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A NOVEL INTEGRATED MCDM-SWOT-TOWS MODEL FOR THE STRATEGIC DECISION ANALYSIS IN TRANSPORTATION COMPANY

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Abstract. *In this paper, based on the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, a matrix of Threats, Opportunities, Weaknesses and Strengths (TOWS) was formed. It represents possible business strategies of the transport company. To choose the right plan, a model based on the integration of Fuzzy PIvot Pairwise RElative Criteria Importance Assessment (fuzzy PIPRECIA), Full Consistency Method (FUCOM) and Measurement Alternatives and Ranking according to COmpromise Solution (MARCOS) methods, has been formed. A case study was conducted in the transport company from Bosnia and Herzegovina which provides services on the domestic and the European Union market for 20 years and belongs to a group of small and medium enterprises (SMEs). The SWOT analysis in this transport company was the basis for forming the TOWS matrix, which represents a set of possible business strategies. These strategies are the basis for developing five basic alternatives. The transport company should choose the best one of them for future business. The research focuses on forming a model for choosing the best strategy by which the transport company seeks to improve its business. Decision-making (DM) is not a straightforward sequence of operations, so the harmonization of methods as well as the verification of their results, are essential in the research. This model is applicable in SMEs that make these and similar decisions. Using this model, companies can adjust their business policies to the results of the model and achieve better business results. This research is the first that allows the use of such a model in making strategic decisions.*

Key Words: *MCDM, Fuzzy PIPRECIA, FUCOM, SWOT, MARCOS, Transport*

1. INTRODUCTION

Increasing speed and reliability of the freight transport is considered a major transport policy objective in most countries [1], so the company management involves planning, organizing, leading and controlling whereby the management, together with other resources, effectively and efficiently accomplishes the goals of the company. If a company wants to operate successfully, it must define the right goals. To assess a newly developed plan, enterprises need well-backgrounded problem-solving models [2]. To achieve its mission the company should provide correlation of internal and external factors. The management finds a way of doing business by getting to know strengths and weaknesses of the company in order to take advantage of opportunities and to master the dangers that come from the environment. The company management must be changing in line with the changing environment in which it operates. Chances often come up from the background. The company needs to be able to recognize and exploit them in time. The management should identify, predict and determine the size and strength of chances. The strategy most often refers to us as the way of determining the direction of growth and development of the company in the domestic and international markets. According to [3], the strategy implies the realization of primary long-term goals and tasks of the company as well as acceptance of the direction of activities and distribution of the means necessary to achieve those goals. Meanwhile, [4] the defined strategy relates to a critical set of management decision tools, encompassing objectives, policies, and ways of achieving them in economic activity. In the narrower sense, the plan is a business decision that defines basic ways of achieving goals. To achieve its goals in the best possible way, the company needs to determine its strategy. It means that the management must make a decision about what and how many resources need to be engaged in the business process. The strategy shows a more rational way of directing limited resources to achieve a specific objective. A strategy is a tool by which the company defines and realizes its goals. It expresses the way in which business responds to the environment over time. Based on the plan, the management defines the relationship between the company and its environment as well as the structure of business competence that will help it to meet the challenges. Strategic management is a separate management process and represents the process of directing the activities of the company. The essential factors of the company's business success are identified based on predicting the chances, dangers, strengths and weaknesses of the company. Strategic management includes the links between leadership, entrepreneurship and management, company-wide knowledge, relationship with the environment, expertise in finance, manufacturing, marketing, as well as the experience of people and their work.

The management will be able to use the research results and make a decision concerning the best strategy to be applied for future business. After the introduction, the second part of the article presents a literature review. The third part of the article presents the formed decision models and the investigation outcome. To achieve these goals, the authors used three fuzzy MCDM methods, namely MARCOS, FUCOM, and PIPRECIA. Based on this model, it will be possible to make a decision about the choice of the best strategy. The fourth part of this article presents a case study and a SWOT analysis of the transport company. In this way, the research describes the current situation in the transport company. This part of the article shows the problem-solving process by using the developed model. Sensitiveness of the outcomes follows in the next part. The last part

of the work presents the conclusions of the research with the directions of perspective exploration.

2. LITERATURE REVIEW

The modern business needs reliable solutions, both locally and internationally. Business leaders should choose excellent and realistic development strategies instead of looking for ways to resolve conflicts and problems [5]. The SWOT analysis can be a useful tool for analyzing the business. A large number of researchers use this method for analyzing the current situation in the company. The SWOT analysis helps us make strategic decisions [6]. This method helps to solve problems in different fields of business. Novikov [7] used SWOT to analyze high-tech strategic development in manufacturing companies. Rauch et al. [8] used this approach to analyze the state of forest fuel supply chains in Southeast Europe and to find a rational development strategy. Živković et al. [9] applied the approach to investigate strategic DM in the Technical Faculty. Bohari et al. [10] and Kolbina[11] performed a SWOT analysis in the food industry. SWOT analysis is applicable in the energy sector [12, 13]. This method of analysis helped scholars in many more areas of research [14-19]. Kuo et al. [20], Comino and Ferretti [21] and Hatefi[22] used the SWOT analysis for strategic planning. Valverde et al. [23], Yan et al. [24] and Jasiulewicz-Kaczmarek[25] performed SWOT analysis as a method of helping management with decision-making.

A widespread use of combinations of the SWOT analysis with other methods proves the relevance of model development in this paper. Abdel-Basset et al. [26] formed a model for strategic planning and DM by combining AHP and SWOT methods. Ruzgys et al. [27] presented an integrated MCDM model to select materials using SWOT, SWARA, and TODIM methods. Edrogan et al. [28] solved the problem of construction management. Turskis and Juodagalvienė [29] integrated ten different MCDM methods to one model and solved the problem of shape assessment. Korableva and Kalimullina[30] created BSC-SWOT matrix and applied it to the optimization of the organization. And there are many more authors who use using combinations of SWOT and other methods in their research [31-35].

Recently, scientific articles using the FUCOM method have been published frequently. Pamučar et al. [36] suggest that managers use a simple algorithm and the FUCOM method to prioritize criteria, as well as evaluate occurrences against decision-makers (DMR) priorities. The FUCOM method, in combination with other methods, gives excellent results when forming DM models [37]. The authors use the FUCOM method to evaluate criteria in different studies [38-42]. When researchers evaluate particular alternatives, they use FUCOM method in their research [43-47].

In this paper, the MARCOS method helps to determine the utility functions of alternatives and to make a compromise ranking concerning ideal and anti-ideal solutions. Stević et al. [48] recently developed the MARCOS method. Several studies [49-51] used it to solve problems.

3. METHODS

The article presents the methodology through five phases. Fig. 1 shows them.
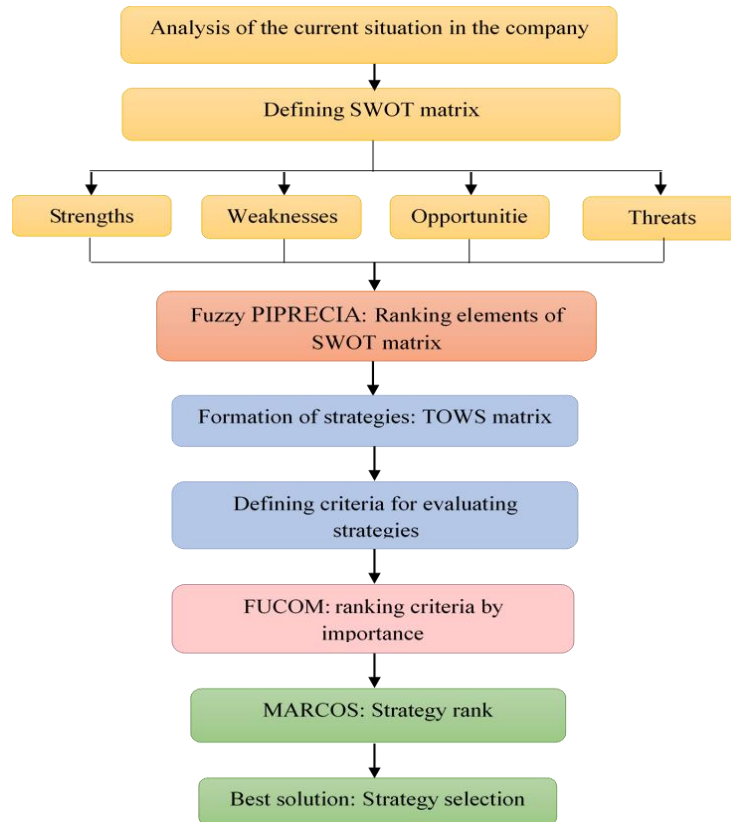

Fig. 1 The decision-making methodology

The first phase will help DMRs to collect data from a particular transport company. It describes the current situation in the transport company and determines its internal strengths and weaknesses as well as external opportunities and threats. The data is the basis for the SWOT analysis.

After this in the second phase, the Fuzzy PIPRECIA method ranked elements of the SWOT. The PIPRECIA method allows DMRs to evaluate the importance of criteria without sorting [52]. DMRs groups solve most multi-criteria decision-making (MCDM) problems. Therefore, the SWARA method forces DMRs to solve this problem systematically [53, 54], taking into account an integrated opinion of DMRs about criteria significance ranks and ensures full consistency of final assessment of criteria weights. If the number of DMRs participating in the fuzzy PIPRECIA increases, the model works worse. Stević et al. [55] developed the fuzzy PIPRECIA method. This method consists of eleven steps. The third phase, the cross-SWOT analysis helps to form the TOWS matrix and to define strategies. This phase defines the criteria to evaluate the strategies.

The FUCOM method helps to rank the criteria in descending order of importance and finally to assess their significance in the fourth phase. The basis of this method is to compare the relative importance of criteria in pairs, from the most important to the least influential, and to present the results, given that the DMRs are sure that the rankings of the requirements given in the previous step are well defined and do not need to be changed [36]. FUCOM requires DMRs to determine the effect of criterion i on criterion j. The FUCOM method has some benefits, such as relatively few pairwise comparisons (number of criteria minus one) compared to the AHP method. In real life, the FUCOM method is the same as the SWARA method. It is the same as the SWARA method. The FUCOM method presents a small modification of the SWARA algorithm. DM in the FUCOM method directly presents the ratios of pair of criteria importance level instead of describing a distance of significance in a pair of criteria, which later add to 1. It means that in the FUCOM method one step from the SWARA method is omitted. The final step of the FUCOM method (determining values of criteria weights of the criteria) includes the subjective effect of DMRs preferences. However, unlike other criteria weighting methods, the FUCOM determines criteria weights with smaller deviations (Puška et al. 2019). The FUCOM method consists of three steps.

The MARCOS approach helps to evaluate and evaluate strategies in the fifth stage. The primary basis of MARCOS is to establish the relationship between alternative and reference values (perfect and anti-ideal alternatives). This approach consists of seven steps [48]. Based on specific relationships, it determines the utility function's values of options and reaches a compromise on ideal and anti-ideal solutions. Utilities show preferences of available options and the position of each choice concerning the perfect and anti-ideal solutions. The best alternative is the one closest to the ideal but furthest from the anti-ideal starting point. Finally, based on this assessment and ranking, the choice chosen first is the best strategy. Therefore, DMRs have to select and implement it.

3.1. Fuzzy PIvot Pairwise RElative Criteria Importance Assessment - fuzzy PIPRECIA method

Step 1 Formation of the required benchmarking set of criteria and formation of a team of decision-makers.

Step 2 In order to determine the relative importance of criteria, each decision-maker individually evaluates the criteria by starting from the second criterion

$$\overline{s_j^r} = \begin{cases} > \bar{1} & if & C_j > C_{j-1} \\ = \bar{1} & if & C_j = C_{j-1} \\ < \bar{1} & if & C_j < C_{j-1} \end{cases} \tag{1}$$

where s_j^r denotes the evaluation of the criteria by a decision-maker r. Decision-makers evaluate criteria by applying linguistic scales.

Step 3 Determining the coefficient

$$\overline{k_j} = \begin{cases} = \bar{1} & if & j = 1 \\ 2 - \overline{s_j} & if & j > 1 \end{cases} \tag{2}$$

Step 4 Determining the fuzzy weight

$$\overline{q_j} = \begin{cases} = \overline{1} & if \quad j = 1 \\ \dfrac{\overline{q_{j-1}}}{\overline{k_j}} & if \quad j > 1 \end{cases} \tag{3}$$

Step 5 Determining the relative weight of the criterion

$$\overline{w_j} = \dfrac{\overline{q_j}}{\displaystyle\sum_{j=1}^{n} \overline{q_j}} \tag{4}$$

Step 6 Evaluation of the applying scale defined above, but this time starting from a penultimate criterion.

$$\overline{s_j^r}' = \begin{cases} > \overline{1} & if \quad C_j > C_{j+1} \\ = \overline{1} & if \quad C_j = C_{j+1} \\ < \overline{1} & if \quad C_j < C_{j+1} \end{cases} \tag{5}$$

$s_j^r{}'$ denotes the evaluation of the criteria by a decision-maker r.

Step 7 Determining the coefficient

$$\overline{k_j}' = \begin{cases} = \overline{1} & if \quad j = n \\ 2 - \overline{s_j}' & if \quad j > n \end{cases}, \tag{6}$$

n denotes a total number of criteria.

Step 8 Determining the fuzzy weight

$$\overline{q_j}' = \begin{cases} = \overline{1} & if \quad j = n \\ \dfrac{\overline{q_{j+1}}'}{\overline{k_j}'} & if \quad j > n \end{cases} \tag{7}$$

Step 9 Determining the relative weight of the criterion

$$\overline{w_j}' = \dfrac{\overline{q_j}'}{\displaystyle\sum_{j=1}^{n} \overline{q_j}'} \tag{8}$$

Step 10 In order to determine the final weights of the criteria, it is first necessary to perform defuzzification *wj* and *w'j*

$$\overline{w_j}'' = \dfrac{1}{2}(w_j + w_j') \tag{9}$$

Step 11 Checking the results obtained by applying Spearman and Pearson correlation coefficients.

3.2. Full Consistency method (FUCOM)

Step 1 In the first step, the criteria from the predefined set of evaluation criteria $C=(C_1,C_2,...,C_n)$.
The ranking is performed according to the significance of criteria $C_{j(1)}>C_{j(2)}>...>C_{j(k)}$

Step 2 In the second step, a comparison of the ranked criteria is carried out and comparative priority ($\varphi_{k/(k+1)}$, $k=1,2,...,n$), where k represents the rank of the criteria) of the evaluation criteria is determined

$$\Phi = (\varphi_{1/2}, \varphi_{2/3},..., \varphi_{k/(k+1)})$$ (10)

Step 3 In the third step, the final values of the weight coefficients of evaluation criteria $(w_1,w_2,...w_n)^T$ are calculated.

3.3. Measurement Alternatives and Ranking according to COmpromise Solution (MARCOS) method

Step 1 Formation of an initial decision-making matrix.
Step 2 Formation of an *extended* initial matrix by defining ideal (AI) and anti-ideal (AAI) solution.

$$X = \begin{matrix} & \begin{matrix} C_1 & C_2 & ... & C_n \end{matrix} \\ \begin{matrix} AAI \\ A_1 \\ A_2 \\ ... \\ A_m \\ AI \end{matrix} & \begin{bmatrix} x_{aa1} & x_{aa2} & ... & x_{aan} \\ x_{11} & x_{12} & ... & x_{1n} \\ x_{21} & x_{22} & ... & x_{2n} \\ ... & ... & ... & ... \\ x_{m1} & x_{22} & ... & x_{mn} \\ x_{ai1} & x_{ai2} & ... & x_{ain} \end{bmatrix} \end{matrix}$$ (11)

Step 3 Normalization of extended initial matrix X.

$$n_{ij} = \frac{x_{ai}}{x_{ij}} \quad if \ j \in C$$ (12)

$$n_{ij} = \frac{x_{ij}}{x_{ai}} \quad if \ j \in B$$ (13)

where elements x_{ij} and x_{ai} represent the elements of matrix X.
Step 4 Determination of the weighted matrix by Equation

$$v_{ij} = n_{ij} \times w_j$$ (14)

Step 5 Calculation of the utility degree of alternatives K_i.

$$K_i^- = \frac{S_i}{S_{aai}}$$ (15)

$$K_i^+ = \frac{S_i}{S_{ai}}$$ (16)

where S_i $(i=1,2,..,m)$ represents the sum of the elements of weighted matrix V.

Step 6 Determination of the utility function of alternatives $f(K_i)$. The utility function of alternatives is defined by Equation

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \dfrac{1 - f(K_i^+)}{f(K_i^+)} + \dfrac{1 - f(K_i^-)}{f(K_i^-)}};$$ (17)

Utility functions in relation to the ideal and anti-ideal solution are determined by applying Equations:

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-}$$ (18)

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-}$$ (19)

Step 7 Ranking the alternatives.

4. CASE STUDY

The SWOT analysis is one of the simplest but most effective ways to determine the situation in a company. Fig.2 shows thus identified the internal and external factors, which affect the success of the transport company's business. Internal factors are those that the management and the company's employees may change or affect in whole or in part. And yet the management and employees cannot replace external factors. However, they can significantly improve the company's business success by systematically evaluating external factors and selecting the right business plan on time.

INTERNAL FACTORS	
STRENGTHS (+)	**WEAKNESSES (-)**
1. Modern trucks and the ability to respond to all requests 2. Worker motivation 3. Professional employees and years of experience 4. Offices in EU and organization and responsibility (family business) 5. Recognition by brand 6. Cost optimization	1. Disloyalty of employees 2. Workers' omissions (information of exponents, etc.) 3. Close relationship in communication between owner and worker 4. Cost optimization 5. Absence of test moves (employee evaluations) 6. Need for one administrative worker
EXTERNAL FACTORS	
OPPORTUNITIES (+)	**THREATS (-)**
1. Expanding business 2. Infrastructure growth 3. Association 4. EU funds 5. Training course through Eco trainings	1. Closing other companies 2. Growth of levies 3. Unexpected problems from the ground 4. Unloyal competition 5. EU restrictions (CEMT, etc.) 6. Fluctuation of labor

Fig. 2 SWOT analysis

Fig. 3 defines the factors that represent internal and external factors, i.e. strengths and weaknesses in the transport company as well as opportunities and threats from the environment. The upper left corner of the figure lists the advantages of the transport company. The transport company has a modern fleet of a large number of trucks and therefore, it can meet all customer requirements. The management of the transport company is aware that the employees are the ones who do most of the work, so they have provided rewards to everyone who achieves excellent results in performing their activities. Twenty years of a successful business are the result of professionalism and business organization. Years of successful business and responsibility have created a recognizable brand of transport services. Costs have been reduced to a satisfactory level, although the managers argue that costs that incurred daily are a significant weakness of the transport company. Using all these strengths, the transport company strives to minimize threats from the environment. The lower right corner of the figure shows the risks. Closing other transport companies on the market, unloyal competition, fluctuation of labor are threats on which the transport company can respond with its experience, professionalism and organization. Growth of levies, unexpected problems from the ground and the EU restrictions are threats to which the transport company can react by associating with other transport companies and taking advantages of the association. The lower-left corner of the figure shows the opportunities. Using all these opportunities, the transport company strives to minimize the weaknesses of the company. The upper right corner of the picture shows all fallings. DMRs hired independent external experts to obtain objective results. The DMRs act in the fuzzy and dynamically changing environment [56]. Analysis of SWOT of transport company helps DMRs assume that organizations achieve maximum strategic success by effectively leveraging and strengthening their strengths and opportunities in a dynamically changing business environment. The use of beneficial and appropriate management tools helps to reduce a company's shortcomings and threats to the vulnerability of its business. Analysis of the impact of internal and external factors on each strategy is also critical.

After the SWOT analysis, the fuzzy PIPRECIA method was used. The approach evaluated and ranked criteria. The weight and rank of each measure were obtained [57]. The authors did a complete fuzzy PIPRECIA calculation. For calculation purposes, the factors of SWOT analysis are marked as criteria: C1 – Strengths, C2 – Weaknesses, C3 – Opportunities and C4 – Threats (Table 1).

Table 1 Results of fuzzy PIPRECIA

Criteria	Weight of criteria	Rank
C1 – Strengths	0.337	1
C2 – Weaknesses	0.274	2
C3 – Opportunities	0.188	4
C4 – Threats	0.231	3

Strengths and weaknesses are on the first and second according to the results of fuzzy PIPRECIA method with importance values of 0.337 and 0.274, respectively. Opportunities and threats are on the fourth and third place with a value of 0.188 and 0.231, respectively. This table helps to conclude that strengths and weaknesses are more critical for the transport company as internal factors with an influence on its business than external factors, i.e. opportunities and threats. DMRs, in each of these groups of elements, each

element of the SWOT matrix evaluated and ranked separately. Therefore, the total number of listed items into the SWOT matrix is 23. The first and the second-ranked element is Modern trucks and the ability to respond to all requests and Brand recognition as factors with the most considerable influence on the business of the transport company. These elements are in the group of strengths. The worst-ranked feature from this group is cost optimization (14th place). The best-ranked component from the group of weaknesses is Disloyalty of employees (3rd place). The worst-ranked element from this group is Workers' failures (18th place). From the group of opportunities, the best-ranked item is the Business expansion, and it takes seventh place. The worst-ranked element from this group is the EU funds, and it takes 22nd. The best-ranked component from the group of threats is the fluctuation of labor, and it takes the sixth place in the total rank. The worst-ranked element from this group is unexpected problems from the ground, which also receives the worst 23rd position in the full status of features.

Spearman's coefficient [58] helps to determine the correlation between these ranks. The calculated value of it is 1.00. The result shows that these ranks completely correlate. Pearson's coefficient [55] helps to determine the correlation between the weights of the criteria. The calculated value of it is 0.985.

The TOWS matrix formed after the ranking of the criteria represents the business strategies of the transport company. Table 2 shows the strategies (TOWS matrix) created by the cross-SWOT analysis.

Table 2 TOWS matrix - strategies

Strategy SO	Strategy WO
1. Expanding business based on years of experience and brand. 2. Applying for European funds based on responsibility, organization and professionalism. 3. Association with other transport companies using business on the territory of the EU.	1. Cost rationalization through eco-trainings. 2. Increasing loyalty of employees by creating a driver evaluation and reward model. 3. Increasing the productivity of disponents by hiring one administrative worker.
Strategy ST	Strategy WT
1. Fight against unfair competition using advantage of modernization and quality. 2. Reducing fluctuation of workers using advantage of motivation. 3. Reducing levies using the strengths and benefits of association.	1. Easier problems solving on the ground by improving communication between workers and management. 2. Faster problem solving by reducing closeness and intimacy between owner and worker. 3. Increasing the volume of domestic transport using the benefits of infrastructure growth and development.

Table 2 shows twelve formed strategies. The transport company can offer its services to new customers and gain their trust based on the years of experience and brand. In this way, the transport company can expand its business. The transport company has been functioning well for an extended period, and its main characteristics are responsibility, organization and professionalism. Based on the features that embellish a business, provides a good chance of receiving support from some European business funds. The transport company operates in the territory of the EU, where it has its offices. Based on this distribution of business, the company can join its forces with other transport companies in

its field of business and in that way, it can use all benefits of the association. Eco training enables reducing costs in the transport company by as much as 15%. Therefore, the transport company needs such training. If every worker, that is, his work and effort were valued, there would be an increase in loyalty of employees. It would avoid the possibility of putting both good and bad workers in the same basket. For the disponent not to waste time and effort on administrative tasks, it is necessary to employ one administrative worker in the transport company. This move would increase the productivity of the disponents, in this case, who would only do their job. The transport company has a modern vehicle fleet and performs all transport services with high quality, so it should use these advantages in the fight against unfair competition. The transport company motivates employees with a variety of rewards that should reduce the fluctuation of employees. Recently it becomes more pronounced. Companies from all areas of the economy are struggling with this. Companies individually do not have any particular strength to fight the levies that are accumulating more and more every day. Still, transport companies together have much more opportunities to act to reduce various taxes in many fields. In this transport company, there are specific problems of delaying information from employees to the management. Untimely informing the administration by the employees about the new issues in the field delays the solution of the same creates problems in transport and generates additional costs. If employees understand the importance of the speed of transmission of certain information, it would be more comfortable and faster to solve problems in the field. Besides, another way to solve problems faster and easier is that the transport company owners should be less biased and attached to workers because this creates the impossibility of objective reasoning. The last few years are witnesses of the growth and development of road infrastructure in the domestic field. It is beneficial to expand and grow the business.

The previously defined strategies are the basis to assess the general strategy of the transport company's development:

1. Expanding business based on the years of experience and brand,
2. Applying for European funds,
3. Cost rationalization,
4. Driver evaluation and rewards program,
5. Increasing the volume of domestic transport using the benefits of infrastructure growth and development.

The following set of criteria was the basis to evaluate the strategies:

C1 - the time of strategy realization,
C2 - the possibility of strategy realization,
C3 - investment costs for strategy implementation,
C4 - the necessary resources for realization,
C5 - the potential benefits of the strategy, and,
C6 - influence on the economic system.

The linguistic scale is the basis to evaluate all criteria. All criteria are equally present from the aspect of criterion orientation. The first, third and fourth criteria need to be minimal (desirable minimum values), while the others maximal (preferable maximal values).

Based on the FUCOM method, the criteria rank according to their importance, i.e. according to the strength of the impact on the evaluation of general strategies.

First step:

$$C3>C2>C1>C5>C4>C6$$

Second step:

C3	C2	C1	C5	C4	C6
1	1.3	1.5	1.9	2	2.2

The determined preferences of criteria are the basis to calculate relative seniority of criteria (Eq. (10)):

$$\varphi_{c_3/c_2}=1.3/1=1.3, \; \varphi_{c_2/c_1}=1.5/1.3=1.15,$$

$$\varphi_{c_1/c_5}=1.9/1.5=1.27, \; \varphi_{c_5/c_4}=2/1.9=1.05,$$

$$\varphi_{c_4/c_6}=2.2 \; /2=1.1.$$

Third step:

a) $\frac{w_3}{w_2}=1.3, \frac{w_2}{w_1}=1.15, \frac{w_1}{w_5}=1.27, \frac{w_5}{w_4}=1.05, \frac{w_4}{w_6}=1.1$

b) $\frac{w_3}{w_1}=1.3\times1.15=1.495, \frac{w_2}{w_5}=1.15\times1.27=1.461,$

$\frac{w_1}{w_4}=1.27\times1.05=1.334, \frac{w_5}{w_6}=1.05\times1.1=1.155$

The following equation defines the final model to determine the weight coefficients:

$$\min \chi$$

$$s.t. \begin{cases} \left|\frac{w_3}{w_2}-1.30\right|=\chi, \left|\frac{w_2}{w_1}-1.15\right|=\chi, \left|\frac{w_1}{w_5}-1.27\right|=\chi, \left|\frac{w_5}{w_4}-1.05\right|=\chi, \left|\frac{w_4}{w_6}-1.10\right|=\chi, \\ \left|\frac{w_3}{w_1}-1.50\right|=\chi, \left|\frac{w_2}{w_5}-1.46\right|=\chi, \left|\frac{w_1}{w_4}-1.33\right|=\chi, \left|\frac{w_5}{w_6}-1.16\right|=\chi \\ \sum_{j=1}^{6} w_j = 1, \; w_j \geq 0, \forall j \end{cases}$$

The solution of this model provides decision-makers with the final weights: (0.255, 0.196, 0.170, 0,134, 0.128, 0,116) and deviation from complete consistency $\chi=0.000$. The tags given at the beginning of Table 3 shows the values of the criteria.

Table 3 Criteria priorities

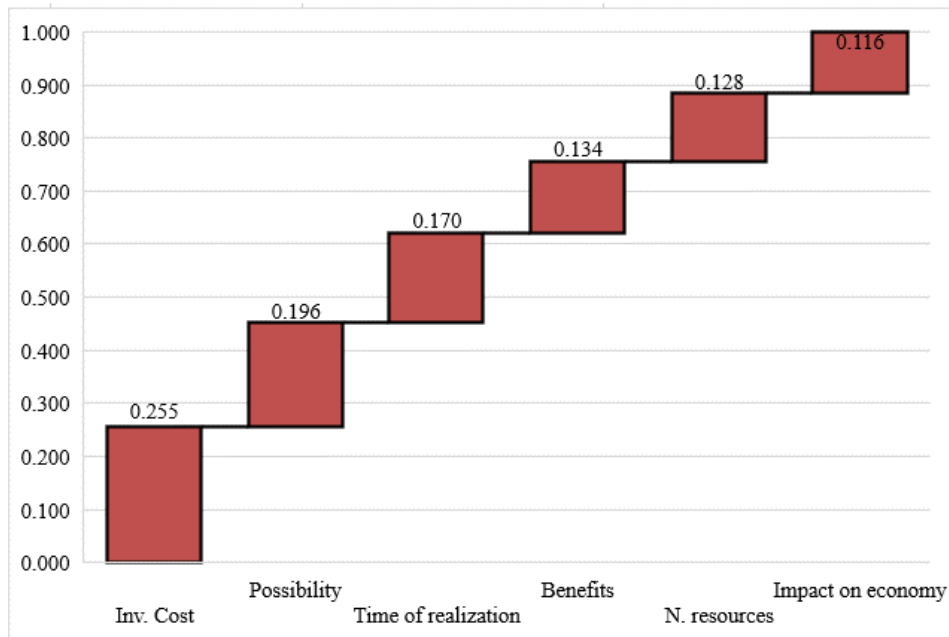| Criteria	C1	C2	C3	C4	C5	C6
ϖ_j	0.170	0.196	0.255	0.128	0.134	0.116

Fig. 3 Weights of criteria for evaluating the general strategies obtained by the FUCOM method

Table 3 shows the results of the FUCOM method. For the sake of transparency, the results are also shown in Fig. 3.

Fig. 3 shows that the criterion C3 - investment costs for strategy implementation is the most significant criterion; that is, this criterion has the most considerable influence on the evaluation of general strategies. Further, the figure shows that the measure is C2 - the possibility of strategy realization is the following by importance, and then C1 - the time of strategy realization. The following is C5 - the potential benefits of the strategy, and then C4 - the necessary resources for realization and in the last place is the criterion C6 - impact on the economic system.

Alternatives, i.e. general strategies, are ranked by importance using the MARCOS method. The main strategies are designated as alternatives.

A1 - Expanding business based on the years of experience and brand,

A2 - Applying for European funds,

A3 - Cost rationalization,

A4 - Driver evaluation and rewards program,

A5 - Increasing the volume of domestic transport using the benefits of infrastructure growth and development.

Steps 1 and 2:

In these steps, the initial extended matrix is formed (Table 4), and the perfect and anti-ideal solutions are determined (Eq. (11)).

Table 4 Initial Extended Matrix

Criteria	C1	C2	C3	C4	C5	C6
Anti-ideal	5.000	5.000	5.000	4.000	5.000	3.000
A1	5.000	7.000	5.000	4.000	9.000	9.000
A2	3.000	7.000	1.000	2.000	5.000	3.000
A3	5.000	5.000	3.000	3,000	7.000	5.000
A4	1.000	9.000	2.000	1.000	7.000	4.000
A5	3.000	5.000	2.000	3.000	5.000	7.000
Ideal	1.000	9.000	1.000	1.000	9.000	9.000

Step 3: DMRs normalized the cost criterion values using Eqs. (12) and (13), from Step 3, for example:

$$n_{ij} = \frac{x_{ai}}{x_{ij}} \; if \; j \in C \; \Rightarrow \; n_{14} = \frac{1.000}{4.000} = 0.250$$

The following equation helps to obtain benefit criteria:

$$n_{ij=} \frac{x_{ij}}{x_{ai}} \; if \; j \in B \; \Rightarrow \; n_{12} = \frac{7.000}{9.000} = 0.778.$$

Table 5 shows the complete normalized matrix.

Table 5 Normalized matrix

Criteria	C1	C2	C3	C4	C5	C6
Anti-ideal	0.200	0.556	0.200	0.250	0.556	0.333
A1	0.200	0.778	0.200	0.250	1.000	1.000
A2	0.333	0.778	1.000	0.500	0.556	0.333
A3	0.200	0.556	0.333	0.333	0.778	0.556
A4	1.000	1.000	0.500	1.000	0.778	0.444
A5	0.333	0.556	0.500	0.333	0.556	0.778
Ideal	1.000	1.000	1.000	1.000	1.000	1.000

Step 4: This step extends the normalized matrix by multiplying all the values of the standardized form by the importance of the criteria (Eq. 14). Table 6 shows the normalized and weighted matrix.

Table 6 The normalized and weighted matrix

Criteria	C11	C12	C13	C14	C15	C16
Anti-ideal	0.034	0.109	0.051	0.032	0.075	0.039
A1	0.034	0.153	0.051	0.032	0.134	0.116
A2	0.057	0.153	0.255	0.064	0.075	0.039
A3	0.034	0.109	0.085	0.043	0.105	0.064
A4	0.170	0.196	0.128	0.128	0.105	0.052
A5	0.057	0.109	0.128	0.043	0.075	0.090
Ideal	0.170	0.196	0.255	0.128	0.134	0.116

The MARCOS method, applying equations from steps 5 and 6, provides the results in Table 7.

Step 5: The process to obtain the results is as follows:

All values (in rows) for alternatives are summed in the following Eqs. (15) and (16), from step 5 as follows for S_{AAI} :

$$S_{AAI} = 0.034+0.109+0.051+0.032+0.075+0.039=0.339$$

The values for the remaining alternatives DMRs similarly calculated.

DMRs, using the following equation, calculated the degrees of benefits concerning the ideal solution are. Example:

$$K_1^- = \frac{0.520}{0.339} = 1.532$$

While applying the following equation, DMRs calculated degrees of benefits concerning the perfect solution, e.g.:

$$K_1^+ = \frac{0.520}{1.000} = 0.520$$

Step 6: The utility function in terms of the anti-ideal solution DMRs calculated by applying the following Eq.18:

$$f(K_1^-) = \frac{K_1^+}{K_1^+ + K_1^-} = \frac{0.520}{0.520 + 1.532} = 0.253$$

While the utility function in terms of the ideal solution DMRs determined by applying Eq. (19):

$$f(K_1^+) = \frac{K_1^-}{K_1^+ + K_1^-} = \frac{1.532}{0.520 + 1.532} = 0.747$$

Finally, DMRs calculated the utility function of alternative A1 by applying Eq. (17):

$$f(K_1) = \frac{K_1^+ + K_1^-}{1 + \frac{1-f(K_1^+)}{f(K_1^+)} + \frac{1-f(K_1^-)}{f(K_1^-)}} = \frac{0.520 + 1.532}{1 + \frac{1-0.747}{0.747} + \frac{1-0.253}{0.253}} =$$

$$\frac{2.052}{1 + 0.339 + 2.953} = \frac{2.052}{4.292} = 0.479$$

Step 7: Table 7 shows the results of the MARCOS method.

Table 7 Ranks of alternatives

Ai	Si	Ki-	Ki+	f(K-)	f(K+)	f(Ki)	Rank
AAI	0.339						
A1	0.520	1	0.520	0.253	0.747	0.479	3
A2	0.642	1.532	0.642	0.253	0.747	0.591	2
A3	0.440	1.891	0.440	0.253	0.747	0.405	5
A4	0.778	1.296	0.778	0.253	0.747	0.716	1
A5	0.501	2.292	0.501	0.253	0.747	0.461	4
AI	1.000						

Table 7 presents alternatives ranked using all seven steps of the MARCOS method. DMRs determined perfect and anti-ideal solutions, that is, values of 1.000 and 0.339, respectively. The best is the alternative whose value of the utility function is closest to the ideal solution, and it ranks as the first alternative. In this research, it is the alternative A4 - Driver Evaluation and Reward Program, whose value of the utility function is 0.716. This alternative stands out as the best because the implementation of this strategy is possible; it does not involve the engagement of additional resources, nor it requires much time to realize, as can be seen from the evaluation of the criteria. The worst-ranked alternative is the one whose value of the utility function is closest to the value of the anti-ideal solution, and here it is alternative A3 - Cost rationalization, with the value of the utility function as 0.405.

5. SENSITIVITY ANALYSIS

To verify the obtained results, we compared the results obtained by the MARCOS method with the results of other MCDM methods. Therefore, this part of the paper presents a sensitivity analysis of the results obtained by the MARCOS method. Sensitivity analysis compared the effects of ranking obtained by the new MARCOS method and four other methods: SAW [59], ARAS [60], WASPAS [61] and MABAC [62]. Table 8 and Fig. 4 show the results of the analysis.

Table 8 Sensitivity analysis of results **obtained** by the MARCOS method

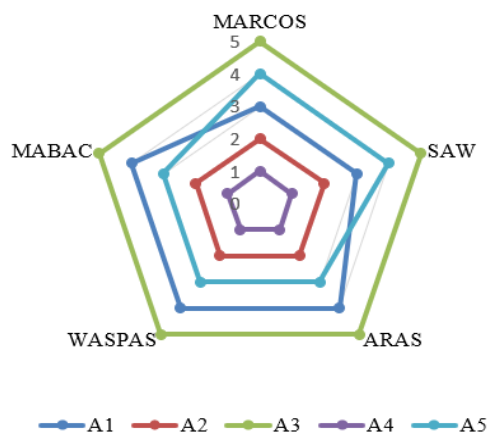| MARCOS		SAW		ARAS		WASPAS		MABAC	
0.479	3	0.520	3	0.472	4	0.461	4	-0.070	4
0.591	2	0.642	2	0.634	2	0.615	2	0.106	2
0.405	5	0.440	5	0.413	5	0.421	5	-0.142	5
0.716	1	0.778	1	0.780	1	0.758	1	0.354	1
0.461	4	0.501	4	0.486	3	0.492	3	-0.022	3

Fig. 4 Validation of results through the application of other methods

Table 8 and Fig. 4 show that there are no significant changes in the position of the strategies. Only the first and fifth strategies change places in some approaches by occupying the third or fourth positions.

One of the ways of checking the validity of the solution obtained by the DM model is to create a dynamic matrix and investigate the results of the application of the model under the newly formed conditions. If the answers reveal some logical contradictions related to the undesirable changes in the ranks of the alternatives, this may indicate problems with the mathematical apparatus of the method used.

Checking the sensitivity of this model to the rank reversal problem is a logical step to validate the model results. To this end, DMRs experimented with assessing the resistance of the model to the rank change problem. DMRs developed three experimental scenarios that simulated changes in problem matrix elements. DMRs changed the number of alternatives for each situation, removing the worst case from further considerations. After defining a new set of choices, DMRs evaluated the remaining options under the newly formed conditions using the proposed model.

In the first scenario, the DMR removed the worst third strategy (A3) from further consideration. After receiving the new assessment, they adopted a new set of four alternatives to using the model. Fig. 5 shows this. The new decision confirms that the fourth strategy is still the best alternative and the fifth strategy is the worst. Furthermore, if the worst-case - the fifth strategy - is not included in the model, the alternatives rank in the same way. In the third scenario, only two strategies need assessment. Based on this confirmation, DMRs concluded that the values of the strategies did not change and the results are relevant.
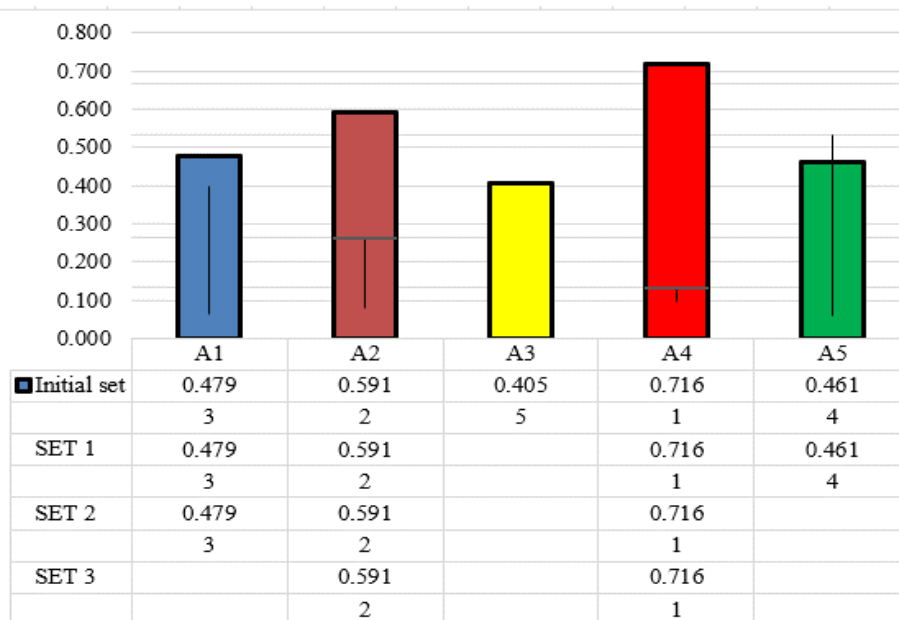

	A1	A2	A3	A4	A5
▣ Initial set	0.479	0.591	0.405	0.716	0.461
	3	2	5	1	4
SET 1	0.479	0.591		0.716	0.461
	3	2		1	4
SET 2	0.479	0.591		0.716	
	3	2		1	
SET 3		0.591		0.716	
		2		1	

Fig. 5 Results of the validity of the model concerning dynamic changes in the initial matrix

In the next validation phase, the DMRs analyzed the impact of the change in the most critical criterion (C3) on the rating. The following equation helped to form ten scenarios:

$$W_{n\beta} = (1 - W_{n\alpha}) \frac{W_\beta}{(1 - W_n)}$$

Here, $W_{n\beta}$ represent corrected criteria values C1, C2, C4, C5 and C6, $W_{n\alpha}$ represent the reduced values of criterion C3, W_β is the original value of the considered criterion and W_n is the initial value of criterion C3.

In the first scenario, the DMRs reduced the value of criterion C3 by 5%, while the values of the other criteria adjusted proportionally using the above equation. In each of these following scenarios, the value of criterion C3 is 10% lower, and the remaining characteristics are adjusted to meet the condition that sum of w_j equal to one. Fig. 6 shows the results of the model derived from the newly constructed ten criteria weights vectors.
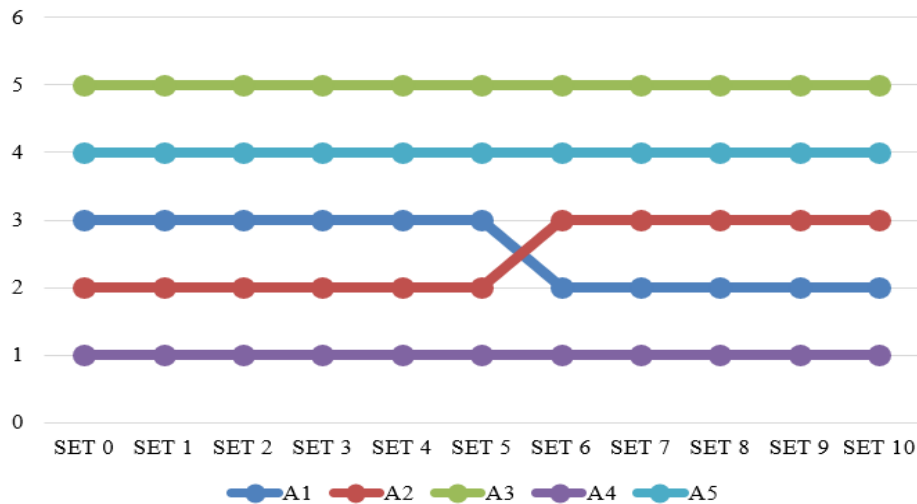

Fig. 6 Results of validity concerning changes in the significance of criteria values

Fig. 6 helps to conclude that the change in the significance of the criteria values does not play a significant role and that the model is not overly sensitive to the importance of the characteristics. The only difference that emerges is the rotation of the first and second strategy, starting with the sixth to the tenth scenario. The reason is that in the mentioned scenarios, there is a drastic decrease in the values of the most critical third criterion, while the importance of all other measures is increasing.

6. CONCLUSION

The authors present the research conducted in a transport company that operates in Bosnia and Herzegovina and the EU. The decision-makers performed a SWOT analysis to determine the current situation in the transport company. Based on that, the strengths and weaknesses of the transport company were determined as well as the opportunities and threats in the environment of the transport company. A TOWS matrix was also formed based on the cross SWOT matrix. In this way, the business strategies of the transport company are determined, among which the management should choose the best one. Managers can decide about the plan based on the results of this research. During the study, the authors developed a decision model. This model involves a combination of the FUCOM, fuzzy PIPRECIA and MARCOS methods. The authors obtained the results using this model. The results show that the best strategy that the transport company can choose at this moment is A4 - Driver Valuation and Reward Program, whose value of the utility function equals to 0.716. This strategy does not involve the engagement of additional resources; neither does it require much time to implement. The worst-ranked plan is the A3 - Cost Rationalization, whose value of the utility function equals to 0.405. According to these results, the management should establish a program to evaluate and reward drivers and to provide both rationalization of costs and reduction of emissions in the operation of drivers. This developed model for DM is applicable in small and medium enterprises.

Following this research, the question that remains for future researchers is: how much cost reduction would be if to implement this strategy? Another issue is the productivity of drivers; that is, how much would this increase their productivity? Thus, further research could include the behavior and performance of drivers after the evaluation and reward of established programs. Of course, future research may also focus on new growth and development of the transport company.

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