

**Keywords:** multi-criteria evaluation; topsis; e-shop delivery, last-mile delivery

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## **MULTI-CRITERIA EVALUATION OF E-SHOP METHODS OF DELIVERY FROM THE CUSTOMER'S PERSPECTIVE**

**Summary.** This article focuses on the multi-criteria evaluation of various delivery options in the conditions of chosen e-shop, from the customer's perspective. The evaluations were performed on conditions of the most popular e-shop in Slovakia and the customer segment was represented by a group of people of productive age. For the multi-criteria analysis, the TOPSIS method was chosen. We identified four basic distribution options in the selected e-shop and nine evaluation criteria. The results of this research show the most preferable option for distribution according to the customer's preference and according to the results of the multi-criteria analysis by TOPSIS.

### **1. INTRODUCTION**

E-commerce is currently the most broadly used form of trading and is expected to be the main selling strategy for both retail and wholesale dealers in the near future. There are several potential players in the global trade chain involved in business worldwide.

The increasing popularity and global success of e-commerce have meant a parallel transformation in the existing support and distribution structures. Traditional business models are evolving and traditional distribution processes are also changing to accommodate these new models of business.

Therefore, the creation of a new logistics and distribution network can become a stimulus towards the further development of e-commerce in the national and international dimension. In creating a new model of logistics and distribution networks, it is essential to identify where the potential e-commerce consumers are, where distribution centres, contact points and shops are suitably located, what mode of transport is required to deal with distribution and delivery and finally how to optimally link selling points and consumers [18]. To find solutions to these problems (especially last mile delivery), we could use e-commerce distribution logistics [16].

### **2. ANALYSIS**

Distribution logistics offers a physical, organizational and information connection between the enterprise and the consumer, its store, contact point or the point of transport of the goods [5]. Authors Lim, S., Jin, X. and Srail, J. S. identify a broad set of contingency variables and operational characteristics of a distribution logistic network configuration (push-centric, pull-centric and hybrid system) via a set of structural variables, which are captured in the form of a design framework [17].

E-commerce distribution logistic explains how to define and create the e-commerce distribution system and, by the allocation of contact points, resolves the design of the customer's distribution region [3, 6, 21]. All of these issues form the entire distribution system of an enterprise that is offering products through the internet and by new distribution channels [19]. Domanski, R., & Adamczak, M, in their

work [4], analyse new distribution channels and define the characteristic features of each new distribution channel and the guidelines on the economics of the flow of goods in a logistics system.

The e-commerce distribution network can be defined as the linking of the elements of the distribution space by means of transport to satisfy the customer's requirements. Freichel, S.L.K. and Wortge, J.K., in their paper [8], state that the design and scope of activities in distribution centres become key challenges and success factors in the transformation process of creating a distribution channel. But from the customer's point of view, at the e-commerce distribution network and particular distribution channels, we can find another set of factors that influence customer satisfaction.

We can find various sources that describe this problem from the customer's perspective. According to the analysis by Gawor, T. and Hoberg, K., price is the most important criterion in distribution channel selection, followed by lead time and convenience [9]. In the work of Xu, J.J., Jiang, L. and Li, Y.L., it was identified that the customers are focused on terminal delivery rather than the overall distribution process [35]. In the work of Zhang, Y., Fan, X.N. and Zhou, L. we can also find that the "last mile" delivery of the e-commerce distribution process will directly target the final customer. This stage has become a key stage affecting the quality of logistics and service and customer satisfaction [39].

The customer's satisfaction depends on the overall distribution model [32], but the most important factor is the last mile delivery to customers (based on the literature review). Today, customers want their merchandise to be delivered rapidly, precisely and at their convenience [15]. They have high expectations with respect to delivery and may consider the speed and convenience of delivery as important as product price and its quality [25, 28].

Therefore, when it comes to e-commerce logistics, e-shops need to deliver huge volumes of parcels fast, sometimes even within a specific or limited delivery time window [23, 29]. In addition, with a higher volume of e-commerce deals, e-shops also need to manage an equivalent volume of returned, exchanged and damaged commodities. Due to this, the design and optimization of e-commerce logistics networks on a cross-border level, but especially on a national level, seems to be significant [34]. The model of e-commerce distribution networks can be classified as follows:

- national distribution networks and
- cross-border distribution networks.

In this article, we will focus on national distribution networks. This type of network is defined as a distribution network within a single country. The design of this network is focused on finding the location of a central warehouse, setting up the national distribution network (location of hubs and contact points) and finally the offer of the best delivery options (last mile delivery options) [14, 20, 24]. Distribution logistics for physical goods generates a significant demand for dedicated delivery services, and results in increasingly difficult last mile logistics as mentioned in the work of Morganti, E., Seidel, S., Blanquart, C., Dablanc, L. and Lenz, B. [26]. According to Ye, C.M., last mile logistics can be analysed from time and space perspectives [36]. Otter, C., Watzl, C., Schwarz, D. and Priess, P. in their paper [27], present e-commerce customer expectations in alternative delivery time frames and consider the impacts in the last mile of attended home delivery, reception boxes and collection-and-delivery points.

An inseparable part of e-commerce distribution models is the space perspective. It represents the ways in which individual e-commerce stores deliver goods ordered by customers. The study of Yuen, K.F., Wang, X.Q., Ng, L.T.W. and Wong, Y.D. analyses the determinants of customers' intention to use various opportunities (especially locker-rooms) for last mile deliveries [37]. According to that study, in national and international e-commerce distribution networks, we can identify the following delivery methods of products with respect to delivery in the last mile:

- delivery to a specific or alternative address – delivery of ordered goods directly to the customer's address or alternative address to office/workplace.
- service points of logistics/postal company – the company is ensuring operational assembly, packaging, sorting orders, handling of goods,
- third-party delivery office – a collaboration of e-shops with the partner's delivery offices,
- e-shop physical store – individual collection via brick-and-mortar retailer facilities and
- self-service delivery sites – individual collection via parcel locker sites.

According to an IPC cross-border e-commerce shopper survey [30] conducted in 2017 on a sample of 28892 respondents worldwide, three-quarters (74%) of respondents had a parcel delivered to their home in the past year [30]. A quarter (26%) picked a parcel up from a Post Office, 19% from a postal service point, 16% from a courier's parcel shop and 16% had a parcel delivered to their office/workplace (see figure 1). In terms of differences by country, the following results were obtained:

- delivery to a post office was the highest in Russia (76%), Iceland (67%), Cyprus (65%), Finland (50%) and Greece (44%),
- a postal service point was most commonly used in Norway (71%), Sweden (70%), Finland (65%) and Denmark (50%),
- an office/workplace was most commonly used as a delivery location in China (44%) and India (41%),
- a courier's parcel shop was most commonly used in France (54%) and
- parcel lockers were most popular in Finland (43%), Denmark (41%) and China (33%).

In our research, we will analyse the delivery methods in the last mile delivery of selected e-shops from the customer's perspective. The most popular e-shop operating in the Slovak market is alza.sk. Alza is one of the most successful e-shops in the Slovak market in terms of turnover, the volume of offered goods and the quantity of offered range. This e-shop offers a variety of options on the delivery of products to customers. Inspired by the work of Gu, Q., M. [10], we analysed delivery opportunities for the customers and found that alza.sk provides the following four delivery options:

- A<sub>1</sub> – delivery to the partner's contact point,
- A<sub>2</sub> – delivery to its own contact point (e-shop physical store),
- A<sub>3</sub> – delivery to an address and
- A<sub>4</sub> – delivery to parcel lockers (self-service places).

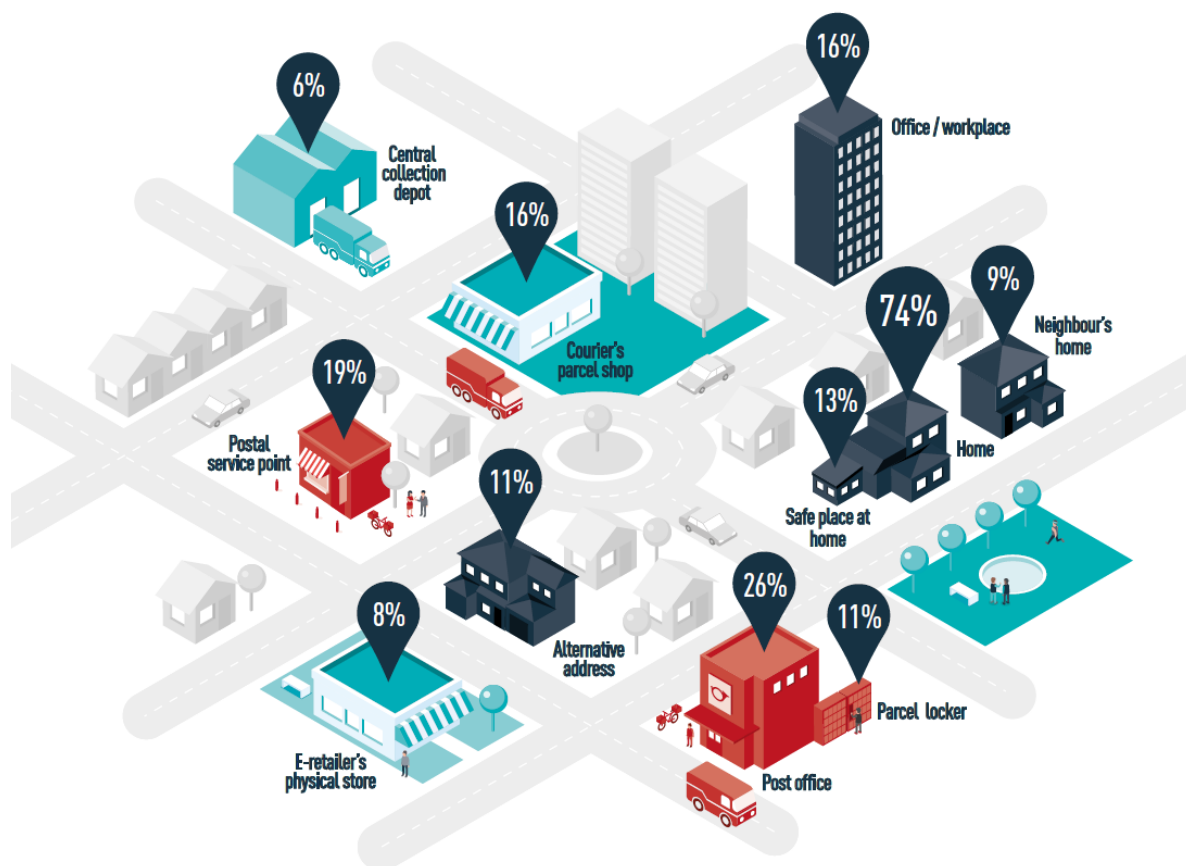


Fig. 1. Delivery locations in the last mile delivery [30]

All the mentioned categories present general ways of delivery in the conditions of e-shop Alza.sk for the last mile. With the personal pick-up option, it is possible to split the delivery services for products ordered from Alza.sk into a personal pick-up through a partner contact point or Alza's (own) contact points. The partner contact point is a facility owned by a company cooperating with Alza. Slovak Post or "Zasielkovňa" is one such company. Brick-and-mortar stores of Alza.sk are considered as their own contact points. The category "delivery to an address" can be characterized as delivering goods to customers at their residential address, respectively, another customer-selected address, for example, work address. This service is provided using express courier services or in-house delivery (Alza's vehicle). Parcel lockers "Alzaboxes" are mainly included in the last characterized category "Delivery to parcel lockers".

### 3. OBJECTIVES AND METHODOLOGY

The choice of methods for the multicriteria evaluation of alternatives solutions depends on the reasons for and objectives of the decision. It is essential to know what needs have to be decided, what are the objectives have to be met, in what aspects to decide and finally to what timeframe the outcome of the decision-making will work. The research problem is solved through multicriteria decision-making, which requires cardinal information on the relative importance of the criteria. According to the method of computing, it works with the finding of maximal benefits, minimizing the distance from the ideal variant or variants evaluation under preferential basis, etc.

Given the above, it is possible to seek a solution to a given task using methods that are suitable for determining the optimal order of existing solution variants. These are as follows:

- method WSA (Weighted Sum Approach),
- method IPA (Ideal Points Analysis),
- method TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and
- method CDA (Concordance Discordance Analysis).

The WSA method is based on the principle of maximizing the benefit, but is simplified in that it assumes only a linear function of the benefit. The IPA method is a modified form of WSA. This is a minimum adjustment, consisting of a reorganization of the list of solution variants so that the lowest-value value is best in this case and vice versa.

The CDA method is quite often used in multicriteria decision-making, but is unsuitable for the present case, given the method of assessment, which is to compare alternatives of selection in pairs.

The TOPSIS method is based on the principle of minimizing the distance from the ideal variant. It enables a complete ordering of the set of all variants, i.e. it is intended for the selection of the best variant based on the criteria values of individual variants and the weights of individual criteria. It assumes the maximization characteristic of all criteria.

The main aim of this article is to evaluate last mile delivery options in conditions of selected e-shop based on the selected multi-criteria evaluation method: TOPSIS. This method was also used by Jayant, A. Gupta, P. Garg, S. K. and Khan, M. for the evaluation and selection of service providers, but for reverse logistics [12].

To be able to fulfil the main objective of this article, we used the following methods, techniques and tools. The analysis of delivery options at e-shop alza.sk creates an essential basis for their next evaluation. To evaluate and rank distribution options in the conditions of selected e-shop, it was necessary to define the criteria on whose basis the customer decides between individual distribution options [22].

After defining the criteria, it was necessary to allocate the weights of the individual criteria, which were allocated on the basis of the information obtained from the questionnaire. We collected from the questionnaire input data for the multi-criteria evaluation where the target segment were the customers of the e-shop. The questionnaire was created in an electronic format using the CAWI method. We collected 441 answers from respondents; 391 of these could be used for our next research (the respondents were the customers of the selected e-shop alza.sk) [15].

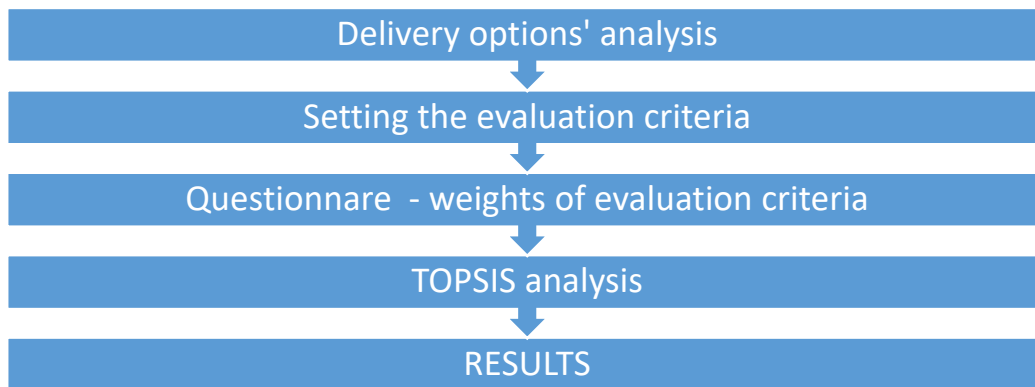


Fig. 2. Methodology of evaluation

The next step was to create a basic criterion matrix from which a modified criterion matrix, a standardized criterion matrix and a weighted criterion matrix were created.

Subsequently, the distances of the individual alternatives from the ideal and basal variants were found. Finally, relative distance indicators were obtained from the computed distances to establish the order of e-shop distribution options.

#### 4. RESULTS

The first step of multi-criteria evaluation is the selection of the criteria group, which is the most important step for e-shop customers when they are choosing the delivery option. In the Kedia, A., Kusumastuti, D. and Nicholson, A. study [13], the set of factors influencing the customers' acceptance of delivery points' placement was identified. They can be categorized into several themes, such as delivery points' network density, parking availability near the delivery point, spatial location of the delivery points, proximity to the consumer's home or office, safe and secure operation, and hours of operation of delivery points. On the basis of that research and according to our questionnaire, we identified the following ten criteria:

- $K_1$  – the cost of delivery in €;
- $K_2$  – delivery speed – individual delivery options are different in terms of time (number of days or hours to deliver goods ordered by the customer to the customer's chosen delivery point);
- $K_3$  – geographical accuracy of delivery – it is especially important for delivery to the customer's address;
- $K_4$  – shipment monitoring and tracking – the customer has the opportunity to track the path of the goods ordered by him or her to identify the location during transport;
- $K_5$  – ecological delivery solution – usage of eco-friendly delivery solutions;
- $K_6$  – delivery reliability – the product will be delivered in its original form (without any damage);
- $K_7$  – delivery time availability (opening hours) – availability during the day;
- $K_8$  – delivery time availability (frequency) – weekly delivery frequency;
- $K_9$  – dimension, resp. weight of shipment – possibility of ordering goods of a large size;
- $K_{10}$  – form of payment – alternative payment options for goods, such as cash, bank transfer, check or cryptocurrency.

According to TOPSIS methodology, the next step is to find the weights for every individual criterion. For this reason, we created the electronic questionnaire that was sent to customers of the selected e-shop alza.sk. One of the questions was as follows: "What option do you prefer for delivery"? The respondents answered that the most preferred option is delivery to an address (46%), the second most preferred option was delivery to a contact point (physical store) (34%) and the third most preferred option was

delivery to the partner's contact point (11%). Delivery to parcel lockers was mentioned only by 9% of the respondents (see Fig. 3). This question was just a control question only, and we used the answers to this question for the final comparison.

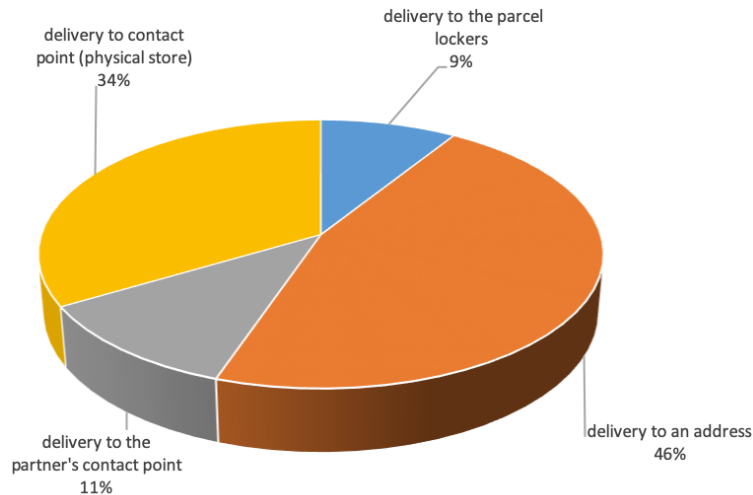


Fig. 3. The most preferred options for delivery from e-shops according of the customers of e-shop alza.sk

The most important question for input data for TOPSIS analysis was related to the importance of criteria  $K_1 - K_{10}$ . Respondents had to assign a level of importance to each criterion (5 indicating the highest importance and 1 indicating the lowest importance) [1, 31]. According to the answers of the respondents to the questionnaire, we determined the average weight of each criterion (see table 1).

Table 1

Criterion average weight

Criterion	Weight	Criterion	Weight
$K_1$ - the cost of delivery	4,26	$K_6$ - delivery reliability	4,13
$K_2$ - delivery speed	4,04	$K_7$ - delivery time (opening hours)	3,67
$K_3$ - geographical accuracy of delivery	3,77	$K_8$ - delivery time (frequency)	3,54
$K_4$ - shipment monitoring and tracking	3,27	$K_9$ - dimension/ weight of the shipment	2,93
$K_5$ - ecological delivery solution	3,22	$K_{10}$ - form of payment	3,61

With this, we had all the input data to initiate a TOPSIS multi-criteria analysis. The first phase of TOPSIS analysis is the construction of a decision matrix, followed by a normalized decision matrix  $Y$ . This step transforms various attribute dimensions into non-dimensional attributes, which allows comparisons across criteria [1, 34].

Table 2

Normalized decision matrix

Y	$K_1$	$K_2$	$K_3$	$K_4$	$K_5$	$K_6$	$K_7$	$K_8$	$K_9$	$K_{10}$
$A_1$	2,12	0	100	100	100	100	10	10	5	6
$A_2$	3,42	1	100	100	100	100	11	500	6	6
$A_3$	0	0	100	100	100	100	10	150	6	6
$A_4$	3,42	1	100	100	100	100	24	30	7	6

Because various criteria are usually measured in various units, the scores in the evaluation matrix  $X$  have to be transformed into a normalized scale. At the end of this step, we have to add the weights of each criterion and create the weighted normalized decision matrix  $Z$  [1, 38].

Table 3

## Weighted normalized decision matrix

Z	K <sub>1</sub>	K <sub>2</sub>	K <sub>3</sub>	K <sub>4</sub>	K <sub>5</sub>	K <sub>6</sub>	K <sub>7</sub>	K <sub>8</sub>	K <sub>9</sub>	K <sub>10</sub>
A <sub>1</sub>	1,71	0	1,88	1,63	2,07	1,62	1,22	0,06	1,47	1,81
A <sub>2</sub>	2,76	2,86	1,88	1,63	2,07	1,62	1,34	2,80	1,76	1,81
A <sub>3</sub>	0	0	1,88	1,63	2,07	1,62	1,22	0,84	1,76	1,81
A <sub>4</sub>	2,76	1,278	1,88	1,63	2,07	1,62	2,93	0,17	2,05	1,81

The next step of multi-criteria analysis is to determine the positive ideal (extreme performance on each criterion) and basal (negative ideal) alternatives (reverse extreme performance on each criterion) [1, 22]. The ideal alternative is denoted by the letter "h" and the basal alternative by the letter "d". The ideal positive solution is the solution that maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. The values of these alternatives are shown in table 4.

Table 4

## Positive ideal and negative ideal alternatives

	K <sub>1</sub>	K <sub>2</sub>	K <sub>3</sub>	K <sub>4</sub>	K <sub>5</sub>	K <sub>6</sub>	K <sub>7</sub>	K <sub>8</sub>	K <sub>9</sub>	K <sub>10</sub>
h <sub>i</sub>	2,76	2,86	1,88	1,63	2,07	1,62	2,93	2,80	2,05	1,81
d <sub>i</sub>	0	0	1,88	1,63	2,07	1,62	1,22	0,06	1,47	1,81

The final part of TOPSIS analysis is to calculate the separation measures from the positive ideal solution  $d_i^+$  and the negative ideal solution  $d_i^-$  and the calculation of the relative closeness to the positive ideal solution  $R_i$ . The set of alternatives  $A_1 - A_4$  can then be ranked by the descending order of the value of  $R_i$ . The alternative that is closest to 1 is the best alternative [1, 38].

Table 5

## Final ranking of alternatives

	$d_i^+$	$d_i^-$	$R_i$	Rank
A <sub>1</sub>	4,479668	4,784229	0,516438	3
<b>A<sub>2</sub></b>	<b>1,615439</b>	<b>6,696136</b>	<b>0,80564</b>	<b>1</b>
A <sub>3</sub>	4,757126	4,648805	0,494242	4
A <sub>4</sub>	3,070432	6,196877	0,668681	2

The results presented in Table 5, based on the previous calculations, show the evaluation of the delivery options' alternatives in the conditions of the Alza.sk e-shop.

From the presented results, it is clear that the customers of the e-shop alza.sk consider the "A<sub>2</sub> – delivery to own contact point" as the most preferable option of delivery through an e-shop physical store. This negates the information obtained through the questionnaire (subjective preferences of the customers), which shows that the most preferred option of delivering goods to customers is delivery to the customer's address (alternative A<sub>3</sub>).

The results from the TOPSIS method can be considered more relevant than the results obtained from the electronic questionnaire. They take into account more criteria and various levels of their importance than simple answers at the questions in the questionnaire.

## 5. CONCLUSIONS

The main objective of this paper was to evaluate the delivery option in the conditions of the e-shop alza.sk. The evaluation was performed by the multi-criteria analysis method TOPSIS. The input data were customers' preferences on delivery options; these were obtained by an electronic questionnaire. The respondents were customers of the most popular Slovak e-shop alza.sk. The results obtained from the multi-criteria evaluation method TOPSIS can be considered more objective than the results obtained from the electronic questionnaire because they take into account a number of criteria of varying levels of importance to the customer.

By evaluating the results of the analysis, we came to the conclusion that the customer's most preferred method of delivery of shipments from the e-shop alza.sk is delivery to the company's physical shops. It is very interesting to note that based on our chosen criteria  $K_1$  to  $K_{10}$  and multi-criteria analysis, the least preferred method of delivery is delivery to an address. This is in contrast to the results of the electronic questionnaire, where respondents stated delivery to the address as the most preferred method of delivery of products from the e-shop alza.sk. Delivery to self-service facilities was the second most preferred method stated. These results confirm the results from previously published researches of Cardenas, I.D., Florio, A.M., Iwan, S., Wang, C.B. and Yuuen K.F. [2, 7, 11, 33, 37] dedicated to e-commerce last-mile delivery options and our assumption resulted from realised research. That results show that e-shop customers want to choose the place and time to pick up the goods and also that courier delivery is very comfortable. However, it is necessary to accept several limitations, especially related to the delivery time (for example, delivery time is between 08:00 and 16:00).

Based on the results of the evaluation, we can conclude that there is a difference between subjective (questionnaire) and objective (multi-criteria analysis) preferences of the delivery option in the selected e-shop. Based on the results of the analysis and subsequent comparison of the results, the e-shop should in the future focus on better spatial coverage of Slovakia with contact centres and self-service facilities (parcel lockers). We will address this issue in our future research.

## Acknowledgement

This contribution was undertaken as part of the research project VEGA 1/0721/18 Research on the Economic Impact of Visual Smog in Transport Using Neuroscience Methods.

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