of sustainability, level of structure, as well as the level of infrastructure and services development. It can be used in the design and evaluation of investment programs and the development of terminal warehouse infrastructure (Pokrovskaya, 2017).

The functional and logistic approach is presented in its general form in Figure 2.

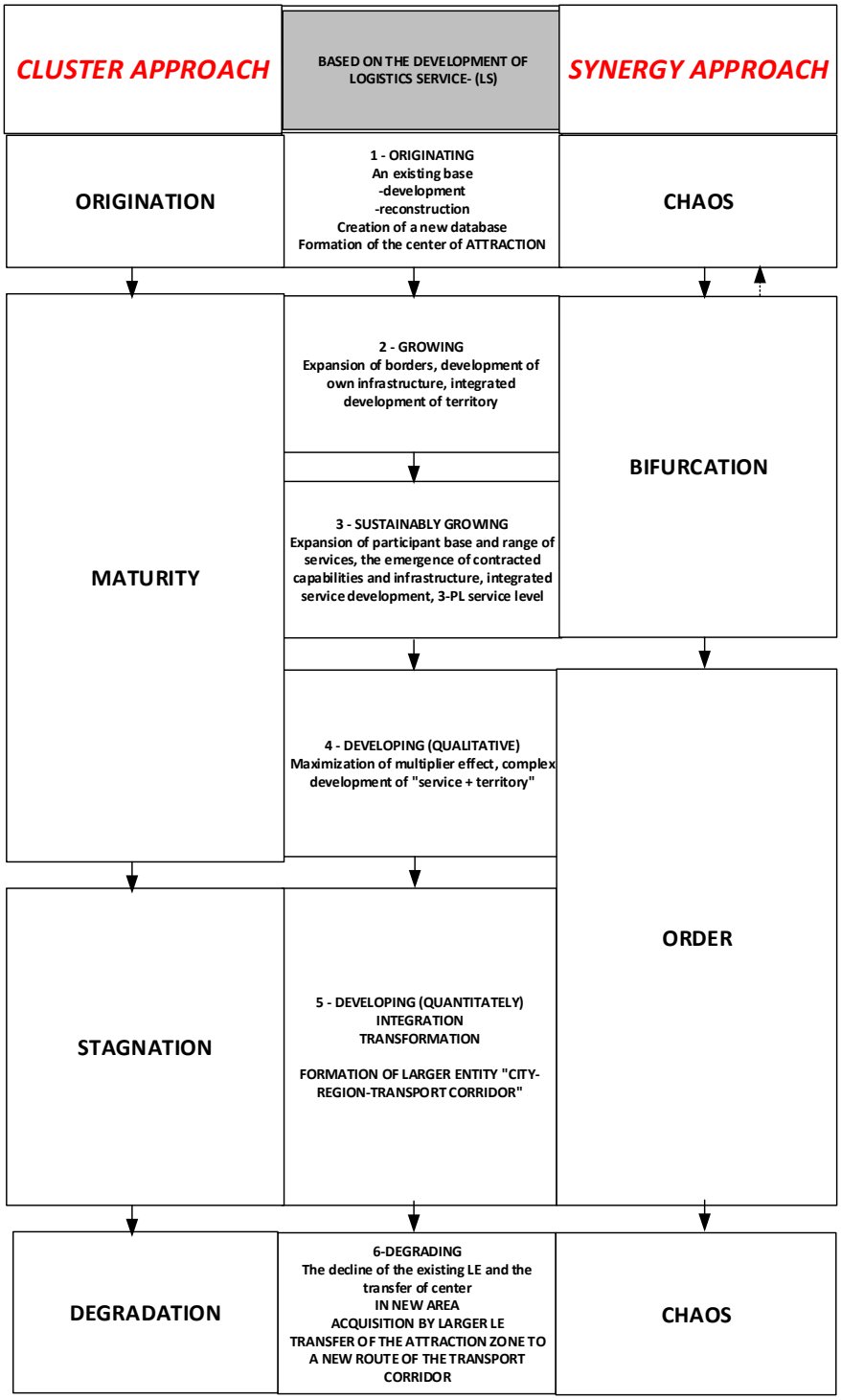

Figure 02. Functional and logistic approach to LE review

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The origination stage corresponds to the stage of chaos (chaotic development). As noted in the central column, the existing base serves as the infrastructure base, and the corresponding development takes place in the form of reconstruction or new construction. The subsequent conditions allow for the formation of a center of attraction, which pulls in labor, finances and other resources. However, element-by-element development is not in order, and the connections of technological interaction are poorly developed. We propose correlating the stage of bifurcation in the synergistic approach the stages of maturity in the cluster approach. There is a gradual expansion of participants and the range of services, where we observe the first manifestations of a multiplier effect. The difference between the growth stage and the stage of sustainable growth is the focus on integrated development - the territory in the former and the service in the latter, respectively. For a synergistic approach, this corresponds to the stage of bifurcation — a change in the established state of system operation. This stage corresponds to the third stage in a synergistic approach - the stage of order.

Stages of stagnation according to the cluster approach, also correspond to the stage of order according to the synergistic one. There is a cyclical development associated with the new petition for quantitative growth, different in its scale from the previous stage. At this stage, integration or metamorphosis into a larger entity may occur. The **stage of degradation** in the cluster approach corresponds to chaos in the synergistic approach. At this stage, the main workload of LEs is transferred to a new area, or to a new promising point of transport interaction.

The functional-logistic approach is presented in the form of the LE development matrix, in Figure 3, which shows the direction of LE evolution (qualitative gradation) - the arrow from left to right, along the arrow, and the hierarchical position of LE (quantitative gradation) - from the bottom up. Each state of the LE involves three levels of hierarchy (type of LE).

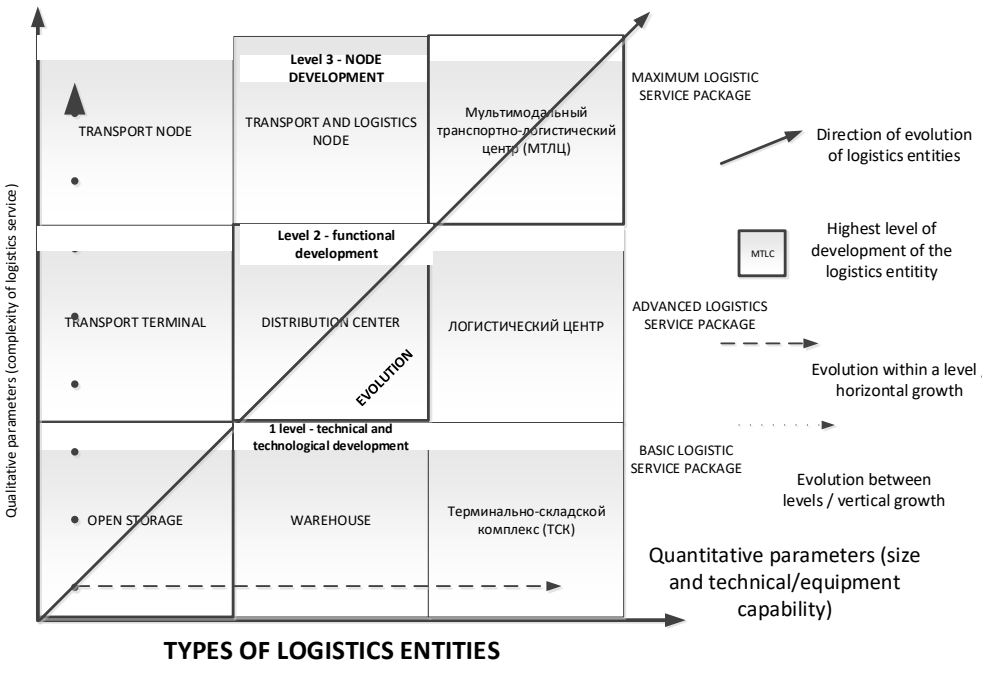

Figure 03. LE development matrix

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The **quantitative parameters** of the entity are the area, the number of trucks, the volume of cargo handling, and similar parameters. The **qualitative parameters** of the entity include the range of transport and logistics services, the provision of a comprehensive "seamless" service, centralized customer service, focus on customer satisfaction, and other similar parameters.

When you combine these types of parameters the result forms a system of 9 segments, the intersections of which designates the LE type. Gradation of quantitative parameters (from left to right) determines the hierarchical LE type at each level.

In this determining matrix, all 9 LE types are systematized in order of increasing values according to two criteria: quantitative (from left to right: horizontal and horizontal arrow), qualitative (bottom-up: vertical and vertical arrow). In this diagram, the arrows are not coordinate axes - they but show the direction of a LE's evolution (increase in values) of quantitative and qualitative parameters (Pokrovskaya, 2017).

Thus, we propose this determining matrix within the framework of the functional-logistic approach, which allows one to determine the type of logistic entity, regardless of complexity, with regard to the level of LE evolution based on quantitative and qualitative parameters.

We would also like to point out that two-dimensionality allows taking into account not only two types of parameters, but also two directions of evolution - horizontal (within the same level) and vertical (between levels). In this case, the evolution of LE type is determined by changes in the range of logistics services provided.

This classification has a direct and practical purpose, since it integrates and unifies the most common approaches for generalizing the multidimensional essence of LEs. This will undoubtedly simplify the joint work of participants in the transport and logistics industry.

For ease of use, the classification is fully automated (certificate of Rospatent No. 2017617975 dated July 19, 2017).

The adequacy of the proposed classification system and the LE hierarchy, which identifies their type and role in the cargo delivery system was tested under the conditions of the Novosibirsk transportation node (Pokrovskaya, 2017).

The proposed classification will help develop a client-oriented, transport and logistics service package, optimize the operating parameters of LEs of all types, rationally engineer and successfully connect them to the existing core railway network and transport corridors.

Additionally, a unified classification system will allow all of the participants in the transportation process to communicate "in the same language", which will simplify the identification of LE type, as well as the interactions in the chains of cargo delivery by way of LEs (Pokrovskaya & Malikov, 2017). It also will allow the development of recommendations for the standardization of the functional LE typology.

7. Conclusion

The study helped us develop a system of classification and hierarchy of LEs as the key elements of the terminal-warehouse infrastructure, based on a new, functional and logistic approach.

Using the functional and logistic approach, we created an alternative classification and hierarchy of LEs, which is characterized by its multidimensionality, integration and universal applicability for various participants in the transport process.

To identify the type of LE on the proposed classification we formulated a conceptual framework. Original terminology of LEs, which is the theoretical support for the classification and serves as a tool for identifying the LE type. It is distinguished by its application of the developed functional and logistic approach, multidimensionality, integration and universal applicability for various participants in the cargo delivery system.

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