Advanced Logistic Systems – Theory and Practice, Vol. 17, No. 2 (2023), pp. 23-35.
https://doi.org/10.32971/als.2023.013

PRACTICAL METHOD OF THE EVALUATION AND SELECTION PROCEDURE OF A LOGISTICS PROVIDER IN A TECHNOLOGICAL ENVIRONMENT PROVIDED BY DIGITALIZATION

GÁBOR NAGY[1] - ÁGOTA BÁNYAI[2] - BÉLA ILLÉS[3]

Abstract: *The purpose of the study is to present the possibility of evaluating and selecting a logistics service provider from a practical point of view in the digitalization environment of the fourth industrial revolution. We will present a possible procedure that makes it possible to use large amounts of data in the evaluation of a service provider. As a result of the task, the organization responsible for the decision receives exact information about the performance of the service providers present in the competitive market according to its own needs, in this way each company can decide and choose the ideal/optimal service provider according to the conditions it considers important.*

Keywords: *logistics service provider, selection, Industry 4.0, digitalization*.

1. INTRODUCTION

The new industrial revolution taking place today provides solutions that prioritize the issue of quality and raise reliability to a new level both on the service provider's and user's side. The purpose of this thesis is to examine the question of how to determine the criteria for the selection of logistics service providers in the current technological environment. The digitized environment offers a solution for accessing large-scale databases, which provide well-founded decision-evaluation plans based on a large number of samples [1]. The quality characteristics influencing the logistics parameters are examined, which are weighted from the aspect of customer requirements [2]. And I try to make the indexes that appear as bottlenecks in the order I determined more efficient with an optimization procedure. The importance of the delimited topic area is confirmed by the global economic processes taking place today, such as the "black swan" events, which include the Covid-19 pandemic and the Russian-Ukrainian war. The global impact of these events was felt by the world, which confirms the importance of supply chains and the fact that they are one of the most important segments of ensuring economic circulation [3]. We could see how the disruptions caused by the above-mentioned events affected the operation of the chains and thus the consumers located at the end of the chains. As an integral part of network operation, logistics also faced many challenges. The aim of the study is to use the technological environment created by the digitization taking place today to develop operating mechanisms that can mitigate the elementary effects of sudden, unexpected events. One possible practical solution to this is predictability, which can be greatly supported by the use of data sets with a large number of samples. In the case I examined, the difficulty of the process may be caused by the fact that the size of the evaluation data structure providing the basis of the examination can be enormous [4].

[1] research assistant, University of Miskolc, Institute of Logistics, Hungary
gabor.nagy4@uni-miskolc.hu
[2] PhD, University of Miskolc, Institute of Logistics, Hungary
agota.banyaine@uni-miskolc.hu
[3] univ. professor, University of Miskolc, Institute of Logistics, Hungary
bela.illes@uni-miskolc.hu

Since nowadays 70-80% of the turnaround time of a given product within a company is logistical, and a significant proportion of the incurred costs are logistical, therefore a special role must be devoted to the digitization of logistics processes.

2. LITERATURE REVIEW

In the 21st century, due to the ever-increasing market competition, globalization, and networked relationships, it has become indispensable for companies to have a future orientation and to create a forward-looking strategy [5]. Those companies can survive and belong to the leading edge, which, in response to new challenges, do not regret investing in continuous innovation and development [6]. Based on practical knowledge, it can be stated that logistics processes have a strategic role, so their performance, or in other words, their quality, must be given sufficient emphasis. The question of choosing the right service provider should be detailed here. Looking at the contemporary scientific life, it can be concluded that many researchers and professionals deal with the topic of logistics service provider selection methods. The multidisciplinarity of the logistics field is supported by the fact that the process is based on mathematical methods, which can be implemented to achieve effective results for the delimited topic area. Countless proposals have been made on the topic, which examine the given issue from different aspects. The digitization environment is important, which, by providing the technological background, generates a huge amount of data, which must be usefully used during the evaluation and selection process. However, due to the complexity of different customer needs, it can be difficult for logistics service companies to effectively understand the different ways customers value the service elements they offer. In this context, the task can be approached in such a way that, on the one hand, the available data set and developed decision-making method help the company using the service in choosing the right service provider, and the service provider is also a benchmark point, which provides feedback on its performance and the parameters in which the intervention to maintain its market position [7].

3. PRACTICAL APPLICATION

The presence of logistics service providers has become more and more justified and slowly indispensable in globalized processes and organizations, so it is essential that these service providers also take advantage of the technological environment provided by digitalization [8]. As technology advances, the range of services they offer offers an increasingly broad portfolio. Increasing the level of service is associated with an increase in the feeling of quality, but in many cases the parameter of a service cannot be defined with the help of a measuring device and its dimension is not an exact indicator [8]. When analysing the quality level, the basic task is to determine how the services can be ranked (according to their importance at the given place and time), compared, measured (the individual also taking into account the dependence relationships of characteristics).

Quality and efficiency as properties form a complex system:

- system, because the property is nothing more than a set of interrelated and interacting elements,
- complex, because we consider several properties at the same time, of which none of the factors may individually reach the "best" level, but together they provide a metric that can be considered optimal among the possible versions [9].

Knowing this, we are still able to assign a value to these criteria and characteristics with the previously described procedures, so choosing a service provider is the result of an informed decision.

3.1. Aspects of selecting logistics service providers

After defining the goal, the first very important step in the process as a whole is to collect the aspects on the basis of which the potential service providers can be categorized. After reviewing the literature, based on research and personal experience, we determined the following five aspects, the parameters of which represent the digitalization environment. These five aspects cover the range of services offered by logistics service providers in a complex manner, so the result of the evaluation provides factual information.

The aspects we define are the following:

- *Delivery capabilities*: One of the most basic parameters for measuring logistics performance is the ability to deliver. This term includes the delivery deadline of the product/service, the punctuality of the delivery, the delivery in the promised quality, the delivery intact, the accuracy of the documents accompanying the goods (invoice, delivery note). In logistics literature, the term capacity refers to the amount of physical space, equipment, or personnel available to transport, store, or deliver goods. Examples include warehouse capacity, transport capacity or vehicle capacity. Capacity is seen as an extremely critical part of supply chain management, so capacity constraints can impact delivery costs. Parameters used in transport S_i; where $i=1,2,\ldots.S_n$.
- *Storage and inventory capacity*: Another very important aspect regarding the evaluation of the logistics process is the warehousing and inventory performance. In a supply network, the purpose of warehouses is to bridge the differences between the time schedule of production, use and delivery with the help of a defined inventory level. Its main task is to store the goods, that is, to preserve the quality and quantity of the goods for a certain period of time, but it also performs many functions, such as: collection, packaging, distribution, etc. Stock is a so-called passive resource available in warehouses, which has value in an economic sense. Stockpiling is particularly important for companies because it is neither physically possible nor economically advisable to produce everything when it is needed. The term defined in the literature as a buffer can be used to balance the discrepancy between the customer's needs and the manufacturer's possibilities. In corporate practice, inventory plays the role of a so-called buffer. The parameters used for storage and inventory are R_i; where $i=1,2,\ldots.s_r$.
- *Service level and quality*: The level of logistics operations and processes describes the quality of the implemented logistics service. In today's economic practice, the primary corporate goal is to achieve the highest level of service at the lowest possible price. The policy used in practice describing the level of service consists of the following steps:
  - defining the service elements that characterize the desired goal (e.g.: order cycle time, stock availability),
  - determination of the corresponding performance standards,
  - measuring the performance of service elements,

- detection and analysis of deviations between specified and actual performances,
- steps and measures aimed at increasing and improving the level of service.

Service level and quality parameters M_i; where $i=1,2,\dots m_p$.

- *Costs*: Cost is perhaps the most weighty element of all the consideration categories considered. Practice proves that this is the parameter that determines the outcome of the decision in most cases. In many cases, we are also able to ignore the value limit of the previously specified quality criterion, if a partner or service provider offers a significantly more favourable price. In the medium and long term, excellent pricing is one of the most important success criteria for a logistics service company. As simple as it sounds, it's actually just as complicated. There are many requirements to be met: to stand up in the market, to be favourable to customers, to compete with competing companies, to generate enough profit to be able to operate sustainably and to offer opportunities for innovation. Parameters used in the case of costs K_i; where $i=1,2,\dots k_a$.
- *Applied technique, technology*: The innovative techniques and technologies of service providers operating in the logistics sector became available with the explosive completion of the IT tool system (hardware, software, internet, etc.). The applied technology and technique in relation to the fourth industrial revolution is manifested in the application of tracking systems (tracking and tracing), electronic data exchange (EDI), internet and e-commerce provision, process development and technology development in the logistics service provider sector. There are few sectors in the economy where IT has become an active tool as quickly as in logistics. The technology used parameters T_i; where $i=1,2,\dots t_b$ [10].

3.2. Parameters defining the aspects

Regarding the aspects, a very important detail is the definition of the appropriate set of parameters. When solving the task, it is necessary to pay a lot of attention to the definition of the relevant parameter system, because this can greatly influence the final outcome of the solution. Below, we have defined the parameters with which the previously introduced aspects can be characterized.

For delivery:

- By on-time delivery (*SZ1*) I mean the punctuality of the delivery, which, according to the service user's expectations, must be fulfilled with the greatest accuracy.
- Accounting and invoicing accuracy (*SZ2*) is an administrative task related to the completed transactions, in which access to documents must be ensured for both parties.
- Condition of vehicles (*SZ3*) is the quality adequacy of the equipment owned by the service provider to carry out the task.
- Loading and unloading (*SZ4*) is an indicator expressed in terms of time and quality of service (product protection, equipment used, appropriate quantity) of the given service task.

For storage and inventory

- The characteristics of the order processing process (*R1*) are the execution of the order process of the service used, the associated relationship management.
- Accuracy of order fulfilment (*R2*) are the characteristics expressing the user's expectations (time, place, quantity, quality).
- On-time storage (*R3*) as a measure of conformity expressed in time as an offered service.
- On-time pick-up (*R4*) as a degree of conformity of the offered service expressed in time.
- Appropriate regulation of stocking (*R5*) is to ensure a transparent, orderly, traceable process on the part of the service provider.

For service level and quality

- Availability of tools and resources (*M1*) is the sufficient availability of human and material resources required for each process.
- Problem-solving ability (*M2*) reacting in case of ad-hoc errors and disturbances.
- The quality of the transport and warehousing service (*M3*) is the degree of the feeling of quality created in the customers during each process, which can be influenced by the specific capabilities of the service provider.
- Financial stability of the company (*M4*) Financial stability can be defined as a state in which the company's financial background is strong enough to withstand shocks and the effects of financial imbalances.
- Market reputation (*M5*) Corporate reputation is based on the company's character and philosophy. Good reputation is a valuable resource for any company. Reputation is trust in a company or brand, which adds a huge emotional surplus to the evaluation of a product or service. The elements of a favourable reputation are mutually reinforcing factors: authenticity, trustworthiness, reliability, responsibility.
- Ability to operate on a global scale (*M6*) is a capability that establishes the possibility of transitioning to global operation.

For costs

- The (specific) cost per transport unit (*K1*) is the cost factor that refers to the monetary expression of the quantity unit assigned to the transport service.
- Storage cost per storage unit (*K2*) is the cost factor that refers to the monetary expression of the quantity unit assigned to the storage service.
- Service cost (*K3*) is the cost factor that expresses the monetary value of other services used.

Applied technique and technology

- Application of tracking systems (tracking and tracing) (*T1*) expresses the existence, extent and quality of tracking tools and systems used during the performance of the service.
- Provision of electronic data exchange (EDI) (*T2*) is a parameter describing the existence, quality and operation of the service.
- Provision of Internet and e-commerce (*T3*) is a parameter describing the existence, quality and operation of the service space and sales platform.

- Willingness for process improvement (*T4*) is a descriptive parameter that evaluates the company's willingness regarding process improvement in the perspective of the Kaizen philosophy.
- Willingness to develop technology (*T5*) is a descriptive parameter that evaluates the company's willingness to develop technology in the perspective of the Kaizen philosophy [10].

4. THE STEPS OF THE EVALUATION AND SELECTION TASK

In the example, the task can be examined from such an approach that individual components of the sample are taken into account to varying degrees according to their importance, significance, strength or other aspects. In determining the mean value, this is called weighting. In relation to the specific example, the weighting can also be examined separately: let's weight the individual parameters by aspect; we only weight the aspects,; we use both methods at the same time. In the example, we examine the last option, where we also specify the relative weight of the aspects, and the parameters describing the aspect also have their own weight value. The first possible method of searching for a solution can be done by weighting the analysed parameters. For this reason, the correct determination of the weight ratio of the aspects/indicators is of fundamental importance from the point of view of the effectiveness of the model. In reality, when looking for a solution (alternative), the parameters have different importance for the customer. We can validate the different importance by introducing weight functions. For a given *k*-th alternative, the value of the weight function of the *j*-th parameter of the *i*-th aspect is $w_{i,j,k}$; where 0< $w_{i,j,k}$<1 assuming that $j=1,2,\ldots.v_i$. For the weight functions, it holds that $\sum_{j=1}^{v_i} w_{i,j,k} = 1$, where *i*= constant; *k*= constant. When determining the values of $w_{i,j,k}$ the previously described must be taken into account: 0< $w_{i,j,k}$<1 and $\sum_{j=1}^{v_i} w_{i,j,k} = 1$. For all values of $i=1,2,\ldots.n$ and $k=1,2,\ldots m$, these relations must be satisfied for all cases of $j=1,2,\ldots v_i$. Based on these, the wi,j,k matrix can be defined, which contains the weight function values. We're investigating the appropriateness of the *k*th alternative. The evaluation index of the *i*-th aspect of the *k*-th alternative is as follows: $e_{i,k} = \sum_{j=1}^{v_i} w_{i,j,k}$, where *i*= constant; *k*= constant. This evaluation index $e_{i,k}$ gives how well the *k*-th alternative corresponds to the *i*-th aspect. If, in the case of a given alternative, we perform the above summary for all examined aspects, then we get the result index of the *k*-th alternative. The result indicator of the kth alternative is as follows: $e_k = \sum_{i=1}^{n} e_{i,k}$ so we get the *k*-th alternative result indicator. Since the maximum number of alternatives is *m*, the result indicator must be defined for each alternative $k=1,2,\ldots m$. Based on this relationship we define e_{opt} and $e_{opt} = \max_k\{e_k\}$ from which follows e_{opt} and the corresponding $k=k_{opt}$ value.

In the task, we try to illustrate the procedure with an example that is more in line with reality, so the sampling number of the alternatives included in the study is *A1, A2,...A10* service providers. The evaluation is done on an independent scale with a value between *1* and *100*. In the example, we used the previously described aspects and the related descriptive parameters, and assigned a weight value to each aspect and related parameter (Table I).

Table I.

Service provider evaluation board

	Name of aspects/parameters	**Weight factor**	**Value (1-100)**									
			A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
S_i	**Delivery**	0,2										
Sz_1	By on-time delivery	0,08	*55*	*53*	*97*	*25*	*60*	*52*	*42*	*33*	*71*	*21*
Sz_2	Accounting and invoicing accuracy	0,04	*76*	*8*	*72*	*55*	*37*	*19*	*42*	*54*	*32*	*24*
Sz_3	Condition of vehicles	0,05	*10*	*35*	*75*	*42*	*35*	*43*	*42*	*62*	*43*	*98*
Sz_4	Loading and unloading	0,03	*77*	*75*	*7*	*16*	*17*	*13*	*42*	*58*	*81*	*93*
R_i	**Storage and inventory**	0,15										
R_1	The characteristics of the order processing process	0,01	*93*	*70*	*65*	*16*	*43*	*67*	*85*	*6*	*48*	*32*
R_2	Accuracy of order fulfillment	0,06	*70*	*65*	*16*	*43*	*67*	*85*	*8*	*48*	*32*	*76*
R_3	On-time storage	0,03	*69*	*95*	*30*	*78*	*51*	*39*	*60*	*26*	*25*	*4*
R_4	On-time pick-up	0,03	*63*	*75*	*61*	*59*	*40*	*90*	*86*	*26*	*67*	*75*
R_5	Appropriate regulation of stocking	0,02	*43*	*10*	*33*	*16*	*30*	*60*	*87*	*59*	*23*	*40*
M_i	**Service level and quality**	0,25										
M_1	Availability of tools and resources	0,08	*81*	*85*	*62*	*84*	*55*	*91*	*36*	*45*	*27*	*48*
M_2	Problem-solving ability	0,06	*55*	*37*	*44*	*11*	*56*	*24*	*8*	*40*	*10*	*38*
M_3	The quality of the transport and warehousing service	0,07	*97*	*83*	*62*	*39*	*66*	*18*	*4*	*8*	*47*	*69*
M_4	Financial stability of the company	0,02	*15*	*72*	*59*	*16*	*19*	*23*	*43*	*40*	*44*	*90*
M_5	Market reputation	0,01	*91*	*19*	*66*	*53*	*36*	*38*	*59*	*92*	*88*	*75*
M_6	Ability to operate on a global scale	0,01	*13*	*84*	*28*	*55*	*34*	*35*	*83*	*83*	*50*	*87*
K_i	**Costs**	0,3										
K_1	The (specific) cost per transport unit	0,005	*6*	*68*	*12*	*63*	*21*	*46*	*30*	*19*	*45*	*36*
K_2	Storage cost per storage unit	0,005	*13*	*9*	*64*	*12*	*28*	*66*	*76*	*81*	*9*	*52*
K_3	Service cost	0,02	*61*	*57*	*82*	*79*	*96*	*37*	*73*	*69*	*77*	*43*
T_i	**Applied technique and technology**	0,1										
T_1	Application of tracking systems (tracking and tracing)	0,05	*32*	*17*	*47*	*44*	*20*	*64*	*23*	*48*	*57*	*7*
T_2	Provision of electronic data exchange (EDI)	0,01	*23*	*48*	*57*	*7*	*41*	*46*	*99*	*20*	*71*	*26*
T_3	Provision of Internet and e-commerce	0,02	*55*	*80*	*63*	*50*	*40*	*22*	*37*	*23*	*70*	*60*
T_4	Willingness for process improvement	0,01	*44*	*33*	*67*	*87*	*85*	*22*	*63*	*71*	*18*	*29*
T_5	Willingness to develop technology	0,01	*33*	*21*	*10*	*67*	*43*	*95*	*65*	*39*	*79*	*81*

After the weighting is done, the table takes the following values, as shown in Table II.

Table II.

Weighted indicators of the evaluation of the service provider

	Name of aspects/parameters	Weighted value									
		A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
S_i	**Delivery**	10,25	8,56	14,60	6,78	8,54	7,46	8,40	9,64	11,54	10,33
Sz_1	By on-time delivery	4,40	4,24	7,76	2,00	4,80	4,16	3,36	2,64	5,68	1,68
Sz_2	Accounting and invoicing accuracy	3,04	0,32	2,88	2,20	1,48	0,76	1,68	2,16	1,28	0,96
Sz_3	Condition of vehicles	0,50	1,75	3,75	2,10	1,75	2,15	2,10	3,10	2,15	4,90
Sz_4	Loading and unloading	2,31	2,25	0,21	0,48	0,51	0,39	1,26	1,74	2,43	2,79
R_i	**Storage and inventory**	9,95	9,9	5	7,17	7,78	10,84	7,45	5,68	5,62	8,05
R_1	The characteristics of the order processing process	0,93	0,7	0,65	0,16	0,43	0,67	0,85	0,06	0,48	0,32
R_2	Accuracy of order fulfilment	4,2	3,9	0,96	2,58	4,02	5,1	0,48	2,88	1,92	4,56
R_3	On-time storage	2,07	2,85	0,9	2,34	1,53	1,17	1,8	0,78	0,75	0,12
R_4	On-time pick-up	1,89	2,25	1,83	1,77	1,2	2,7	2,58	0,78	2,01	2,25
R_5	Appropriate regulation of stocking	0,86	0,2	0,66	0,32	0,6	1,2	1,74	1,18	0,46	0,8
M_i	**Service level and quality**	17,91	17,3	14,06	11,51	13,46	11,17	5,92	9,11	8,31	14,37
M_1	Availability of tools and resources	6,48	6,8	4,96	6,72	4,4	7,28	2,88	3,6	2,16	3,84
M_2	Problem-solving ability	3,3	2,22	2,64	0,66	3,36	1,44	0,48	2,4	0,6	2,28
M_3	The quality of the transport and warehousing service	6,79	5,81	4,34	2,73	4,62	1,26	0,28	0,56	3,29	4,83
M_4	Financial stability of the company	0,3	1,44	1,18	0,32	0,38	0,46	0,86	0,8	0,88	1,8
M_5	Market reputation	0,91	0,19	0,66	0,53	0,36	0,38	0,59	0,92	0,88	0,75
M_6	Ability to operate on a global scale	0,13	0,84	0,28	0,55	0,34	0,35	0,83	0,83	0,5	0,87
K_i	**Costs**	1,315	1,525	2,02	1,955	2,165	1,3	1,99	1,88	1,81	1,3
K_1	The (specific) cost per transport unit	0,03	0,34	0,06	0,315	0,105	0,23	0,15	0,095	0,225	0,18
K_2	Storage cost per storage unit	0,065	0,045	0,32	0,06	0,14	0,33	0,38	0,405	0,045	0,26
K_3	Service cost	1,22	1,14	1,64	1,58	1,92	0,74	1,46	1,38	1,54	0,86
T_i	**Applied technique & technology**	3,7	3,47	4,95	4,81	3,49	5,27	4,16	4,16	5,93	2,91
T_1	Application of tracking systems (tracking and tracing)	1,6	0,85	2,35	2,2	1	3,2	1,15	2,4	2,85	0,35
T_2	Provision of electronic data exchange (EDI)	0,23	0,48	0,57	0,07	0,41	0,46	0,99	0,2	0,71	0,26
T_3	Provision of Internet and e-commerce	1,1	1,6	1,26	1	0,8	0,44	0,74	0,46	1,4	1,2
T_4	Willingness for process improvement	0,44	0,33	0,67	0,87	0,85	0,22	0,63	0,71	0,18	0,29
T_5	Willingness to develop technology	0,33	0,21	0,1	0,67	0,43	0,95	0,65	0,39	0,79	0,81
		43,13	40,76	40,63	32,23	35,44	36,04	27,92	30,47	33,21	36,96

The colour marking illustrates the obtained result, the service providers marked in green performed the best and those marked in red performed the worst. The next step is the multidimensional scaling procedure (MDS), which I use in the example using the SPSS software. In the first step, with the help of the program, I create a distance matrix from the received weight values of the aspect (Table III), which illustrates the Euclidean distance of the points measured from each other in the 5-dimensional space (Table IV).

Table III.

Criteria weight values received as a service provider

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Delivery	10,25	8,56	14,60	6,78	8,54	7,46	8,40	9,64	11,54	10,33
Storage and inventory	9,95	9,9	5	7,17	7,78	10,84	7,45	5,68	5,62	8,05
Service level and quality	17,91	17,3	14,06	11,51	13,46	11,17	5,92	9,11	8,31	14,37
Costs	1,315	1,525	2,02	1,955	2,165	1,3	1,99	1,88	1,81	1,3
Applied technique and technology	3,7	3,47	4,95	4,81	3,49	5,27	4,16	4,16	5,93	2,91

Table IV.

The measured distance of the dimensions included in the study

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
A_1	0,000									
A_2	1,824	0,000								
A_3	7,766	8,569	0,000							
A_4	7,898	6,792	8,508	0,000						
A_5	5,311	4,433	6,853	3,010	0,000					
A_6	7,515	6,554	9,698	3,832	4,437	0,000				
A_7	12,414	11,672	10,551	5,863	7,580	6,453	0,000			
A_8	9,827	9,309	7,086	4,073	5,007	6,098	3,855	0,000		
A_9	10,853	10,684	6,619	6,048	6,802	7,264	4,700	2,719	0,000	
A_{10}	4,095	3,938	5,684	5,059	2,278	5,642	8,805	5,972	7,313	0,000

The mathematical quality of the MDS procedure in SPSS is characterized by the following two fit indicators, s-stress and RSQ. The s-stress indicator is nothing but an indicator calculated from the difference between the coordinates of the plotted and the original points. Therefore, the smallest values of s-stress are desirable, because they correspond to the smallest possible distortion (Table V).

Table V.
The value and quality of the S-stress indicator (based on my own editing [9])

S-Stress	Quality	Comment
<0,05	Excellent	It probably contains all the relevant information.
0,05<0,1	Good	Correct, the results are interpretable.
0,1<0,15	Medium	The results stand their ground in relation to the task.
0,15<0,2	Acceptable	It's worth dealing with. The result is still mostly interpretable.
0,2<	Inadequate	For the given dimension number, it can only be represented with a large loss of information. It is worth using a larger dimension number.

RSQ (R SQUARED) - another fit indicator calculated by SPSS - is simply the square of the correlation coefficient calculated between the corresponding elements of the plotted and the original matrices, which directly indicates what proportion of the total variance can be explained by the given MDS model [11].

For this indicator - in contrast to the previous one - of course, lower values indicate a worse fit. RSQ> 0.6 is the acceptable value range.
In the example, with regard to the given data set:

- Stress = 0,06053 ' Takes a "good" value.
- RSQ = 0,98481' Appropriate value.

The next step of running the program is to determine the coordinates of the points in the space transformed to 2 dimensions (Table VI).

Table VI.
Coordinates of points in 2D space

	Dim1	Dim2
A_1	1,8428	-0,053
A_2	1,6511	0,383
A_3	0,2819	-1,7974
A_4	-0,3506	0,7314
A_5	0,3707	0,2296
A_6	-0,1066	1,1807
A_7	-1,8942	0,5191
A_8	-1,1131	-0,2404
A_9	-1,3914	-0,7195
A_{10}	0,7094	-0,2333

The following table (Table VII) illustrates the distance of the points located on the transformed projection.

Table VII.

Distance between points on a transformed projection

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
A_1	0									
A_2	0,551	0								
A_3	2,345	2,587	0							
A_4	2,385	2,05	2,569	0						
A_5	1,603	1,338	2,069	0,909	0					
A_6	2,269	1,979	2,928	1,157	1,34	0				
A_7	3,748	3,524	3,186	1,77	2,289	1,948	0			
A_8	2,967	2,81	2,139	1,23	1,512	1,841	1,164	0		
A_9	3,277	3,226	1,998	1,826	2,054	2,193	1,419	0,821	0	
A_{10}	1,236	1,189	1,716	1,527	0,688	1,703	2,658	1,803	2,208	0

In the last step, the dot plot reduced to two-dimensional space is shown. This mapping means mapping the five-dimensional (point of view) space into two dimensions, where in fact all 5 original dimensions appear to a greater or lesser extent. From the point diagram and the standard deviation of the alternatives, we can deduce where the original dimensions appear in the new coordinate system. Deciphering the X-axis was quite clear, since the points are scattered mostly along the service level dimension (Table VIII).

Table VIII.

The distribution of the standard deviation of each descriptive aspect

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	***Deviation***
Delivery	10,25	8,56	14,60	6,78	8,54	7,46	8,40	9,64	11,54	10,33	***2,14***
Storage and inventory	9,95	9,9	5	7,17	7,78	10,84	7,45	5,68	5,62	8,05	***1,90***
Service level and quality	17,91	17,3	14,06	11,51	13,46	11,17	5,92	9,11	8,31	14,37	***3,66***
Costs	1,315	1,525	2,02	1,955	2,165	1,3	1,99	1,88	1,81	1,3	***0,32***
Applied technique and technology	3,7	3,47	4,95	4,81	3,49	5,27	4,16	4,16	5,93	2,91	***0,89***

Regardless, the other dimensions also make their impact felt in the reduced space, for example two original dimensions are close to the y axis: transportation and storage and inventory. The reason for this is that these original dimensions also correlate (negatively) with each other (Table IX).

Table IX.
The magnitude and direction of the linear relationship between the two aspects

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	**Correlation**
Delivery	10,25	8,56	14,60	6,78	8,54	7,46	8,40	9,64	11,54	10,33	-0,5715
Storage and inventory	9,95	9,9	5	7,17	7,78	10,84	7,45	5,68	5,62	8,05	

Among the original dimensions, the 4th (applied technique, technology) and 5th (costs) dimensions are also included in the reduced space, but their position is more difficult to determine, as they are less differentiated in the initial five-dimensional space. After the investigation, as a result of the conclusion, it can be concluded that the best correlating aspect during the transformation is the level of service and quality (M_i) displayed on the horizontal (x) axis, the next two best correlating aspects along the vertical (y) axis are transportation and storage and inventory.

The axes depicted in the diagram are oriented according to the display shown in Fig. 1. Along the x-axis, the neighbourhood of the minus value can be interpreted as the "lower" service level, and in the direction of the positive value, the "higher" service quality can be seen. Along the y-axis, the minus value is represented by service providers focusing on the "delivery aspect", and the positively oriented value is represented by the service providers focusing on the "warehousing and stocking" aspect. The essence of the technique used lies in the fact that we can display the service providers qualified in the complex evaluation system in a two- or three-dimensional coordinate system where the axes represent various properties, and the service providers are scattered along these trends. This makes it clear to the decision-makers what the individual service providers are stronger than their competitors, as well as what are the strengths and weaknesses of the individual service providers, and which is the best performing service provider in the comparison.

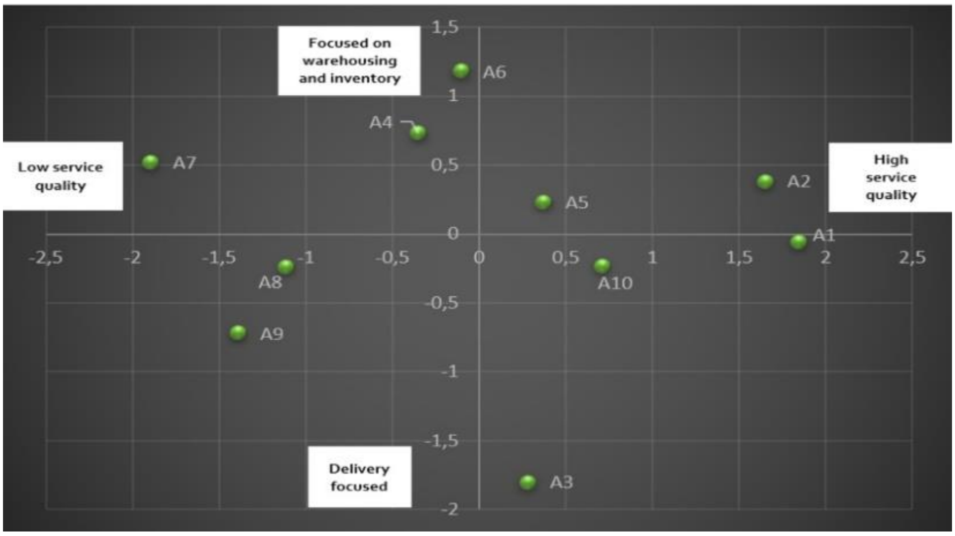

Figure 1. Scattering of alternatives in the transformed dimensional space

5. SUMMARY

The primary goal of the process is to provide service users with assistance in the selection process. The test method and the presented example were specifically presented for the evaluation process of companies offering logistics services as a decision support method, but at the same time, with minimal correction, they can be used in all evaluation-selection processes However, the procedure can also be approached from the context of providing service providers with feedback on the performance of their processes. Moreover, in such a way that there is a service provider with the best results for each aspect. This process can be called benchmarking, the purpose of which is to give alternative service providers a picture of the situation at which level they currently stand in the evaluation ranking, what result is associated with their current performance, and what kind of lag or competitive advantage they have compared to their competitors. The realized selection ranking can also be considered a benchmarking evaluation for the service provider, by which it can position itself in the competitive market.

REFERENCES

[1] Wang, K. (2016). Logistics 4.0 solution-new challenges and opportunities. *Proceedings of the 6th International Workshop of Advanced Manufacturing and Automation*. 68-74, 2352-5428, Atlantis Press, https://doi.org/10.2991/iwama-16.2016.13

[2] Illés, B., Glistau, E. & Coello Machado, N. I. (2007). *Logisztika és minőségmenedzsment*. Miskolc University Press, ISBN: 978-963-87738-0-7

[3] Mellat-Parast, M. & E. Spillan, J. (2014). Logistics and supply chain process integration as a source of competitive advantage: An empirical analysis. *The international journal of Logistics Management* **25**(2), 289-314, https://doi.org/10.1108/IJLM-07-2012-0066

[4] Govindan, K. et al. (2018). Big data analytics and application for logistics and supply chain management. *Transportation Research Part E: Logistics and Transportation Review* **114,** 343-349, https://doi.org/10.1016/j.tre.2018.03.011

[5] Csákné Filep, J. & Karmazin, Gy. (2016). Financial Characteristics of Family Businesses and Financial Aspects of Succession. *Budapest Management Review* **47**(11), 46-58, https://doi.org/10.14267/VEZTUD.2016.11.06

[6] Karmazin, Gy. (2016). *A logisztikai szolgáltatók stratégiai sikertényezői*. Akadémiai Kiadó Zrt., Budapest, ISBN:9789630597166

[7] Ruchi, M., Singh, R. K. & Koles, B. (2021). Consumer decision-making in Omnichannel retailing: Literature review and future research agenda; *International Journal of Consumer Studies* **45**(2), 147-174, https://doi.org/10.1111/ijcs.12617

[8] Mosiichuk, K. A. (2006). *Logistics parties*. National Aviation University, Kyiv, UDC 656.073.5

[9] Andersson, D. (1997). *Third party logistics-outsourcing logistics in partnership*. Linköping Studies in Management and Economics, Linköping University. Dissertation No. 34 (Doctoral dissertation)

[10] Hosie, P. et al. (2012). Determinants of fifth party logistics (5PL): Service providers for supply chain management. *International Journal of Logistics Systems and Management* **13**(3), 287-316, https://doi.org/10.1504/IJLSM.2012.049700

[11] Mangan, J., Lalwani, C. & Gardner, B. (2004). Combining quantitative and qualitative methodologies in logistics research. *International journal of physical distribution & logistics management* **34**(7), 565-578, https://doi.org/10.1108/09600030410552258

[12] Takács, Sz. (2013). Többdimenziós skálázás. *Psychologia Hungarica Caroliensis*, **1**(1), 140-149, https://doi.org/10.12663/PsyHung.1.2013.1.7