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Research paper

Planning Regional Logistics Infrastructure taking into account Cross-sector Partnership of Stakeholders and Sustainable Development Principles

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Abstract

The objective of the study was to solve the pressing problem, which justify need for a responsible attitude of business and government towards society and the environment. The methods of determining the location of the logistics center as an object of the regional logistic infrastructure were used for this purpose, taking into account requirements and interests of all stakeholders and sustainable development principles. The methodology of the study was based on the authors' analysis of foreign and Ukrainian publications, concerned with the formation of the regional logistics infrastructure and statements of the stakeholders' social and environmental responsibility. The study has suggested the main principles of planning logistics infrastructure based on cross-sector partnership of stakeholders, which, in the authors' point of view, would contribute to the sustainable development of the region and raise the level and efficiency of the regional logistics. A positive aspect of the paper was the results of analysis, namely the regional logistics center impact on the formation of sustainable development indicators in the region, the features and factors that determine the specifics of the Ukrainian regions transition to sustainable development and create preconditions for cooperation of stakeholders of different sectors such as community, business and authority.

Keywords: *corporate social and environmental responsibility, cross-sector partnership, regional logistics center, regional logistics infrastructure, stakeholders.*

1. Introduction

The consistent movement of Ukraine towards market economic transformations and the implementation of the European integration aspirations in all fields of social development give new relevance to the issues of regional policy and raise requirements for its effectiveness. The choice of effective methods and approaches to management, the use of which will ensure the competitiveness and sustainable development of the region are very important in this case. Under such conditions, the task of regional authorities is to initiate the formation of qualitatively new institutional foundations for a new model of the regional development, when economic, social and environmental factors are harmoniously combined, and this model will be implemented with active interaction with other business entities.

Many years of experience in the development of the intersectoral partnership (the model of partnership between the state (government), business and society) of European countries proves that such partnership promotes a constant and well-established dialogue in the society. Therefore, under conditions of administrative and economic reforms in Ukraine, the issue of developing and maintaining rules and principles of partnership, constructive cooperation of stakeholders, that is, creating a model, will contribute to increasing the social, environmental and economic responsibility of all participants while implementing activities aimed at ensuring sustainable development of the region.

Taking into account the interests of all stakeholders becomes especially relevant during the process of the creation of new regional infrastructure facilities, whose activities affect both the socio-economic development of the region and the state of the natural environment. One of the examples of such regional infrastructure facilities, in particular logistics, is the regional logistics center, which combines the activities of various business entities with the purpose to ensure sustainable development of the region and solve economic, social and environmental problems.

The increased interest to the facilities of the logistics infrastructure is due to their significant negative impact on the environment, in particular, they account for 9-10% of greenhouse gas emissions and other environmentally hazardous substances, and the transport that is widely used in logistics is the source of 50% of emissions (90%) [3]. In this regard, European countries placed the emphasis of the implemented logistics solutions for overcoming the following phenomena: air pollution caused by solid particle emissions from diesel fuel, nitrogen oxides, hydrocarbons; noise pollution; high traffic; producing household solid waste [3], etc.

The following scientists were involved in improvement and development of methods for determining the optimal location of logistics infrastructure facilities (warehouses, logistics centers): Govorukha [5], Krykavskyy [8], Mukhtarova [9], Oláh [10], Rakh-

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mangulov [10], Rodymchenko [2, 13, 14], Shusheng [16], Velychko [18], Zielińska [23] etc.
Foundations for the study of social, environmental and economic responsibility of stakeholders were formed by the work of such scientists as Ginevičius [4], Karintseva [7], Onyshchenko [11], Shkarupa [15], Skrylnik [17], Sotnyk [19], Vasylieva [22] and etc.
In our previous studies [2, 3, 11, 13] we analyzed the influence of economic entities on the formation of social, economic and environmental indicators of the region development. Taking into account the above mentioned authors and the research of Grabara [6], Simanaviciene [16], Vasilyeva [21] we consider it appropriate to justify the need for a responsible attitude of business and government to society and the environment, and to confirm this by a practical example.
Thus, the objective of the research is to form such a method for determining the location of the logistics center in the region that would satisfy the requirements and interests of all stakeholders and would be based on the principles of sustainable development.

2. Specific features of stakeholder's interaction during the process of planning regional logistics infrastructure

As practice shows, today the logistics infrastructure of the most cities of Ukraine, inherited from the former USSR, does not meet the requirements of modern business and the European standards of environmental security for the local community. Professor Ye. V. Krykavskyy and Associate Professor N. V. Chornopyska [3] define the logistics infrastructure as follows: "Logistic infrastructure is a system of means for spatiotemporal transformation of logistical flows (material, information, financial, human), as well as a combination of enterprises of various organizational and legal forms, which form organizational and economic conditions for the passage of these flows by building the capacity of appropriate logistics services". The logistics infrastructure should include: roads, railways, airports, railway stations, container terminals, logistics centers, various types of vehicles, etc.
Thus, the effectiveness of transformation of the regional logistics infrastructure in order to comply with the requirements of sustainable development directly depends on the level of consistency of stakeholder views of various sectors (public, financial, social), that is cross-sector partnership, concerning the structure and scale of this infrastructure, the location of specific logistics facilities, their participation in the process of investment support of transformational changes [3]. Such cooperation is beneficial for solving social, environmental and economic problems and useful to each of the parties and residents of the territory where it is implemented.
We suppose that the influence of the local community is determining in the cross-sector partnership, since it endangers the health of its members in case of low social, environmental and economic responsibility of the business that initiates the transformation of the logistics infrastructure. As regards the issue of guarantees of a quality of environment, we believe that the authorities (state or local authorities) should play the main role and the authorities have entrusted with the function of monitoring the compliance with the current legislation. Business structures, public organizations should comply with the norms of legislation and respond to the requests from the community, whose members can be their customers, consumers and influence the results of their activities. Thus, society needs to interact fully with business and government to meet their own interests.
It should be noted that implementation of a mechanism of partnership between the authorities, donors and communities is impeded by a number of restrictions in the context of Ukrainian realities. In particular, this is the imperfection of the legislative framework for an effective partnership. The fact that business and government institutions do not always perceive society as a full partner, capable of dialogue, conducting and defending their interests, and, in fact, do not perceive the partnership model, also causes concern. At the same time, the public also demonstrates an inert attitude to the solution of social, environmental and economic issues, shifting responsibility for them to the state. And this, in turn, prevents the active development of the state as a whole.
We have determined the basic principles of planning the logistics infrastructure based on the cross-sector stakeholder partnership (Table 1).

Table 1: Principles of planning the logistics infrastructure based on the cross-sector stakeholder partnership

Principle	Essence
Principle of system approach	The approach to the logistics infrastructure as a system - the maximum effect can be obtained only if the logistics flows are optimized throughout the entire logistics chain.
Principle of logistics coordination	Ensuring the consistency of all links of the logistics chain in time, i.e. the development of mutually agreed plans for logistics management with the minimum permissible level of impact on the ecosystem.
Principle of optimization	The chosen optimal variant of planning the logistics infrastructure should take into account the interests of all partners.
Principle of rational location	While locating the facilities of the logistics infrastructure, the distance to the city should be taken into account as the distance to a source of skilled labor, as well as the distance between the facilities themselves and accessibility to consumers and suppliers.
Principle of sustainability and adaptability	Facilities of the logistics infrastructure should contribute to the formation of sustainable development of the region while fulfilling their functions.

**Source: designed by authors*

In our opinion, the suggested principles of planning the logistics infrastructure based on the cross-sector stakeholder partnership contributed to socio-economic development, improve the level and efficiency of regional logistics, and support of the sustainable development of the region.

3. Regional logistics center and sustainable development

We have already noted the decisive role of the community in the cross-sector partnership. Therefore, top priorities for regional development are the use of the maximum possible set of logistics infrastructure links to meet the needs of consumers and the reduction of the destructive impact on the environment in order to obtain a total social, environmental and economic effect. As a result of the constant growth of environmental pollution problems, the reduction of anthropogenic impact, maintenance of the environmental friendliness of transport, management of waste products and their disposal, etc. are considered to be the tasks of logistics management [13]. Planning of the regional logistics center location, whose activities have a significant impact on the environment is not an exception too. The regional logistics center is an important element of the logistics infrastructure, designed to handle transport, information and freight flows (Figure 1) [2].
We have investigated the factors influencing the optimal location of logistics centers. In particular, it has been established that most scientists consider the optimal location of logistics centers, taking into account only economic, geographic and social factors. At the same time, the factors of negative impact on the environment have not been taken into account. Therefore, we consider it expedient to take into account economic, social and environmental factors while planning the creation of a regional logistics center.

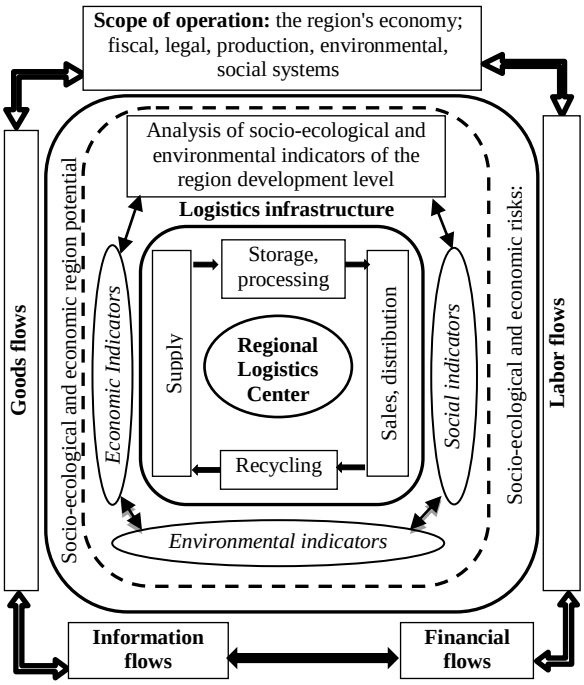


Fig. 1: Characteristics of the impact of the regional logistics center on the formation of indicators for the region sustainable development*
**Source: designed by authors [2]*

This statement became the basis for the formation of an algorithm for choosing the location of the regional logistics center, suggested in research [12], that is based on the use of correlation and regression analysis methods. *At the first stage*, the performance indicator (P_n) is suggested to be determined, which is the key one for the creation of a regional logistics center. For example this may be the volume of retail turnover in the region, the increase of which is in business and authorities interest. Economic, social and environmental factor indicators that affect the performance indicator are determined *at the second and third stages* [14]. Then, *at the fourth stage*, the selected indicators are checked for multicollinearity. Multicollinearity of the input data is one of the significant obstacles to the effective application of the regression analysis apparatus. Very often this problem occurs during the analysis of economic data containing the results of observations of time when the input variables vary from point to point almost linearly. If the factors are not multicollinear, then we should proceed to the next stages, namely, the formulation of the pairwise regression equations and the determination of weighting coefficients for each of the groups of economic, social and environmental indicators [14]. *At the fifth stage*, we formulate the pairwise regression equations for the factor indicators and the performance indicator P_n. *At the sixth stage*, we determine the parameters tgα for each of the pairwise regression equations, determining $\sum tg\alpha[i]$ for the relevant group of economic, social and environmental indicators. *At the seventh stage*, the weighting coefficients of the *i*-th index of *each group* are determined by the formula:

$$v_i = \frac{tg\,\alpha[i]}{\sum tg\,\alpha[i]} \tag{1}$$

where v_i is the weighting coefficient of the *i*-th indicator of *relevant* group of indicators (economic, social, environmental);
$tg\alpha$ is the value of the angular coefficient for each of the pairwise regression equations of the relevant group of indicators;
$\sum tg\alpha[i]$ is the sum of the values of the angular coefficients for each of the groups of economic, social and environmental indicators.
At the eighth stage, the analysis of the weighting coefficients of each group of indicators that have the greatest impact on the performance indicator and their choosing is proposed to be carried out using the coefficient of reliability of approximation (R^2). This indicator shows whether there is a correlation with the model, its value varies from 0 to 1. If the coefficient equals 1, then there is total correlation with the model, and if it equals 0, then this regression equation is bad for predicting the values of the performance [14]. From the above, we will choose the weighting coefficients of each group of economic, social and environmental indicators, for which R2≥0.6 (if the number of factors of each group is more than five). *At the ninth stage*, the weighted coefficients for the selected indicators for stages 6 and 7 are re-determined. *At the tenth stage*, the value of economic, social and environmental indicators is adopted to a comparable type using the method of interpolation of numerical intervals [1]. This method allows to adopt the compared data to a closed interval [0;1]. The adoption of positive indicators (indicators stimulators) is carried out by the formula:

$$I_i^+ = \frac{X_i - X_{i\min}}{X_{i\max} - X_{i\min}} \tag{2}$$

where I_i^+ is adopted to be a comparable type of the *i*-th indicator value (indicator stimulator);
X_i is the value of the *i*-th indicator in the studied group of indicators;
X_{imin} is the minimum value of the *i*-th indicator in the studied group of indicators;
X_{imax} is the maximum value of the *i*-th indicator in the studied group of indicators.
The adoption of the indicators of negative direction (indicators disincentives) is carried out by the formula:

$$I_i^- = \frac{X_{i\max} - X_i}{X_{i\max} - X_{i\min}} \tag{3}$$

where I_i^- is adopted to a comparable form the *i*-th indicator value (indicator disincentives).
At the eleventh stage for each option of the regional logistics center location, the integrated indicator for each group of social, environmental and economic indicators is determined by the formulas:

$$I_{soc} = \sum_{i=1}^{n} I_{soc_i}^{+/-} \cdot v_i^{soc} \tag{4}$$

$$I_{econ} = \sum_{i=1}^{n} I_{econ_i}^{+/-} \cdot v_i^{econ} \tag{5}$$

$$I_{eco} = \sum_{i=1}^{n} I_{eco_i}^{+/-} \cdot v_i^{eco} \tag{6}$$

where I_{soc}, I_{econ}, I_{eco} are integrated indicators of social, economic and environmental groups of indicator, respectively;
$I_{soc_i}^{+/-}$, $I_{econ_i}^{+/-}$, $I_{eco_i}^{+/-}$ are adopted to a comparable form the *i*-th indicator value of relevant group of social, economic and environmental indicators, where *n* is the number of indicators;
v_i^{soc}, v_i^{econ}, v_i^{eco} are weighting coefficients of the *i*-th indicator of the relevant group of social, environmental and economic indicators.
At the twelfth stage, the total integrated assessment indicator is calculated while choosing the regional logistics center location for a separate location option using the mean geometric formula:

$$I_{RLC} = \sqrt[3]{I_{soc} \cdot I_{econ} \cdot I_{eco}} \tag{7}$$

where I_{RLC} is the total integrated indicator for choosing the regional logistics center location for a separate location option (accepts values between 0 and 1).
Then *at the thirteenth stage, the maximum value* I_{RLC} among analyzed ones is determined, and *at the 14th stage* a decision on the location of the regional logistics center is taken or rejected and the infrastructure for its location is additionally assessed.

Based on the above method, we analyzed the location of the creation of a regional logistics center, taking into account the social, economic and environmental indicators of the development of Sumy region. The purpose of creating such regional logistics center is to design an integrated system for trade flows management in the region, the implementation of a quality control and strategic management system, and the development of logistics infrastructure in the region as a whole.

We chose the retail turnover of enterprises as performance indicator P_n which is the volume of sold consumer goods to the population through the retail trade network and restaurant industry network by all operating enterprises, as well as industrial, transport and other non-trade enterprises directly to the population through the cash account of the enterprise [14].

Since Sumy is a regional center where the value of all indicators is much higher than in regions and cities, it was excluded for reliability of the obtained values and further calculations of weighting coefficients.

Further, we chose the factors influencing the studied indicator P_n. The weighting coefficients v_i were determined for the indicators that remained after the check for multicollinearity (Table 2).

Table 2: Economic, environmental and social indicators of influence on retail turnover

№	Name of an indicator	Weighting coefficient
	1. *Economic indicators*	
1.1	Wholesale turnover, thousand UAH	0,015
1.2.	The volume of services sold to the population, thousand UAH	0,029
1.3.	Volume of sold industrial products (products, services), million UAH	0,956
	2. *Social indicators*	
2.1	Population	1
	3. *Environmental indicators*	
3.1	Emissions of harmful substances into the atmosphere from private vehicles, t	0,47
3.2	Emissions of harmful substances into the atmosphere from motor vehicles of economic entities, t	0,48
3.3	Current expenses of enterprises, organizations, institutions on the protection and rational use of natural resources, thousand UAH	0,05

**Source: designed by authors*

The above-mentioned indicators were calculated for each district of Sumy region as a separate option for locating a regional logistics center. After the calculations we obtained the following values of the integrated indicator of the assessment while choosing the location of the regional logistics center (Table 3).

Thus, as can be seen from the calculations, the largest value of the integrated indicator I_{RLC} belongs to Sumy district of Sumy region, which lies within $0<0,3684<1$. But at the same time this value is not high enough. As we can see, the value of the total integrated indicator of the assessment when choosing the location is reduced precisely due to the environmental component, since it is the Sumy region that has the greatest negative impact on the natural environment of the region. Therefore, it is the creation of the regional logistics center that will effectively manage all the economic flows of the region, optimize transportation and thereby reduce the negative impact on the environment, and all this in turn will provide the sustainable development of the region.

Table 3: Calculation of the integrated indicator of the assessment while choosing the location of the RLC for each district

№	Districts of Sumy region	I_{soc}	I_{econ}	I_{eco}	I_{RLC}
1	Bilopillya	0,1112	0,0031	0,8815	0,0672
2	Buryn	0,0296	0,0031	0,9073	0,0436
3	Velyka Pysarivka	0,0093	0,0000	0,9390	0,0044
4	Hlukhiv	0,1323	0,0092	0,8519	0,1013
5	Konotop	0,3355	0,1073	0,6949	0,2925
6	Krasnopillia	0,0388	0,0090	0,9136	0,0683
7	Krolevets	0,0711	0,0090	0,8852	0,0828
8	Lebedyn	0,0964	0,0179	0,8714	0,1146
9	Lypova Dolyna	0,0077	0,0068	0,9257	0,0365
10	Nedryhailiv	0,0262	0,0002	0,9350	0,0170
11	Okhtyrka	0,1866	0,3879	0,6887	0,3681
12	Putyvl	0,0371	0,0014	0,9222	0,0367
13	Romny	0,1914	0,0964	0,7789	0,2431
14	Seredyna-Buda	0,0001	0,0010	0,9516	0,0001
15	**Sumy**	**1,0000**	**1,0000**	**0,0500**	**0,3684**
16	Trostyanets	0,0614	0,1550	0,8979	0,2044
17	Shostka	0,2620	0,1282	0,7702	0,2958
18	Yampil	0,0246	0,0074	0,9356	0,0554

**Source: designed by authors*

4. Conclusions

To date, although various types of models and mechanisms of cooperation among the state, business and the public have been suggested by different researchers, scientists and practitioners we should agree that only a sufficient level of development and the capacity of these institutions can lead to productive partnership and cooperation.

It is important that local entrepreneurs and residents are actively involved in discussing plans for the development of the city logistics infrastructure, since convenience for consumers and doing business is a precondition for the long-term and sustainable functioning of the local business environment. This is especially important while implementing measures in the context of the formation of sustainable development of the region, when it is necessary to take into account not only the transport and geographic, economic factors of the logistics infrastructure facilities location, but special attention should be paid to environmental impact.

The activity of the regional logistics center of any significance makes it possible to improve significantly the quality and efficiency of transport processes during transportation, both at the regional and interregional levels, and also to reduce the environmental load by optimizing transport routes, and therefore each region will sooner or later face the need to create of the regional logistic center. In our opinion, taking into account the social, environmental and economic indicators of the regional development, the suggested algorithm for determining the location of a regional logistics center, makes it possible to take into account not only transport and geographic, economic and social indicators (important for business and authorities), but also environmental indicators (important for the population), which, in turn, will support the concept of sustainable development in the region.

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