METHODOLOGY FOR THE FORMATION OF THE COMPANY'S LOGISTICS SERVICE SYSTEM

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Abstract. The modern post-industrial stage of development of the market economy is characterized by the gradual transition of market power from producers of products or services to consumers. Under such conditions, the struggle for the customer forces logistics companies to increase the level of logistics service and develop strategies based on a compromise between the costs associated with the provision of logistics services and the level of logistics service provided to customers. In this regard, there is a need to develop adequate methods and approaches to assessing the required level of logistics service and its impact on the achievement of the company's strategic goals. The study discloses organizational and methodological approaches to the development of a logistics service system based on a set of target indicators (key indicators for evaluating logistics service) aimed at achieving the selected strategic task of the company's logistics. Methods of economic, statistical, and mathematical modeling, and system analysis were used as research tools. The paper proposes a methodology for the formation of a logistics service system, built by the MAI method within the framework of the general policy of the company for logistic customer service. Its approbation of the example of the company "Sfera-Avto" showed that the chosen operational policy in the field of customer service, taking into account the most significant alternatives, corresponds to the chosen strategic objective of the company's logistics, namely "minimization of the cycle of the fulfillment of customer orders". The choice made is reflected in the company's logistics from the strategic level (building a strategic map of the logistics department and forming a balanced system of logistics indicators) to the operational level (performing logistics operations within the framework of implemented business processes).

Keywords: criteria tree, logistics costs, logistics service, hierarchy analysis method, decision-maker, targets.

Introduction

In the theory of logistics, customer service is considered in different planes as one of the key activities, as an integrated business process in the supply chain, and as a general policy of the service company, which also includes logistics services. However, with any approach to making management decisions to improve the efficiency of logistics activities, the key task is to determine the balance between the level of logistics service provided by the enterprise and the costs of its support.

The analysis of existing approaches to assessing the level of logistics service has revealed the interest in this area, researchers are constantly discussing the methods and models they propose, and at the same time lack of unity in the methods of forming a system of significant factors of enterprise activity. To date , there is no agreed model for measuring the quality of logistics services and the efficiency of the company's logistics system as a whole. The economic literature deals with the problems of general approaches to the assessment of logistics activities [1-4]; the impact of the quality of logistics services on the level of customer relations [5-7]; selection of an alternative strategy for the provision of logistics services [8-10] and methods of its evaluation [11; 12]. However, the issues of the formation of the logistics service system and the methodology for determining its key indicators are reflected in them in a fragmentary manner, and the business environment, which is constantly changing, requires their constant improvement, which encourages further research.

The publication develops a methodology for the formation of a logistics service system based on a set of target indicators (key indicators for evaluating logistics service) to achieve the selected strategic task of logistics.

Materials and methods

At the present stage of economic development, the mechanism of market power is mostly concentrated in the hands of the consumer. Accordingly, the struggle for the customer forces logistics companies to develop strategies based on a compromise between the costs associated with the provision of logistics services and the level of logistics service provided to customers. Among them, the most popular is the optimal cost strategy [13,14], which concentrates the company’s efforts on providing a higher level of customer service quality at a price at the level of competitors or even lower.

In its implementation, the primary task of the logistics service is to provide conditions for performing operations that guarantee an improvement in the quality of customer service. Yes, the supplier company can implement this strategy in different ways. For example, it can be:

- placement of stocks in warehouses as close as possible to customers;
- use of the fastest methods of product delivery;
- formation of supply lots of such a size that will be most acceptable for the client.

Each of the listed options for managing the material flow will be the response of logistics to the strategy chosen by marketing. At the same time, different marketing strategies will have different effects on the activities of the logistics itself – its budget, the level of logistics costs, the level of use of logistics infrastructure, etc. Coordination of marketing and logistics strategies gives rise to several strategic logistics tasks related to improving the quality of logistics service through the regulation of the level of logistics service, or the level of logistics costs (Fig. 1).

<table>
<tr><td rowspan="3">Strategic objectives (directions) of logistics</td><td colspan="6">Improving the quality of logistics service</td></tr>
<tr><td>Minimization of operational logistics costs</td><td>Minimization of current logistics assets (inventory levels)</td><td>Improving the efficiency of the use of logistics infrastructure</td><td>Flexible response to customer needs</td><td>Customer Fulfillment Cycle Resilience</td><td>Optimization of current logistics assets (inventory levels)</td></tr>
<tr><td>Maximizing the level of logistics service</td><td>Maximizing the parameters of logistics services</td><td>Maximizing the performance of logistics infrastructure</td><td>Maximum flexibility in logistics services</td><td>Reliability of customer order fulfillment</td><td>Minimizing the Execution Cycle order</td></tr>
</table>

Fig. 1. **Determination of strategic directions of logistics activities**

Solving each of these tasks separately requires the use of resources (financial, industrial, labor, informational, etc.), and the result does not guarantee the overall success of the company. Moreover, it is well known that local optimums are the biggest enemies of the overall efficiency of the company because focusing only on achieving targeted improvements can lead to undesirable and sometimes dangerous consequences for the organization as a whole.

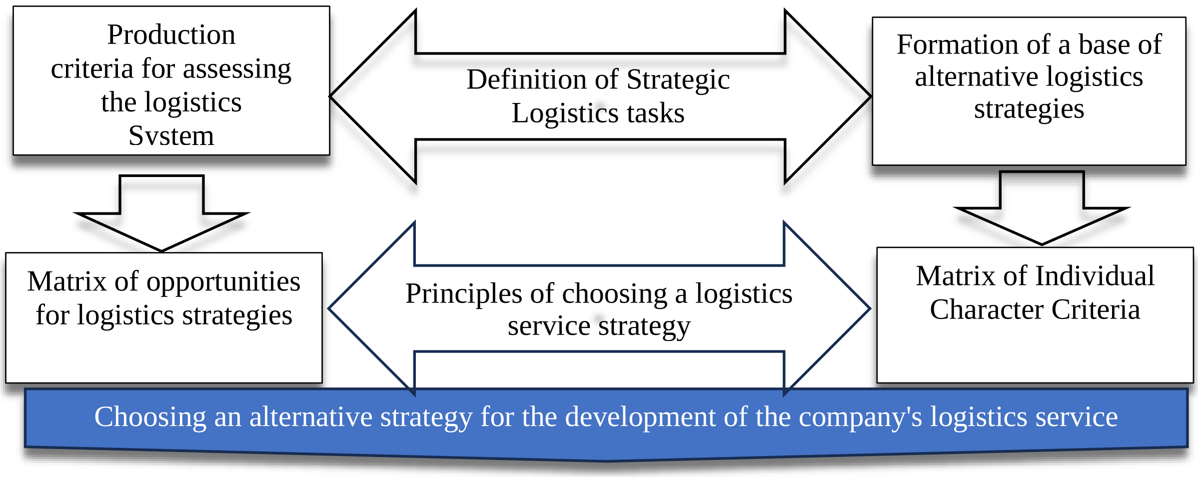

Fig. 2. **Scheme for choosing a company's logistics service strategy**

Therefore, when setting strategic goals, it is recommended to use a set of indicators that characterize the effectiveness of the company’s activities in a certain direction. However, the abundance of elements and connections makes it difficult to analyse them and make an informed decision. There are many methods for solving decision-making problems with many criteria: the method of bringing the criteria to one (complex criterion, fair compromise, construction and analysis of the set); the method of psychological characteristics of the decision-maker (ODM) (multi-criteria theory of utility, method of hierarchy analysis, methods of ranking multi-criteria alternatives). Of this group, the most common and easiest to understand is the method of hierarchy analysis MAI (which later evolved into the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP)) [15].

Along with mathematical procedures, MAI/AHP/ANP is based on psychological aspects, namely the subjective assessment of expert judgments, or ODM. The proposed methods allow structuring a complex decision-making problem in an accessible and rational way in the form of a hierarchy, comparing and quantifying alternative solutions in order to choose the best one, taking into account the advantages of ODM.

Table 1

Common features and features of MAI, ANR, ANP

Methodological principles	**MAI**	**AHP**	**ANP**
Shared	1.Based on the concept of breaking down a complex problem into smaller, more easily manageable parts with a hierarchical structure. 2. Paired comparisons are used to assess the relative importance or advantages between elements of the hierarchy. 3. Peer reviews are used to determine the weight of each element or criterion in the hierarchy. 4. A structured approach to decision-making that allows for an objective evaluation and comparison of alternatives using systematic methods.		
Special	A general methodology that includes the concepts of pairwise comparison analysis, prioritization, and hierarchical modeling. Be used for various types of analysis, including problem-solving, decision-making, and prioritization.	A specific method that is within the scope of MAI. It is used to solve decision-making problems, where it is necessary to compare alternatives according to several criteria, assess their importance and make a decision.	A specific method that is also included in the framework of MAI. It expands the concepts of AHP, allowing you to model the relationships between the elements of the hierarchy not only vertically, but also horizontally.

Based on pairwise comparisons of criteria and individual indicators, the choice of the best of the proposed alternatives, the characteristics of which are vectors with heterogeneous, including vaguely defined, individual components, is substantiated. Therefore, when comparing values, it is possible to work not only with numbers (formalized indicators), but also to draw logical conclusions in verbal form (non-formalized indicators).

In logistics, the use of the MAI method has several advantages:

- helps to structure the problem hierarchically, breaking it down into smaller subtasks and criteria, which makes it easier to analyze and compare alternatives;
- makes it possible to simultaneously operate with a significant number of criteria: cost, time, quality of service, etc.;
- takes into account expert assessments and opinions of participants in the decision-making process, which allows taking into account not only quantitative indicators, but also qualitative aspects;
- facilitates decision-making and implementation;
- allows you to take into account risks and uncertainties, as well as assess their impact on decision-making in logistics systems.

The method is used to perform decision-making tasks in different formulations: choose one or several best options, order (rank) all options by preference і which is most important in the formation of a logistics service system, taking into account uncertainty and risk.

Results and discussion

To implement the approach to the formation of a logistics service system under real market conditions [16], a methodology for optimizing a set of key indicators (target indicators for assessing logistics services and restrictions for the provision of logistics services) for achieving the chosen strategic direction of logistics and a method for determining the appropriate optimal set of logistics services will be used.

Experimental studies of the proposed method were carried out on the example of the company selling cars and spare parts "Sfera-Avto". The company has chosen minimization of the customer order cycle as the main strategic direction of logistics (see Fig. 1), and based on its content, ten of the most important key indicators have been identified, the improvement of which will contribute to the achievement of the defined goal:

1) I_1 – the share of orders completed on time;
2) I_2 – vacancy or reserved capacity rate;
3) I_3 – the amount of fines due to non-fulfillment of delivery conditions;
4) I_4 – dynamics of the number of completed orders;
5) I_5 – inventory turnover time;
6) I_6 – the level of stocks of demanded goods;
7) I_7 – costs of warehousing a unit of goods;
8) I_8 – average order cycle time;
9) I_9 – accuracy and completeness of cargo handling;
10) I_{10} – operating logistics costs per unit of goods

For the justified use of certain indicators in solving the selected strategic task of logistics, it is necessary to evaluate them, comparing key indicators with specific criteria, based on which further management decisions will be made. Such criteria include:

1) C_1 – duration of the cycle of execution of the customer's order;
2) C_2 – deviation in the terms of execution of the client's order;
3) C_3 – logistics costs for the fulfillment of the client's order;
4) C_4 – the average level of the company's stocks;
5) C_5 – response time to customer needs.

The selected criteria C1-C5 will allow us to assess the most significant parameters of the company's logistics activities: the speed and duration of the client's order, the reliability and flexibility of logistics, the value of current assets, and the efficiency of logistics operations.

Using the MAI algorithm, we structure the problem to be solved in the form of a hierarchy.

To do this, let's define three levels of the hierarchy: goals, criteria, and alternatives. In our case, the very formulation of the strategic task of logistics – minimizing the cycle of customer orders – will act as a goal. The five indicators listed above (C_1-C_5) will serve as criteria. Finally, the key indicators (I_1-I_{10}) will represent alternatives for achieving the set goal. Graphical formalization of the problem is presented in Fig. 3.

Before performing the procedure of pairwise comparisons of elements for each level of the hierarchy, we will evaluate the alternatives under consideration for their Pareto optimality. We will exclude from the analysis those alternatives that are losing (not optimal according to Pareto). To do this, we use Table 1, formalized according to the structure of the problem shown in Figure 3, for criteria and alternatives.

The values in Table 2 are formed from the analysis of retrospective data on the activities of the company "Sfera-Avto", as well as as from the application of scenario analysis and modeling of the implemented processes by the logistics of the enterprise. It should be noted that some indicators are determined on the basis of expert assessments ODM, but this should not affect the demonstration of the general principles of the wholesale company.

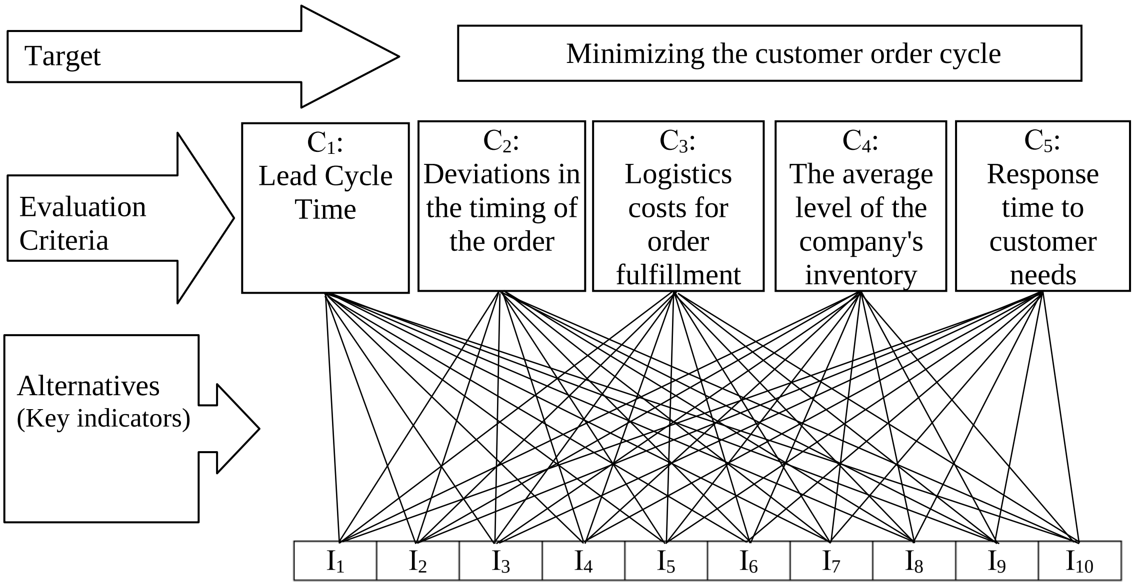

Fig. 3. **Hierarchy of selection of a set of basic logistics services in the formation of a logistics service system**

Table 2

Significance of criteria C_1-C_5 for alternatives I_1-I_{10}

	Criteria/Units of Measurement				
Alternatives	**C_1, Week**	**C_2, Week**	**C_3, Million. UAH/year**	**C_4, Million. UAH/year**	**C_5, Week**
I_1	2.5	± 3.0	3.5	8	3.5
I_2	4.5	± 3.5	2.0	7	3.5
I_3	5.0	± 4.0	2.0	7	1.5
I_4	5.5	± 2.0	2.5	10	3.5
I_5	5.0	± 2.5	4.0	11	2.5
I_6	5.5	± 1.0	2.0	10	3.5
I_7	1.0	± 2.0	3.0	12	2.5
I_8	7.0	± 4.0	2.5	4	3.5
I_9	6.0	± 3.5	3.5	7	4.0
I_{10}	5.5	± 3.0	2.5	5	3.5

Taking into account the direction of optimization for all criteria – minimization – we can see that when comparing, several alternatives are dominant over others. Thus, alternatives I_2 and I_6 dominate over I_9 and I_4, respectively. Therefore, the latter can be excluded from further consideration.

We make pairwise comparisons of the elements of each level, namely:

1) compare the importance of the criteria about the possibility of achieving the goal (this is implemented taking into account the attitude ODM to assess the importance of criteria (“equal importance”, “moderate advantage”, etc.);

2) compare the indicators of alternatives for each criterion in terms of their significance (this is also implemented taking into account the attitude of ODM to such indicators).

When comparing, numerical values are translated into a linguistic form (equal importance, moderate advantage, significant advantage, strong advantage, very strong advantage), which are subsequently directly compared with numerical characteristics for the implementation of calculations (1; 3; 5; 7; 9 – respectively).

3) For each criterion, an eigenvector is calculated, which is equal to the geometric mean root of the priority product of the row of the pairwise comparison matrix:

$$y_i = \sqrt[n]{\prod_{j=1}^{n} V_{ij}} \qquad (1)$$

where V_{ij} – priority of the ij-th alternative

This makes it possible to determine the weights (in% of the total value) for each of the criteria, as well as the coefficients of importance for each alternative in the context of the corresponding criterion. The obtained data are presented in the form of comparison tables. The results of pairwise comparisons of the importance of the given criteria judgment-based ODM are presented in Table 3.

Table 3

Results of pairwise comparisons of the importance of the given criteria

Criteria	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**	**Custom Vector**	**Criterion weight, w_i, %**
C_1	1	9	5	3	7	3.9	53
C_2	1/9	1	1/5	1/3	1/3	0.2	3
C_3	1/5	5	1	1/3	3	1.0	14
C_4	1/3	3	3	1	5	1.7	23
C_5	1/7	3	1/3	1/5	1	0.5	7

And since there are many analyzed values – 1 table 5x5 and 5 tables 8x8 – and there is a risk of misperception of the data, pairwise comparisons are checked for consistency. For this purpose, the consistency index (IU) proposed by T.L. Saaty and K.P. Kearns [17] is calculated, the value f which should be ten to “0”.

$$\delta = \frac{\lambda_{\max} - k}{k-1} , \tag{2}$$

where $\lambda_{\max}$ – The main value of the matrix of paired comparisons;
k – the order of the square matrix.

For our task, the condition was adopted that the consistency index should not exceed 0.1.

The results of pairwise comparisons of the significance of the indicators of the analyzed alternatives concerning criterion C_1 are presented in Table 4.

Table 4

Evaluation of alternatives according to the criterion “C_1: duration of the customer order fulfillment cycle”

	I_1	**I_2**	**I_3**	**I_5**	**I_6**	**I_7**		**I_8**	**I_{10}**	**Own vector**	**The importance of the alternative, V_{IjC1}, %**
I_1	1	4	7	7	1/2	9		5	9	3.8	31
I_2	1/4	1	3	3	1/4	5		1/2	5	1.3	11
I_3	1/7	1/3	1	1	1/6	3		1/2	4	0.7	6
I_5	1/7	1/3	1	1	1/6	3		1/2	3	0.7	6
I_6	2	4	6	6	1	5		4	6	3.7	30
I_7	1/9	1/5	1/3	1/3	1/5	1		1/4	1	0.3	2
I_8	1/5	2	2	2	1/4	4		2	4	1.4	11
I_{10}	1/9	1/5	1/4	1/3	1/6	1		1/4	1	0.3	2

Comparison of indicators of other criteria (C_2-C_5) is carried out in the same way. The weight of the criteria and the significance of the indicators of alternatives according to the criteria for the convenience of perception of information are given as a percentage. The calculations use these values in fractions of one. The results of comparisons in all tables have been checked for consistency. At the same time, in all cases, the requirement of IU < 0.1 was met. The quantitative indicators we are interested in for making a decision are called the priorities of alternatives. At the same time, the higher the priority, the better the alternative for ATS. The priorities of alternatives are calculated using the formula:

$$V_j = \Sigma(w_i \; x \; V_{IjCi}), \tag{3}$$

where V_j – priority of the j-th alternative {1, ..., 10};
w_i – weight or importance of the i-th criterion {1, ...,5};

V_{IjCi} – significance of the J-th alternative indicator by the *i*-th criterion.

Calculations using this formula are presented in Table 5. The totals are in the last column, and the highest priority value is in bold.

Table 5

Calculation of the priority of choosing a set of key indicators for one of the strategic tasks of logistics in the formation of logistics service

Alternatives	Criterion weight					Priority alternative, %	Rank
	wC_1	wC_2	wC_3	wC_4	wC_5		
	0.53	0.03	0.14	0.23	0.07		
	Coefficients of importance of alternatives for each criterion						
	V_{IjC1}	V_{IjC2}	V_{IjC3}	V_{IjC4}	V_{IjC5}		
I_1	**0.31**	**0.1**	**0.03**	**0.05**	**0.06**	16.7	**1**
I_2	0.11	0.03	0.12	0.1	0.29	11.8	4
I_3	0.06	0.16	0.02	0.02	0.15	5.3	8
I_5	0.06	0.26	0.07	0.03	0.03	5.8	7
I_6	0.30	0.06	0.02	0.01	0.10	15.0	3
I_7	0.02	0.02	0.04	0.3	0.03	10.8	5
I_8	0.11	0.15	0.25	0.19	0.2	16.2	2
I_{10}	0.02	0.16	0.31	0.1	0.03	9.1	6

The data obtained in the table give reasonable estimates of the weight of the importance of the criteria (taking into account the specified elements of the processes of the analytical hierarchy and the advantages of ODM. Analysis of Table 4 reveals an interesting pattern. The two most popular sets of logistics services provided by the company (alternatives I1 and I8), the difference between the values of which is only 0.5 percent, provide for the imposition of restrictions on the minimum size of the customer's order, which in turn is emphasized by the third most important alternative I6, "Stock level of demanded goods", while they are directly related to the duration of the order fulfillment cycle, which corresponds to the name of the strategic task of logistics and the logic of decision-making. In addition, the best alternative shows the timeliness of order fulfillment.

Thus, the methodology for choosing the logistics strategy of the company "Sfera-Avto" and the necessary set of logistics services has shown that the implementation of the set strategic task of logistics "Minimizing the cycle of the client's order" to achieve the best financial results should include such target indicators as "Share of timely completed orders", "Average order cycle time" and "Inventory turnover time". By the way, it should be noted that from other ODM (i.e. with other advantages), the choice of a set of key indicators may be different. This can be attributed to the advantages of the proposed approach to decision optimization, since, as it is known in the theory of decision-making according to many criteria, the choice of such optimization tasks depends on the system of ODM preferences.

Conclusions

1. The struggle for the customer forces logistics companies to increase the level of logistics service and develop strategies based on a compromise between the costs associated with the provision of logistics services and the level of logistics service provided to customers.
2. When forming a logistics service system, it is necessary to take into account several factors affecting the company's activities, but which cannot be pinpointed. These include the company's strategy, characteristics of the activities of customers, competitors, suppliers, and the company itself – the provider of logistics services.
3. The paper proposes a methodology for the formation of a logistics service system, built by the MAI method within the framework of the general customer service policy. Its approbation of the example of the company "Sfera-Avto" showed that the operational policy in the field of customer service was chosen, taking into account the most significant alternatives I1 "Share of timely completed orders" with a priority of 16.7%, I8 "Average order cycle time" with a priority of 16.2%, and I6, "Stock

level of demanded goods” with a priority of 15%, most closely corresponding to the defined strategic objective of logistics “Minimization of the customer order cycle”. The choice made is reflected in the company’s logistics from the strategic level (building a strategic map of the logistics department and forming a balanced system of logistics indicators) to the operational level (performing logistics operations within the framework of implemented business processes).

Author contributions

Conceptualization, formal analysis and writing – Zagurskiy O.; original draft preparation methodology and project administration –Savchenko L.; methodology – Demin O.; data curation and visualization – Zagurska S.; funding acquisition – Ohiienko A. All authors have read and agreed to the published version of the manuscript.

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