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Formation mechanism of logistics cluster in Belarus

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Abstract

A relatively small number of large industrial enterprises and major exporting companies has a dominant position in the market and determines the corresponding demand for transport services. Logistics activity in the country is one of the growth points of the economic system. One of the ways for increasing the efficiency of logistics activities in agriculture and food transport management sectors in Belarus is the creation of logistics clusters. The article proposes a methodological approach to the formation of logistics cluster in the region. The approach is based on three phases of work: identification of a cluster, evaluation logistics rents and logistic potential of the region, where the cluster is located. This allows assessing the expedience of cluster formation and its subsequent development. This process is connected with agriculture and food processing activity.

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Keywords: logistic; cluster; rents; potential.

1. Introduction

Processes of globalization, increasing of competition, slowing down market conditions and declining of business activity during the recession create macroeconomic risks for the Belarusian enterprises. It determines the need of improving competitiveness of industrial production, the formation of a strategic reserve of economic growth.

Currently, the tendency of clustering the industries can be observed. This tendency also applies to logistics, which is now associated with the operation of enterprises based on integrated cross-flows (Szołtysek, 2010).

Transport and logistics clusters (TLC) – industry clusters, the end products of which are transport and logistics services in the cargo sector, the passenger sector, or both. Interest in the formation of these structures is caused mainly by two reasons:

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1. TLC – clusters of services, whereas the traditional literature on industrial clusters focused on clusters of commodity production.

2. Transport and logistics industry as well as transport and logistics systems occupy a special position in the country's economy, along with cities and metropolitan areas, important elements of regional economies and their sustainable development.

Because of these reasons the level of transport and logistics system development in the country to some extent determines its economic growth. The efficiency of the logistics industry in the country is estimated by its gross domestic product (GDP) share: in the US, Japan, EU logistics costs volume doesn't exceed 10–12%, while in China it is still less than 25% of GDP (Figure 1) (Zhudzhun et al., 2008).

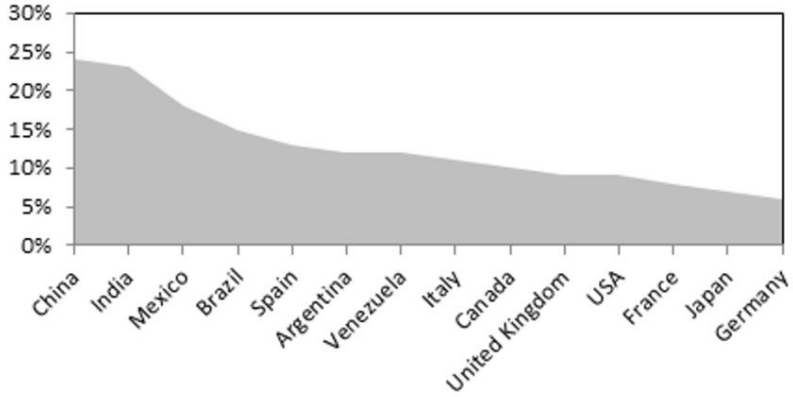

Fig. 1. The share of logistics costs in total GDP Worldwide for 2011

The analysis of Figure 1 shows that the largest logistics costs have those countries in which there are the long routes and logistics supply chain. Also worth noting is that not always the highly developed countries may have a perfect logistics network. For example, despite the fact that logistics in China is recognized as one of the most perspective sectors, the logistics market of China lags behind world standards and technologies. Construction of logistic networks, the introduction of modern logistics technology and the system of distribution and inventory management in China show low efficiency. The average period of raw materials storage for manufacturing enterprises in China is 20 days, finished goods – 51, trading stock of companies – 34 days. Percentage of goods damaged during storage and distribution exceed 2% (Buglak and Zverev, 2006). In Belarus, the situation in the field of logistics is improving in many aspects. Belarus is ahead of the Commonwealth of Independent States (CIS) in three areas of logistics, namely in the effectiveness of customs clearance procedures, the development of transport infrastructure and tracking the passage of goods. Nevertheless, Belarus lags in the availability of services for the organization of international traffic, as well as in competence of the national logistics industry. In Belarus, the transport and logistics sector plays an important role in the economy. The Republic is a net exporter of almost all kinds of transport services. Transit transport corridors between the countries of the European Union (EU) and, potentially, between the EU and Asia pass through the country. This is due to the fact that Belarus has a strategic geographical position on the routes of two European transport corridors, in the development of which the EU and the Russian Federation is interested. Along with a high level of geographical concentration of international trade, the structure of trade by commodity groups in Belarus is also characterized by a high degree of concentration. A relatively small number of large industrial enterprises and major exporting companies has a dominant position in the market and determines the corresponding demand for transport services. Logistics activity in the country is one of the growth points of the economic system. One of the ways for increasing the efficiency of logistics activities in Belarus is the creation of logistics clusters.

2. Logistics cluster: concept and characteristics

Before moving on to the concept of logistics cluster is necessary to define the category of "cluster". Summarizing the work of Rosenfeld (2005), we can conclude that the economic cluster is a group of companies belonging to the same sector (region) and operating in close proximity to each other (Rosenfeld, 2005).

In the economic literature, logistics cluster is defined as an integral part – usually infrastructure – of economic cluster or its subsystem, interpreting it as a cluster formed at the intersection of the main material flows and consolidates profile logistics facilities (Evtodieva, 2011ab;), as well as a type of economic cluster (Kibalov et al., 2007). From this point of view, the range of tasks for such logistics structure are to ensure the through stroke flow of the processes between producer and end-user with the inclusion in integrated supply chain linked products which based on known and similar types of economic activity. In other words in scientific researches logistics cluster is seen as appendix to a particular type of economic activity (Leenders and Fearon, 2006; Sheffi, 2012), highlighting the fact that the logistics cluster provides logistics services to the end user and in fact acts as a cluster of services.

Also logistics cluster is treated as geographically concentrated set of activities cconnected with logistics or as geographical agglomeration of logistics activity. It is characterized by, among other factors, low transportation costs and high level of transport service when moving goods in and out of the cluster. Logistics clusters are examples of public-private partnership, and the strength of this partnership usually determines the success of cluster development (Sheffi, 2012). From our point of view, the logistics cluster is especially organized an integrated logistics system consisting of a group of related organizations (companies, corporations, universities, banks and so on.) concentrated on some territory, complementary to each other and reinforcing the competitive advantages of individual companies and the group as a whole, aimed at the organizational and structural, organizational and analytical improvement (optimization) of flow processes and streaming functions of any content (logistics activity) in the reproductive cycle.

Experts have criticized the restriction of "logistics cluster" concept to the transport and logistics cluster, offering the argumentation and developing appropriate classification of logistics clusters (Houérou et al., 2006; Evtodieva, 2011a; Vladimirov and Tretiak, 2008). If to consider the integrated logistics chain itself as a network, in such logistics networks are presented elements of different quality by nature, several control units and a complex system which combine the interests of the communication subjects is used. In this case, the logistics cluster can be viewed from the position of the object and process decomposition of the logistics network based on the principle of "triple helix" (the interaction of business, government and science). In this case, the logistics cluster in addition to the structural units of the logistics system (network, channel chain) and key business processes (logistics process, function, operation) is complemented by features and characteristics of economic clusters. In this case the cluster approach is reflected to the construction of logistics systems. Along with it also synergistic, tectological and cybernetic approaches are distinguished to the construction of logistics systems and its combinations. In the economic logistics using cluster approach allows you to raise modeling logistics processes and operations to a higher level of organization. In view of this, according to some foreign and domestic researchers in logistics is a change of scientific paradigm – integrated logistics paradigm is maintained (Aphanasenko, 2013). Logistics clusters exhibit the same properties that industrial clusters: increasing productivity through shared resources and suppliers; improvement of social networks, including the transfer of knowledge; the presence of tacit knowledge; high levels of trust and social capital; availability of highly specialized workforce, research centers, technology transfer centers, academic and university research, consulting firms and analytical platforms and innovation centers. However, logistics clusters have some characteristics that make them unique in terms of the formation of clusters and their contribution to economic growth. Logistics cluster benefits can be considered in two limits of two categories: operational benefits associated with transportation, and benefits associated with collaborative resources and assets of the cluster formation participants (Sheffi, 2013; Bookbinder, 2013). Both benefits are increased significantly due to the mutual gain feedback mechanism, generating and forming a kind of logistics rent. The majority of logistics clusters are developed due to certain driving factor of development. The main factor is the government. In younger logistics clusters public-private partnerships and quasi-government structures play a key role. The main factors of development are the characteristics of the natural environment, mainly geographical position. Generally logistics clusters are similar to the economic clusters, combining the features of logistics systems and economic clusters, obeying to the general principles of functioning and development of complex organizational systems. Because of this, the logistics cluster is a specially organized logistics system – the concentration of logistics activities that shown by a group of companies and organizations aimed at organizational and structural, organizational and analytical improvement (optimization) of flow processes and flow functions of any content in the reproductive cycle.

3. Mechanism for the creation of regional logistics clusters

During determining what is meant by the logistics cluster, the question naturally arises as to the appropriateness, necessity and the purpose of its formation or development within a certain area or region. For making a decision on the establishment of a logistics cluster in the region is necessary to evaluate the possibility of building such cluster. Within the first direction clusters in the regions should be searched or identified. Identification is carried out according to the procedure (Androsik, 2013 and 2014) on the basis of calculating the coefficients of localization and agglomeration – two signs of the existence of the cluster – based on economic (logistic) activities in the region, which are reduced to the integral index of clustered region. In the proper sense of the word it's not the clustering. Cluster receives natural impulse for its emergence and development. The essence of controlling actions is to correct and control the trajectory of cluster development. *Clustering regions level* can usefully be measured in the context of localization and agglomeration effects (Record, 201). Typically, they are considered as separate concentration types.

Calculation of the localization coefficients is used to identify clusters by the characteristics of the region (area). For such characteristics are used indicators of employment, income, revenue, investment, number of enterprises, and others (Golovachyov and Khotko, 2013):

$$C_{ij} = \frac{x_{ij}}{\sum_{i} x_{ij}} \times \frac{\sum_{j} x_{ij}}{\sum_{ij} x_{ij}} \tag{1}$$

C_{ij} – localization coefficient under characteristics, x_{ij}– characteristics of the i-th industry in the j-th region.

The coefficient reflects the ratio of the share of this industry in the structure of the region to the specific gravity of the same industry in the country. If the index is greater than one, conclude that the production is localized in this region. Next we calculate the agglomeration coefficient. There are arguments for and against the positive impact of agglomeration on the development of the regions and regional clustered growth, however, in view of the high role of agglomeration effects, the structure of urbanization and the size of urban settlements, population density and its qualification structure are paramount. Analyzing the agglomeration effect used the idea of expanding the production function due to urbanization level, its structure and agglomeration potential indicator of the territory and urban settlements. As the level of agglomeration adopted indicator of the share of the urban population, and for characterization of the capacity to generate agglomeration effects used indicator of a medium-sized city. In view of the fact that regions differ in size and economic activity, to eliminate the correlation scale and economic activity, for evaluation are used the indicators of the gross regional product and fixed production per capita.

To calculate the agglomeration coefficient the formula is used:

$$U_{ij} = \frac{G_{ij} \cdot GRP_{ij}}{\sum_{j} GRP_{ij}} \tag{2}$$

U_{ij}– agglomeration level indicator of the j-th region (area) i-th settlement (district), G_{ij} – urban population share of the i-th profile district (city) in the j-th region, GRP_{ij} – gross regional product of the i-th settlement the j-th region.

If indicator strives to one it shows the growth of the level of agglomeration process and agglomeration potential development. This formula may be supplemented by the agglomeration regions criteria, such as the concentration of the population, the concentration of economic and social infrastructure and management, concentration of scientific and technological activities and education, improving the quality of life. In order to clarify the level of agglomeration effect of the region and its determining as a clear sign of the existence of a cluster in the region, it is advisable to monitor the dynamics of the level of gross regional product per capita (GRP growth rate). The positive dynamics of this coefficient indicates the presence of a cluster. Negative dynamics of the coefficient in the particulars years contrary to the nature of cluster formation, because the cluster, by definition, may not be effective and, therefore, is the point of attraction of resources (attractor). Based on the localization and agglomeration coefficients integral clustered index of region is calculated by the formula:

$$KI_{ij} = C_{Iij} \cdot U_{ij} \quad (3)$$

KI_{ij}– integral clustered index of the j-th region (area) i-th industry, C_{Iij}– potential clustered index of the i-th profile city (district) j-th region, U_{ij}– agglomeration level indicator of the j-th region (area) i-th settlement (district).

The results of calculation of the the index of potential clustered region in the period from 2006 to 2010 are shown in Table 1.

Table 1. The index of potential clustered region.

Region	2006	2007	2008	2009	2010
Brest	2.7291	2.5744	2.1337	1.6779	1.7382
Vitebsk	0.0006	0.0001	0.0002	0.0004	0.0004
Gomel	0.0465	0.0499	0.0488	0.0650	0.0636
Grodno	0.2375	0.2446	0.2906	0.2253	0.2403
Minsk	0.1286	0.1547	0.2033	0.2675	0.2559
Mogilev	0.0312	0.0246	0.0281	0.0378	0.0367

The findings suggest that the regional characteristics of areas influence on the development and effectiveness of logistics operators, which directly determine the possibility of the clusters formation. As a result of the analysis the greatest potential for clustering has Brest region. Calculations show this area the most perspective for development of the potential logistics cluster. Considering the spatial arrangement of areas can be also assumed that the close location of Minsk and Grodno regions will allow include them in a potential cluster. It is necessary to emphasize the fact that almost all plants are located on the main highways of the country that directly related to the infrastructure of roads and railways. The high density of industrial production in Brest and Grodno regions is provided by large enterprises, while small businesses are not widely represented. The high density of industrial production in the Minsk region is provided in both large and small enterprises. This fact shows two fundamentally different clustering models. One (in Brest and Grodno regions) is built on a "Hub-and-Spoke" model when there is an integration of large local firms with small local business and the presence of a clear hierarchy can be seen. The second (in the Minsk region) is constructed on a "Marshallian cluster" model, when there is an integration of small businesses due to their precise specialization, strong local competition in the presence of co-operation, a relationships based on trust. Conducted above calculations were carried out according with block A (based on the localization effect) presented methodology. The next step is to calculate the agglomeration effect (Block B). Analyzing statistics for the urban population can be seen that its numbers vary slightly from year to year as a percentage of the base (previous year). This indirectly indicates the absence of active agglomeration processes in the regions. Dynamics of the share of urban population is smooth, with no major changes, but shows an upward trend. This means that agglomeration processes are slowly enough and the proportion of the urban population is gradually increased. According to the statistics on areas, GRP has an almost permanent structure, the contribution of the regions in the total GRP almost does not change, the change in shares occurs smoothly, indicating the established structure of industrial production and continuing current trends. Next, calculate the agglomeration coefficient according to the methods of clusters identification. The results of these calculations are presented in Table 2.

Table 2. Agglomeration coefficients by regions.

Region	2008	2009	2010	2011
Gomel	0.1016	0.1030	0.0992	0.0963
Grodno	0.0656	0.0697	0.0671	0.0636
Minsk	0.0966	0.0861	0.0922	0.0985
Mogilev	0.0705	0.0696	0.0720	0.0641

According to the method aspiration of the coefficient to one shows the growth of the development level of agglomeration processes and agglomeration potential of economic space. The calculated values are quite low. This

testifies to the low intensity of agglomeration processes. In order to clarify the level of agglomeration effect of the region and its definition as a clear sign of the existence of a cluster in the region, it is advisable to monitor the dynamics of the level of gross regional product per capita (chain GRP growth rate). The calculated values are shown in the Table 3. It is also worth noting that the indicator of GRP began to be calculated in 2008. The positive dynamics of indicator shows the presence of a cluster. Negative dynamics contrary to the nature of cluster formation, since the cluster by definition cannot work effectively.

Table 3. Dynamics of the level of gross regional product per capita.

Region	2008	2009	2010	2011
Gomel	0.0053	-0.0434	-0.0235	0.0558
Grodno	0.0526	-0.0463	-0.0491	0.0529
Minsk	-0.1101	0.0723	0.0813	-0.0106
Mogilev	-0.0141	0.0352	-0.0987	0.0671

The presence of negative values shows a decrease of GRP share in total regional product, although only increasing should be observed. Agglomeration coefficients on the regional level because of the nature of agglomeration processes are low. The second direction is based on the identification of assumptions and possibilities for cluster formation in the economy. In this case, the cluster does not exist, but there are conditions for its formation and development. Then clustering management involves implementation of the opportunity to create a cluster structures, and further their maintaining and support. In this case, assessment of the region prospects is carried out in terms of opportunities and conditions for the formation and using of logistics rents and logistics potential in the region. Calculation of the existing logistics rents (rents received from the organization of the movement of material flows) is presented below:

$$R_{lr} = k_1 \cdot AV + k_2 \cdot T, \tag{4}$$

AV – added value, which remains in the region, rubl., T – transit material flow through the region, rubl., k_1, k_2 – the rate of return obtained from the organization of the logistic function of material flow circulating in the region.

Calculation of the potential logistics rents is presented below:

$$R_{pl} = \frac{T_p}{T_c} R_{сл}, \tag{5}$$

T_p – assessment of logistic potential in the region, T_c – the current assessment of the region in terms of logistics.

To rank the regions according to their attractiveness is advisable to use a criterion calculated by the following formula:

$$E_f = \sum_{t=1}^{N} \frac{(R_{ct} - R_{lr} - \dot{O}_{\pi t})}{(1+r)^t} - \sum_{t=1}^{N} \frac{I_t}{(1+r)^t} - \sum_{t=1}^{N} R_t, \tag{6}$$

R_{ct} – logistics rents in period t, R_{lr} – actual logistics rent (basic), $T_{\pi t}$ – the growth rate of inflation to the base period, %, I_t – required investments in period t, R_t – risks in period t, r – interest rate.

In the case of a positive assessment decides to support cluster initiatives and projects, ensure the clustering process and the implementation of cluster programs and strategies of logistics clusters formation. Thus in the cluster projects are defined purpose, authority, responsibility of cluster subjects, strategic management, financing, costs, risks, participating in using results. The most appropriate is a partnership agreement, the terms of which are: a form of partnership, the type

and order of project implementation, the transfer of ownership on the created object, the allocation of profit, legal and financial guarantees to participants and other features of the agreement (Golovachyov and Khotko, 2013). Institute of public-private partnership supports a set of critical mass of the cluster and ensure its further development. Next formed or determined core of logistics cluster, created and built up logistics infrastructure, the boundaries of the cluster are expanded, which includes logistics operators, trading and manufacturing companies, educational and research institutions. The result of the logistics cluster functioning of the first level is the growth of logistics potential of the region and logistics rent (let's call it the logistics rent I). In this case, at this stage unique logistical assets are created and allow you to be integrated into the international supply chain. As a result, companies receive logistics rent I. During interacting of the logistics cluster with companies from other regions (countries) are generated logistics rent II, which is based on the evolution of inter-firm linkages, both within the logistics cluster and beyond. This allows you to manage their logistics assets more effectively and leads to synergistic effects that can be divided into additive and non-additive. Despite the availability of a variety of theoretical and practical research on the issue of cluster interaction in the literature hardly developed evaluation questions of synergistic efficiency. Thus, Kulagin and Kulagin noted: "there is no clear, uniform methodology for evaluating the effectiveness of integrated units" (Denisov, 2012). The most complete picture of the structure of synergetic effect as a multifaceted concept is revealed in the model of R. Matthews, in which the mechanisms of Subadditivity (S_{sub}) and Superadditivity (S_{sup}) are recognized as the main components of the total synergetic effect (S_k):

$$S_k = S_{sub} + S_{sup} \tag{7}$$

Subadditivity as a characteristic of logistics cluster connectedness leads to reducing of the total costs of the merging companies which attracts capital eliminates duplication of staff functions, etc., while saving the existing volumes of cargo handling. Subadditivity described by the formula:

$$F(x_1 + x_2 + \ldots + x_n) \le F(x_1) + F(x_2) + \ldots + F(x_n) \tag{8}$$

Inequality means that the value of F function from the sum of the variables x_i is less than or equal to the sum of the values of the functions of each of the variables.

Synergetic effect from subadditivity measured by the value:

$$S_{sub} = F(x_1 + x_2 + \ldots + x_n) - (F(x_1) + F(x_2) + \ldots + F(x_n)) \le 0, \tag{9}$$

Superadditivity determines profit growth due to the growth of cargo handling (as a result of strengthening the logistics position of the combined company, the implementation of new investment projects which could not be implemented separately, etc.). Superadditivity described by the inequality:

$$G(x_1 + x_2 + \ldots + x_n) \ge G(x_1) + G(x_2) + \ldots + G(x_n) \tag{10}$$

This means that the value of the G function from the amount of variables x_i greater than or equal to the sum of the functions of each of the variables.

Synergies from Superadditivity measured by the value:

$$S_{super} = G(x_1 + x_2 + \ldots + x_n) - (G(x_1) + G(x_2) + \ldots + G(x_n)) \ge 0, \tag{11}$$

In this way, depending on the S_{super} and S_{sub} ratio the total S_k synergistic effect may be positive or negative. At the same time, the more positive synergies S_k, the deeper and more stable integration process and the more stable logistics cluster becomes; and in the case of $S_k \le 0$, when the synergistic effect is absent or is negative, the cluster disintegrates sufficiently quickly. The problem of evaluating the synergistic effect is one of the most undeveloped in the analysis of effectiveness of integrated structures development in the form of associations of economic entities in the cluster structures. Integration system should be abolished in the case of approximation of losses to the value of synergetic effect.

Effect from the interaction of economic agents (cluster-forming activities) S should exceed the total effects of their autonomous activity ($\sum_{i=1}^{m} S_i$) (outside the cluster):

$$S > \sum_{i=1}^{m} S_i = S_1 + S_2 + ... + S_m, \quad (12)$$

A synergistic effect (S_k) is expressed by the difference:

$$S_k = S - \sum_{i=1}^{m} S_i, \quad (13)$$

There are 3 options:

1) $S_k > 0$ (positive synergetic effect; the larger the S_k value, the more productive the functioning of the cluster is and the better the interaction of participants).

2) $S_k = 0$ (synergistic effect is zero, interaction loses its meaning).

3) $S_k < 0$ (negative synergistic effect, the interaction is not possible).

These effects lead to the formation of the level II logistics cluster or the so-called streaming cluster, under which we understand sustainable interaction geographically independent market actors, whose efforts are focused on maintaining a full cycle of basic and accompanying flows and optimization of resources from the original suppliers to the end users. This type of integration is transforming the relationship between its members on organizational and planning rather than on spontaneous market bases and formed to manage the material, financial, information and human flows from raw material suppliers and manufacturing companies to consumers, interacting with each other within a single chain of the value creation and improving the logistics potential of cluster members.

4. Conclusion

In this case, the construction of the logistics clusters, in relate to servicing of agriculture as well as food processing products, in the region is conducted through three key stages: the identification of cluster, identification and assessment of the value of the rent and logistics potential in the region. Within the calculated evaluations the prospects of development of the region is defined in terms of logistics. In the case of positive ratings, logistics cluster of the first level is formed and created. Its successful operation leads to increasing efficiency of logistics companies, agriculture enterprise, and the emergence of logistics cluster of the second level. It is diagnosed on the growth of the cluster potential and the logistics rent due to the generation of synergy effects.

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