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THE LOGISTICS INFRASTRUCTURE NETWORK OF BELARUS AND ITS UNIVERSAL APPLICATIONS

INFRASTRUKTURA LOGISTYCZNA I WYMOGI WSPÓŁCZESNE. PRZYKŁAD SIECI LOGISTYCZNEJ BIAŁORUSI Z UNIWERSALNYMI APLIKACJAMI

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Abstract: The effective functioning of logistics infrastructure is a prerequisite for the modernization of a regional and national economy. It is also a prerequisite for the transition to an innovative development path; to include the amelioration of a population's living standards. The study of historical patterns and characteristics of the development of logistics will allow us to determine the main directions for improving the activities of logistics infrastructure, whilst making recourse to appropriate management tools. The most important element of regional infrastructure is traditionally road and rail transport networks, which can both enhance and facilitate a region's local and international linkages.
Keywords: logistic infrastructure, scientific approaches, international logistic centers, management, territories, transport

Streszczenie: Skuteczne funkcjonowanie infrastruktury logistycznej jest warunkiem koniecznym modernizacji regionalnej, a co za tym idzie, gospodarki narodowej, przejścia na innowacyjną ścieżkę rozwoju, a także podniesienia standardu życia ludności. Badanie historycznych wzorców i charakterystyk rozwoju logistyki pozwoli nam określić główne kierunki usprawnienia działań infrastruktury logistycznej i pozwoli zastosować odpowiednie narzędzia zarządzania. Najważniejszymi elementami infrastruktury regionalnej są tradycyjnie transport drogowy i kolejowy, zapewniający lokalne i międzynarodowe połączenia regionu.
Słowa kluczowe: infrastruktura logistyczna, podejścia naukowe, międzynarodowe centra logistyczne, zarządzanie, terytoria, transport

Introduction

Prospects for the development of territories depend on logistics infrastructure. Infrastructure forms a totality of production and non-production sectors and facilities that make up the material and technical basis for the formation and development of clusters, including logistic, scientific, and industrial complexes, free economic zones and other forms of the spatial organization of regional economies. The most important element of the regional infrastructure is road and rail transport, which provides both internal and international linkages.

Pertaining to the implementation of interregional relations, logistics infrastructure has actively affected the development of the economic and social indicators of Belorussia's various regions. In this article one of the main issues addressed is the study of the features of a logistics infrastructure in the context of the genesis of logistics. Such considerations will be extended to Belarussian contexts. The study reflects various points of view, reflecting the opinions of scholars about the composition and functions of the logistics infrastructure objects have made possible here to formulate a definition and set out modern requirements for infrastructure objects.

Literature review

In order to characterize the concept of "logistics infrastructure", it is necessary to systematize the approaches to its definition, having considered the interpretations of researchers in this field. In scientific literature, the following approaches may be identified:

1) A system category. E.V. Krikavski maintains "that the logistics infrastructure is a set of elements that fulfill important logistics tasks and ensure the implementation of logistics processes" (Krykavskyi, 2005). In addition, E.V. Krykavskyi and N.V. Chornopyska define a logistics infrastructure as a system of spatial-temporal transformation of logistics flows (material, informational, financial, human), as well as a totality of enterprises and organizations of various legal forms that create certain conditions for the movement of these flows by harnessing the potential of relevant logistics services (Krykavskyi, Chornopyska, 2009).

2) The functional approach. V.V. Klimenko, characterizing logistics infrastructure, presents it as a combination of multidirectional activities, with the help of which it is not only implemented but it also serves a process of movement of material, financial and information flows (Klimenko, 2011). Sharing the ideas of the functional approach, V.S. Kolodin represents the logistics infrastructure as a functional implementation by the entities of the logistics process that are directly involved in the movement of goods through certain forms, methods and means. In his opinion, such an infrastructure is the only whole that includes organizational, information and communication support (Kolodin, 1999).

3) The elemental approach. In the framework of this approach, L.L. Kovalska considers logistics infrastructure as a complex of objects that have a certain geographical disposition and different characteristics (Kovalska, 2009). Bowersox J. Donald divided infrastructure into types of logistics facilities, breaking the entire system into components: manufacturing enterprises, loading and unloading terminals, trains and trains, shops, etc. Each of the presented facility types has its own special functions: "processing customer orders, inventory management or cargo handling" (Bowersox, 2008).

S.A. Taran holds a similar point of view, having divided all typical infrastructure objects involved in the movement and shipment of goods into tangible objects, including real estate (buildings and structures) and movable (vehicles) (Taran, 2010).

N.G. Kuvaev proposed the dividing "of all elements of logistics infrastructure into three groups: transport, storage facilities and service elements, the functionality of which is associated with cargo handling and the provision of additional services. At the same time, each element of the infrastructure should be provided with resources of a certain type: material and technical, human, informational, financial and others" (Kuvayev, 2006).

M.M. Kuznetsov presents logistics infrastructure "as a totality of elements that take part in the movement of commodity-material flow from a producer to a consumer. These can be: an organizational base, which consists of supply and marketing, brokerage, and other intermediary organizations; material base, consisting of transport facilities, warehouses; information system – including means of communication; credit and settlement base as part of banking and structural institutions" (Kuznetsov, 2012).

Within the framework of the elemental approach V.I. Sergeyev distinguishes the following components logistics infrastructure:

– storage facilities (compositions of various types and purposes);
– units for the operation of transport;
– communications (roads, access roads, etc.);
– auxiliary units (repair of vehicles of varying degrees of complexity);
– information and telecommunication systems (Sergeyev, 2005).

The given totality of approaches and definitions allows us to point to the fact that logistics infrastructure has its own peculiarities that affect both formation and functioning.

Research methodology

Our consideration of various points of view make it possible to systematize approaches (systemic, functional, elemental) to the definition of the category of "logistics infrastructure". This study takes into account the systematization of existing theoretical and methodological approaches, which allowed us to propose an author's approach to determining the logistics infrastructure of the regions, which is considered as a complex category, which consists of a set of functions, subjects focused on the development of logistics organizations by optimizing financial, informational, material and other flows taking into account the peculiarities of interaction with different groups of stakeholders. The optimization of material or commodity flow is realized by the increasing of working capital, reducing the level of stocks in warehouses, etc. Logistics infrastructure is an integral part of the region's logistics system; therefore, the study is based on the basic principles of a systematic approach, one that defines each system as an integrated whole even when it consists of separate, disconnected subsystems.

Results and discussion on the Belarussian example

What follows is a taxonomical assessment of the importance of infrastructure for the development of economies and populations (Kolodin, 1999; Voshchanova, 2001).

As a result of the systematization of existing theoretical and methodological approaches, an approach is proposed here regarding the definition of the logistics infrastructure of regions, which is considered as a complex category that incorporates a totality of functions, subjects that are focused on the development of an organizational logistics sphere by optimizing financial, information, materials and other flows, taking into account the peculiarities of interaction with different groups of stakeholders.

The proposed research process reveals that most researchers (Kuznetsov, 2012; Anikin, 2000) subdivide the logistics infrastructure facilities into the following groups:

Group 1 – objects of small groups: "these are local truck fleets, logistics centers with the provision of certain types of services. These include objects that control the commodity flows of individual enterprises and their network associations" (Dybskaya, 2009; Taran, 2010).

Group 2 – regional facilities, the functionality of which "is represented, as a rule, by a more complete range of logistics services. They are located in a territory with a well-developed transport infrastructure and a modern information system" (Kuhan, 2018; Zakharov, 2017). Such dispositions facilitate the efficient managing of good flows within a territory possible.

Group 3 – "international logistics centers which are complex infrastructure facilities, the territorial dimensions of which can be quite large. They are located, for the most part, in close proximity to highways, railway junctions, seaports and airports" (Anikin, 2000). Such a disposition supplemented by a full range of logistics services and the capabilities of modern information technologies can significantly speed up the time for the movement of goods through the country in which they are located.

As a rule, the logistics infrastructure facilities include the following:

– enterprise warehouses;
– logistical and distribution centers;
– terminals.

Roadside service infrastructure currently has insignificant growth dynamics, and in some cases the position is also declining (Table 1).

Table 1. Roadside service infrastructure in the Republic of Belarus for the period 2012-2018

Types of infrastructure	2012	2013	2014	2015	2016	2017	2018
Hotels, motels, campsites	47	49	57	54	64	74	75
Service Stations	-	66	56	52	47	85	82
Retail Stores	777	857	854	894	934	1008	1019
of which gas stations	463	493	480	475	485	473	482
Catering facilities	464	483	501	529	556	598	602

Source: Statistical Yearbook of the 2018: Transport and communications in the Republic of Belarus, Minsk, p. 67.

Such unstable dynamics reflect the current economic problems that impede the development of logistics infrastructure and related services.

Each enterprise independently decides how many logistics infrastructure facilities it needs and where to locate them. In special situations a part of the operations or their entire spectrum can be outsourced. In some cases, conducting operations at such facilities may be transferred to third-party specialists who provide the relevant services. Whoever performs the work on the implementation of logistic services, all infrastructure facilities are considered as integrated elements of the enterprise's logistics system. At the same time, it is necessary to take into account that the number of objects, their capacity and location have a direct impact on the level of service and the amount of costs when realizing the service of this type. Therefore, the optimization of the infrastructure (distribution, logistics) network is one of the most important issues for enterprises and regions; as this network provides an efficient delivery of goods to consumers.

A sufficiently large number of state and regional programs in Belarus are aimed at the development of a logistics infrastructure. As a positive example, we can consider the construction and commissioning of logistics centers, which are objects of logistics infrastructure, the effective operation of which affects the economy of the region in which they operate.

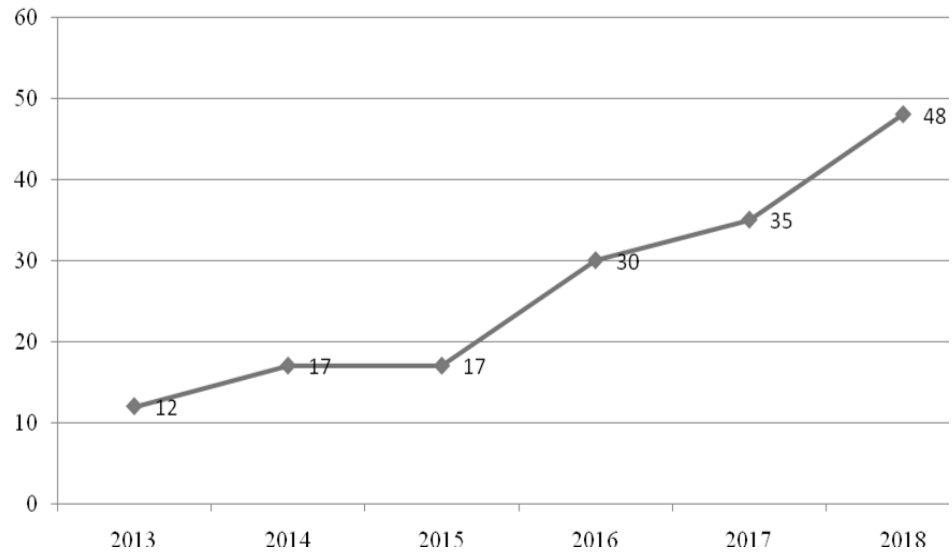

Figure 1. The number of logistics centers built in the Republic of Belarus for the period from 2012 to 2018.
Source: based on data Statistical Yearbook 2018: Transport and communications in the Republic of Belarus, Minsk, p. 79.

Given the constant dynamics of the external environment, changing supply conditions and variety of assortment, each company strives to maintain and improve its competitive advantage. That is why the choice of the best location for the logistics network, to incorporate the functionality of distribution centers and warehouses, has been and remains an important management issue.

The transport costs of any enterprise have a rather large share in the cost price of production; therefore, the activities of an enterprise in the transportation of goods are determined not only by the storage location of stocks, but also by the parameters of the infrastructural network, as well as information and communication capabilities. The shipment of goods within the logistics network can be organized in one of three options:

1) the use of one's own transport fleet;
2) the involvement of specialists and equipment of the transport company or forwarding firm (outsourcing);
3) the use of various combinations of transportation modes (multimodal, intermodal or combined schemes) with a differentiated approach to customers.

In addition to the above-mentioned costs, inventory management remains an important component of the infrastructural management process. The maintenance of storage facilities, the storage of stocks, and their maintenance often become an overwhelming burden for an enterprise; and therefore stockpile requirements are determined, as a rule, by the logistics infrastructure and a given level of service. This situation arises when the organization, due to limited or lack of storage space, resorts to renting the required number of areas. In this case, the main task is to obtain the requested level of service at the minimum total cost for the required amount of inventory inventory (Kovalska, 2009).

Given that stocks are "related" financial assets, most enterprises seek to reduce them. Therefore, the main goal of inventory management is the desire to reduce the turnover period in the process of satisfying customer requirements. A rational inventory management policy is based on the selective allocation of resources with five grounds, which include: segmentation of the consumer market (composition of consumers), the required range of products, integration of freight transportation, temporary needs, and competition requirements (Kuhan, 2018).

Moreover, if the main problem for the logistics of an enterprise becomes an issue of the organization of a warehouse, they can draw on their own resources or make recourse to the outsourcing of warehouse services. At the same time, the search for a warehouse is the easiest problem to solve; because many actions, important for logistics as a whole, are implemented when the goods are in stock. These involve the sorting of goods, paperwork, order processing, as well as picking consignments for shipment to one destination and much more. To increase the efficiency of cargo handling and transportation, enterprises use the integration of standard modules into larger cargo units. Such an option facilitates increases in the volume of transported cargo without changing the costs of its shipment.

Thus, we can conclude that the logistics system is a symbiosis of four areas of activity: organization of infrastructure, information exchange, movement (transportation) of goods and inventory management. Activities in each direction achieve a certain level of service. In reality, a combination of these four constitutes an integrated logistics solution system. The remaining functional activities within the logistics network of – warehousing, cargo handling, and packaging – are also parts of the logistics system, but they do not occupy such an independent position as the first four.

It is necessary to note the central part of a warehouse in the enterprise logistics system, as each functional area of logistics (supply, production, distribution) is more or less connected with it. “This peculiarity is reflected both in the functions and tasks of a warehouse. Moreover, the nature of a functional area of the logistics system affects the solution of warehousing logistics problems: the choice of warehouse ownership, the location of warehouse network, the technical equipment of the warehouse, the storage system and the organization of warehouse process” (Sergeyev, 2005).

Choosing the best location for a logistics network may be the first step for regional enterprises to gain competitive advantage. Given the parameters of the infrastructure network and the information capacities of a logistics system, the geographical distribution of an enterprise’s reserves is determined by its transport capabilities. In our opinion, due to the fact that transportation and the obvious costs associated with it underlie any area of activity, they are important. The process itself of transporting goods can be organized in accordance with the capabilities of a company (Voshchanova, 2001). It can be owned transport or outsourced transport services. Attracting a third-party organization which specializes in providing transport services will reduce the costs associated with maintaining one’s own transport. An interesting option is the combination of different transportation modes that provide a combination of transport services (multimodal, intermodal and combined schemes), which allows satisfying the individual needs of customers. Despite the fact that the complexity and quality of logistics services may be at a discernible low level, the tariffs for these services provided by logistics centers and logistics operators in the Republic of Belarus remain higher than those of its neighboring countries.

When drawing up the Concept for the logistics system in Belarus: the infrastructure features together with the need to improve increase economic activity in the regions and positive impact on the cost of transport services were taken into account (Kuhan, 2018).

In accordance with the Concept, the main projects which form a promising logistic infrastructure are:

1) the development of a logistics services market, contributing to the maximum implementation of the multimodality principle;
2) increasing the transit potential by involving logistics operators and the logistics system of Belarus in international projects of commodity distribution market, the basic projects of which are:
   - the integration of logistic infrastructure and technology into the implementation of the concept of “One belt, one way” (Kuznetsov, 2012; Kuhan, 2018);
   - integration into activities of international container operators and the implementation of innovative technologies in the field of container transportation, including the passage of container flows in the direction of China – the European Union – China through the territory of Belarus;
3) integration in terms of global international transport and logistics companies in the sphere of export-oriented distribution networks. The flagship project is the ‘Great Stone’ Chinese-Belarusian industrial park, taking into account the positioning of the given park as a support point of the Silk Road Economic Belt, etc.

One of the main goals of the socio-economic development of Belarus is to create a competitive advantage for the region; therefore, creating an optimal logistics (distribution) network based on a justified and economically grounded decision of creating logistics infrastructure facilities remains strategically important.

The quality of such decisions depends on the information available to people who make decisions (decision makers). In a dynamically changing economic environment, the process of designing a logistics network which includes the choice of the best location and designing the construction of a logistics center is a multi-stage process that requires taking into account many external and internal factors. Taking into account external factors, it is necessary to remember about the implementation of the project in the framework of the legislation, social and geographical environment, etc. Internal factors include the qualifications of the managerial staff, as well as their attitude to innovation and organizational changes (Bor, 2000).

The choice of location for new logistics centers should be made taking into account export, import, transit and domestic cargo flows. It is necessary to take into account the fact that the main sources of cargo flow in Belarus are free economic zones (FEZ)

of regional centers, as well as cities: Baranovichi, Borisov, Zhlobin, Mozyr, Orsha, Pinsk, Soligorsk. The use of the advantages of urban agglomerations that perform distribution functions, as well as, international transit corridors for the accumulation or distribution of transit export-import cargo flows is confirmed by the world practice of creating a European distribution network (Kuhan, 2018).

When choosing the location of the logistics center one should be guided by the following principles:

1) using the expansion possibilities of existing distribution warehouses or logistics centers in terms of a favorable geographical location;
2) it is advisable to reserve as much land as possible - not less than 100 hectares;
3) when designing, it is necessary to take into account the territorial multi-functionality of the logistics center: the presence of a container terminal, warehouses, other service facilities (gas stations, vehicle service stations, catering establishments, hotels, etc.) , as well as, organizations requiring office premises (administration, customs services, banking and insurance centers, IT, etc.);
4) the combination of small distribution centers in one city into one major logistics center;
5) it is desirable to have maximum proximity to the highways;
6) use of the latest logistics technologies in planning, organizing and management of commodity, transport and financial flows;
7) the presence in the center of information companies (divisions) that provide support for the transportation process, storage, cargo handling, service and other types of logistic services;
8) ensuring the maximum synergy effect on the basis of establishing mutually beneficial partnership relations between the participants of the logistics process while maximizing customer satisfaction as a service (Bor, 2000).

Before the construction of a logistics center, it is necessary to create a location selection model and develop requirements that it must meet in order to ensure its versatility. It is assumed that the model should include four stages: preliminary analysis; determination of a general location; making decisions about choosing the best location of the logistics center; project implementation (Kuhan, 2018).

Progressive computerization and universal access to information have had a positive effect on the acceleration of economic processes. These changes also have a direct impact on the speed of economic analysis, their accuracy and decision making. Certain fragments associated with the calculations, in the implementation of models of the methodology can be automated, which in its turn will lead to an increase in a speed of obtaining information necessary for decision-making.

In order to correctly define the first and second degree goals: the measures needed to achieve them and the forming of a set of possible solutions to the problem, additional information is required (demand, volumes of material and financial flows, structure and number of available transport vehicles, timeframes at individual delivery points, etc.).

The choice of data and their time range depends on the intended goals. Brainstorming is most often used to improve information gathering and determine possible options. Other methods that support the identification of possible solutions to the problem are: benchmarking (comparison with the best organizations in the studied sector, this method allows us to implement solutions that have already been tested), scenario methods, expert methods, including the Delphi method.

The second step, which determines the potential location of a center, is to determine the location search area. This stage is quite important and further affects the amount of transportation costs generated in the future.

The stage consists of three elements: the construction of a mathematical model for choosing the location of a logistics center, geocoding and the process of modeling the selection of the location of a logistics center. The result of the calculation is the determination to of the search area for the detailed location. To obtain a more accurate solution, it is possible to use several mathematical methods, as well as software that generates digital maps (Kuhan, 2018). However, mathematical analysis may not be enough. The economic reality is more complex, and limiting the analysis can lead to a management error.

During the implementation of the third stage, it is necessary to take into account the influence of factors reflecting the economic situation in the region. These factors may be specific to a particular industry geopolitical situation. Existing mathematical models allow, as a rule, only the analysis of design factors. Consideration of other factors can be associated only with the subjective opinion of a decision maker.

When evaluating calculational options, the following criteria should be considered: the area of land, the availability of utilities, an analysis of the regional development plan, a possibility of creating a special economic zone for an emerging logistics center, the existing infrastructure. The assessment of the estimated transportation costs for the options analyzed is another element supporting the decision to choose the best location for the center. This is the most important element, as correctly estimating costs can have a significant impact on the final decision. Calculating the cost of transportation is

possible by using specialized software that solves traveling salesman problem within time intervals to find the best configuration for the distribution of goods. Using digital maps, taking into account the type of transport, orders, price lists and other available options, you can calculate the value of the logistics costs for a given location.

In addition to the estimated transportation costs, the cost of the investment must be indicated. Depending on whether a logistics center will be formed on the basis of the finished storage areas, or if investment in a new project is required, such costs should be considered for each option under consideration.

Also, an important element is the identification of additional factors that may have a significant impact on the location of the logistics center, for example, the distance from a multimodal hub or an airport.

The choice of location should be verified in terms of cost effectiveness. The most popular method is the analysis of NPV, IRR, MIRR (Wieteska, 2012). Alongside transport and infrastructure costs, you should consider the operating costs of the object and capital costs when assessing the value of the current project. Financial analysis should be confirmed by an additional recommendation for the selected location of a logistics center in accordance with the preferences of a decision maker. The result of the calculation process is the recommended location of the distribution center.

The fourth stage – the implementation of the project – consists of three elements: the assessment of the results, taking into account the planned and actual indicators, the implementation of the logistic center construction project, costs control, taking into account the objectives adopted at the analysis stage. Project implementation and results monitoring are necessary in order to confirm that all project assumptions have been fulfilled.

The use of multi-criteria decision-making methods makes the decision-making process more flexible, and it allows for the analysis of many quantitative and qualitative factors that have not been taken into account so far.

An integrated and universal approach to the problem of choosing the location of the distribution center is a multi-dimensional and innovative approach. Highly detailed methodology must always come to the fore.

Conclusions

TThe choice of a common location determines and links the future of an infrastructure object with a given region or its enterprises, retail outlets, suppliers providing raw materials, as well as the labor market. The location of the infrastructure object should take into account the physiographic nature of the selected site, its technical equipment, the availability of transport infrastructure, and plans for its development. An important aspect is the presence of competitive facilities. Estimating transportation costs for the options being analyzed is another element that supports the decision to choose the best location for the center. A preliminary calculation of the cost of transportation is possible by using specialized software that solves the traveling salesman problem with time intervals in order to find the best distribution configuration. Using digital maps, taking into account the type of transport, orders, price lists and other available parameters, we can calculate logistics costs for the selected location of the infrastructure object.

It is important to note that as a system of interconnected elements, logistics infrastructure is characterized by objective laws inherent in the development of systems. Knowing the nature of the development of systems and by using the laws of their development and managing them, it is possible to predict the development of regions successfully, to plan the creation of communication lines effectively, to build a competent government policy pertaining to the financing the construction of roads, communications and other elements of logistics infrastructure.

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