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Methodological approach to assessing the efficiency of an integrated transport and logistics system

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Abstract. One of the main tools for assessing a firm's performance is an analysis of its logistics performance, which enables an objective characterization of the internal and external relationships of the analyzed entity, its development prospects, and opportunity of further making substantiated managerial decisions. The aim of the study is to develop a methodological approach to assessing the effectiveness of an integrated transport and logistics system to enable operational management decisions. The study identifies the functioning features of an integrated transport and logistics system and the factors affecting the efficiency of the functioning of an integrated transport and logistics system. Also the authors develop an algorithm for assessing the efficiency of an integrated transport and logistics system. The authors' methodological approach allows us to identify problem areas and active areas of the integrated transport and logistics system. Also it makes possible to make management decisions aimed at improving the efficiency of the system's functioning in the interests of all participants.

Keywords: logistics, efficiency assessment, integrated transport and logistics system, logistics management, decision-making.

JEL codes: B41, R4, M15

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Introduction

The country's economy is largely determined by the development of its transport industries, with transport and logistics systems aimed to reduce the costs of the entire supply chain. By fierce competition, exacerbated by the coronavirus pandemic, most businesses are reducing their supplying, stop the business or gone bankrupt. Thus, demand for transport services decreases. Transport companies, which are intermediaries between suppliers and consumers of products, experience the significant difficulties. If the transport and logistics system already had problems, this can only exacerbate the situation and can eventually lead to the bankruptcy of the company. To avoid this, management needs to use accurate and informative methods to evaluate the performance of the transport and logistics system.

Theoretical issues related to the peculiarities of the functioning of logistics systems and approaches to their evaluation are reflected in the works of such domestic and foreign authors as Anikin B.A. (2013), Gajinsky A.M. (2006), Mirotin L.B. (2000), Nerush Y.M. (2006), Rodkina T.A. (2001), Sergeev V.I. (1997), Stepanov V.I. (2006), Daniel L. Wardlow, Donald F. Wood & James S. Johnson (2002), Winkelhaus S, & Grosse E.H. (2020), Samal S.K. (2019), Tijan E. et al. (2019), Rubio S. et al. (2019) and others. Logistical optimization focuses on the criterion of minimum costs in the process of moving products from the supplier to the consumer, and it is not the absolute level of total costs. The most important is the ratio between the effort and the results obtained. In order to control logistics costs, logistics professionals need to identify cost centres in the supply chain

where costs accumulate and where effective cost reduction can have a real impact. However, at the moment there is no generally accepted approach allowing an accurate assessment of the logistics system efficiency. All chain actors are interlinked and responsible for economic results. This is an issue of emerging of integrated transport and logistics system and its correct assessment.

The modern economic conditions make the study relevant. The activities of each business entity are the subject of attention of a wide range of participants in market relations interested in the results of its functioning. On the basis of the available information they assess the financial position of the company. The assessment of logistics performance allows to objectively characterizing the internal and external relationships of the analyzed object, the prospects for development, and making the informed management decisions.

The aim of the study is to develop a methodological approach to assessing the effectiveness of an integrated transport and logistics system to enable operational management decisions.

The logic of the work was the sequential implementation of three interrelated blocks of research:

- analysis of the functioning of an integrated transport and logistics system;
- identification of factors affecting the efficiency of an integrated transport and logistics system;
- developing an algorithm for assessing the efficiency of an integrated transport and logistics system.

Main Part

A logistics system is a fundamental concept in logistics. It is a set of elements (links) that are in relationships and links with each other and form a certain integrity, designed to manage flows, perform certain logistics functions and operations, consisting, as a rule, of several subsystems and having developed links with the external environment (Anikin, 2013). This paper proposes to consider the integrated transport and logistics system both in terms of the system approach as a set of interrelated subsystems united by a common goal and in terms of the process approach, presenting the system as a chain of interrelated functions and operations (business processes), where the resources is input to the process and the output is the product/service.

The authors consider to suggest the following mandatory elements of a transport and logistics system:

- transformation process in terms of which the given initial condition (input) transforms into the desired result (output);
- system owner;
- agents carrying out the main activities within the system;
- consumers (external and internal). For them the functioning of the system results in the creation of added value and they are therefore influenced by the activities carried out by the system;
- environmental restrictions.

An essential feature of economic systems is the tendency to be «loosely structured», i.e. they do not have a clear structure. The systems approach should both help to achieve a given objective and correctly formulate the objective of the transport and logistics system itself, i.e. to highlight the main stages of the process of a particular product moving to a particular consumer.

A transport and logistics system has a complex structure and typically includes warehouses, terminals, transport, banks and contact centres. It can be extended with other elements, depending on the aims and functions of the system. All the chain agents are responsible for the economic results. The costs control is an effective mean to focus total resources fully on achieving results.

The scheme of an integrated transport and logistics system shown in Figure 1 clarifies the areas of responsibility of the process participants.

Transport and logistics systems are the complex objects of study, which manifests itself in the integral interaction of complex factors such as:

– presence of a large number of elements;
– complex nature of the interaction between the elements in terms of material, financial, information and other;
– multidisciplinarity (multi-assortment) of material flows;

– interrelationships and performance criteria of the elements of the system are difficult to formalize, qualitative in nature;

– stochastic nature of most factors and processes, making it difficult to assess system performance and management decision-making procedures;

– significant role of subjective factors due to the presence of human beings in the management systems of logistics structures.

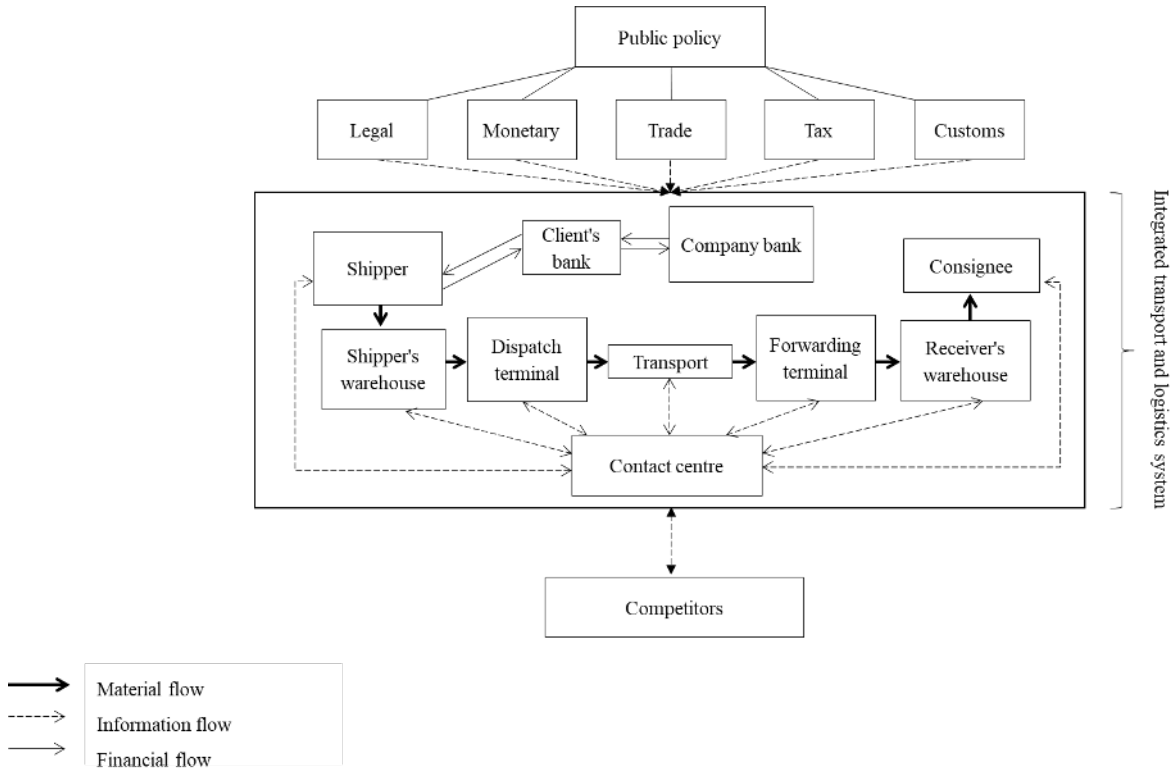

Figure 1. The scheme of an integrated transport and logistics system

Source: composed by authors

This variety of cause-effect relationships makes it difficult to assess the performance of a logistics system, which necessitated a systematization of the factors in terms of the possibility/impossibility of the logistics system to control them.

The complex factors were divided into two groups:

– objective and subjective;

– external and internal.

The objective controllable factors include the material, energy, financial, information and human resources required to support the activity of the transport and logistics system. The objective uncontrollable factors include the public policy elements shown in Figure 1, which are determined by the economic, political and social situation in the country as well as in the countries within the zone of the transport and logistics system.

The subjective controllable factors include the professional and personal characteristics of employees. The subjective uncontrollable factors include unstable inflation rates, political instability, unstable tax legislation, constant changes in laws and regulations governing logistics companies.

The external factors include those that a company cannot normally change, but must consider because they affect the bottom line. They be divided into direct impact factors (legislation regulating companies; actions of state and local authorities; current tax system; system of relations with business partners; competitors and competition; state of demand for services; possibility of changes in prices for services; technological level of the shipper, etc.) and indirect impact factors (political and economic situation in the country, the economic situation of the business sector, international actions, natural disasters, scientific and technological progress,

etc.)

Internal factors include the diversity of the transport environment, company strategy, management principles and methods, resources (technological, labour, information, financial) and their level of utilization, marketing activities, quality of work/services, etc.

All of the factors named are linked: a change in one factor can cause changes in others. It should be noted that the number of external factors affecting the functioning of transport and logistics systems, which need to be taken into account in production and economic activities, is increasing every year.

The efficiency of transport and logistics systems is the ratio of the results obtained from ensuring the required volume and quality of transport services, improving the economy of operation, reducing the time of cargo delivery, ensuring regularity of departure and arrival of cargo regardless of weather and climatic conditions, maximizing the safety of transported cargo, ensuring environmental friendliness of transport operations, etc. to the costs of achieving them.

We proposed to present the efficiency of a logistics system as a complex economic category, which characterizes the quality of the entire logistics system (degree of customer satisfaction) at a given level of total (logistics) costs.

$$K_i = \Sigma P_i / \Sigma S_i, \quad (1)$$

where K_i – is the coefficient of performance of the transport and logistics system;

P_i – is the profit of the transport and logistics system;

S_i – is the cost of the transport and logistics system.

The concepts of minimizing overall logistics costs and managing the quality of logistics functions and operations throughout the production and business cycle are decisive for the formation of efficient integrated transport and logistics systems. The efficiency of transport and logistics systems can be improved if two conditions are met:

1st condition: ∑P tends to the MAX;

2nd condition: total cost tends to MIN.

In an integrated transport and logistics system synergy effects arise as an intersection of a number of intra-organizational processes and processes reflecting¬ the influence of the external environment:

$$Ce_t = \{S_1 \cup S_2 \cup S_3\} : \{S_4 \cup S_5 \cup S_6\}, \quad (2)$$

in which $\{S_1 \cup S_2 \cup S_3\}$ – is the dynamics of the external environment, including:

S_1 – are changes in the external environment of the macroeconomic order (the non-linear nature of global economic development, the non-equilibrium nature of global economic processes, etc.)

S_2 – are changes in the external environment of the microeconomic order (economic kinetics of the region, the synergistic nature of specific markets, etc.);

S_3 – is a global trend;

$\{S_4 \cup S_5 \cup S_6\}$ – is the dynamics of intra-organizational change, including:

S_4 are the intra-organizational changes (processes of competition, intra-organizational cooperation, unification, etc.)

S_5 – is forming a set of management tools for the organization;

S_6 – is building the capacity of positive feedback channels (building an appropriate organizational management structure, motivation for innovation, etc.)

The «:» sign in formula (2) denotes synchrony, coherence in space and time of frequency, rhythm, directionality of dynamic endogenous and exogenous processes.

In modern reality the processes are asynchronous, the interests of the participants (links) of an integrated transport and logistics system will be different. Moreover, the priorities of participants' interests will change. It is important to reconcile the interests of all participants, which will minimize conflicts and ensure that the system functions most effectively within its intended purpose.

If we consider the integrated system from the perspective of trade-off theory, there is a clear need for a deliberate balancing of the interests of the participants, both at the macro and micro level. The above can be

represented in terms of a target function:

$$\sum_{i=1}^{n} \Pi_i = \sum_{i=1}^{n} \sum_{j=1}^{m} C_{ij} * \Pi_j \rightarrow \max \quad (3)$$

in which Π_i is the utility set (efficiency) of the integrated logistics system;
Π_j – set of utilities (efficiency) of the subsystems of an integrated logistics system;
C_{ij} – coefficient of linkage of the subsystems of an integrated logistics system;
n – is a number of the subsystems of an integrated logistics system;
m – is the number of structural links within each subsystem.

When assessing the efficiency of a transport and logistics system, it is necessary to:
- consider the enterprise's business as a single cost stream;
- identify cost centres;
- identify the most important cost points within each cost centre.

The efficiency of the economic activities of the links of an integrated logistics system is proposed to be evaluated as

$$K_{li} = D_{pli}/D_{zli}, \quad (4)$$

where K_{li} is the coefficient of economic efficiency for each link in the logistics system;
D_{pli} – is the share of profit of each link in the total net profit of the logistics system;
D_{zli} – is the share of each link in the cost of the logistics system.

The links in the logistics system are ranked according to the value of the business efficiency coefficient from the most significant to the least significant.

An assessment of the efficiency of the transport and logistics system is proposed according to the following algorithm, shown in Figure 2.

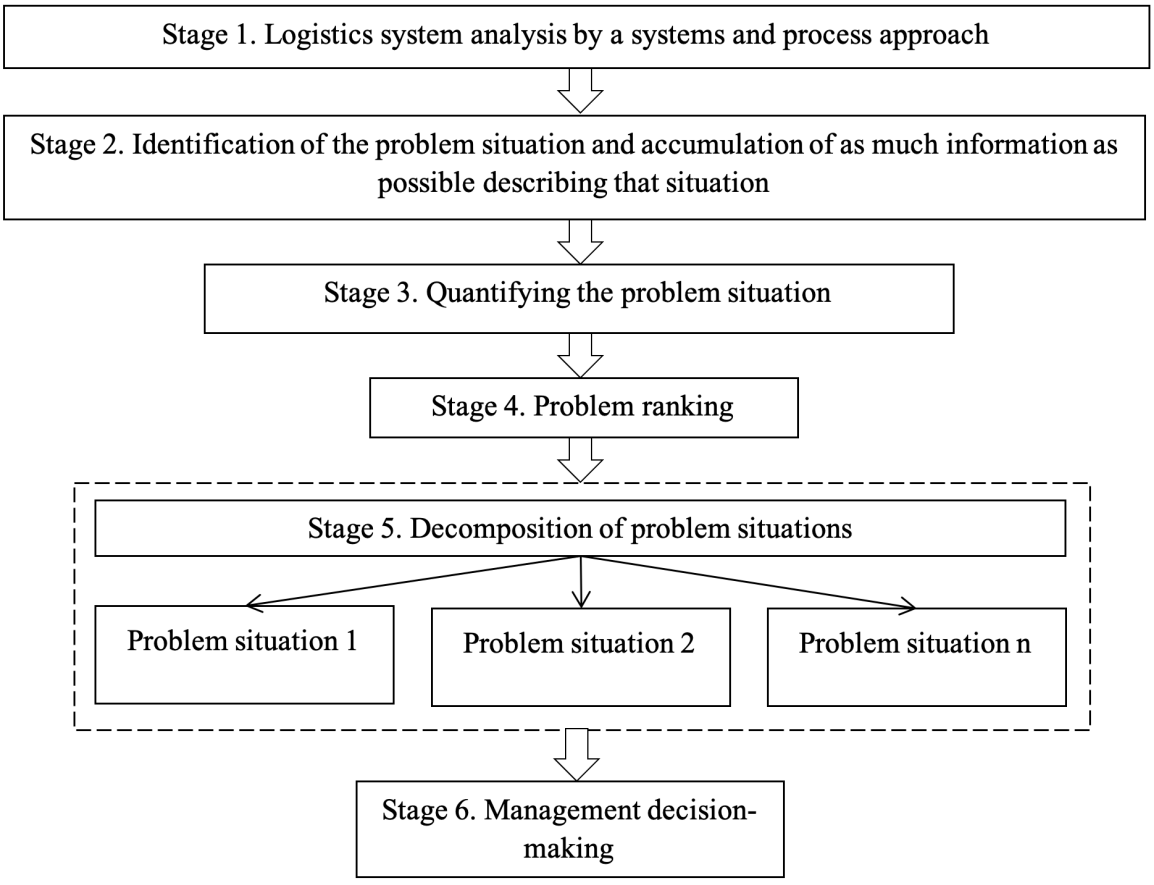

Figure 2. Algorithm for assessing the efficiency of an integrated transport and logistics system
Source: composed by authors

Each step of the algorithm has a strict set of sequential operations: setting objectives, forming tasks, collecting input data, calculating and forming the reporting module. The performing of operations according to strictly defined rules allows a full assessment of the efficiency of the transport and logistics system and determines the final level of its performance. The outcome should be improved enterprise performance through increased business flexibility and reduced response time to environmental changes, which is crucial to realizing the synergies of integrated transport and logistics systems in Russia.

Projects aimed at improving the efficiency of an integrated transport and logistics system should be assessed in terms of the likelihood of success.

An assessment of the effectiveness of such projects can be represented as

$$Y_k = \sum_{i=1}^{n} Y_{ik} \cdot C_i \quad (5)$$

in which Y_k is the summary indicator of k project;
Y_{ik} – is the ball score of k project;
C_i – coefficient of importance (expert ranking).

$$Y_{ik} = \frac{Y_{ik}}{Y_{max}} \quad (6)$$

if the i-indicator is aimed at reducing
or

$$Y_{ik} = \frac{Y_{min}}{Y_{ik}} \quad (7)$$

if the i-indicator is aimed at reducing
in which Y_{ik} is the value of the i-indicator for k project;
Y_{max} – is the maximum value of the indicator for the projects compared.
Y_{min} – is the minimum value of the indicator for the projects compared.
Y_{ik} should aim for max.
The probability of success of the project:

$$E_x = 1 - R_x \quad (8)$$

where R_x is the risk ratio; 0.33_{max} / 0.07_{min}
When substituted into formula 5, it takes the form of:

$$Y_k^E = E_x \cdot \sum_{i=1}^{n} Y_{ik} \cdot C_i \quad (9)$$

The project with the highest Y_k^E value is selected for implementation of the management decision.

Conclusions

Logistics management in an integrated system is a management approach to the organization of its operation which ensures that time and space factors are taken into account to the fullest extent possible in optimizing the management of logistics flows to meet the strategic, tactical and operational objectives of a given enterprise in the marketplace. In this context, management decisions defining as projects, are aimed at the following objectives in the area of improving the efficiency of the enterprise's operations:

- increasing control over the activities of the transport company's links;
- reducing the time needed to find the «weakest link» area of the logistics system;
- improving the efficiency of logistics processes.

The authors' methodological approach allows to identify problem areas and active areas of the integrated transport and logistics system. Also it makes possible to make management decisions aimed at improving the

efficiency of the system's functioning in the interests of all participants.

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