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LBWA – Z-MAIRCA MODEL SUPPORTING DECISION MAKING IN THE ARMY

Darko Božanić [1]*, Dragiša Jurišić [2], Dražan Erkić [3]

[1] University of Defence in Belgrade, Military Academy, Belgrade, Serbia
[2] Security Research Centre, Banja Luka, Bosnia and Herzegovina
[3] Police department Zvornik, Ministry of Internal Affairs Republic of Srpska, Bosnia and Herzegovina

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Abstract: *The paper presents a hybrid model LBWA – Z-MAIRCA used to support decision making in the selection of a location of a camp (camp space), which has a role of providing individuals and army units with regular life and operation conditions in the field, i.e. in the conditions outside the barracks. The paper defines and explains the criteria affecting the selection of a camp (camp space), and the LBWA method is used to define the weight coefficients of the criteria. Using the MAIRCA method, which is modified with Z-numbers, it is selected the best alternative. In the final phase of the model development, the sensitivity analysis is performed and the results obtained by the developed model are compared with the results obtained by applying other methods and their various modifications.*

Keywords: *LBWA, MAIRCA, Z-number, fuzzy number, MCDM*

1. Introduction

The army performs numerous different activities. A part of these activities is realized outside the locations of permanent residence (outside the barracks), i.e. in the field. When organizing longer stays in the field, it is necessary to provide basic conditions for life and operation. These conditions are provided by adequate organization of a camp space (camp).

The camp, i.e. the camp space, means organized land space with camp facilities for accommodation and resting of units outside the populated area (Military Lexicon, 1981). It consists of tents, barracks, huts, casemates, sometimes a building or a combination. It is organized in all situations when the need arises (in peace, state of emergency and war) for the realization of trainings, works, combat operations, *etc*.

* Corresponding author.
dbozanic@yahoo.com (D. Božanić), bicbl@yahoo.com (D. Jurišić), drazan.erkic@hotmail.com (D. Erkić)

In the camps, it is necessary to provide space for various activities: accommodation, economic, medical, recreational, technical, storage, sanitary facilities and quarters. (Hristov, 1978).

Considering a series of conditions that a camp space should meet, the selection of the location for the organization of a camp space is an issue ideal for solving by multi-criteria decision-making methods. The literature dealing with this issue usually provides general conditions on which the selection should depend, which further indicates that experience plays a significant role in making such decisions. In order to group experiences and help less experienced decision makers, a model is developed and presented in this paper. The model is based on the experiences of the engineering leaders of the Serbian Army, but it is also applicable to other branches. The experiences of engineering officers are used because the engineering units of the Serbian Army have constant engagements outside the barracks due to the performance of a wide range of operations and are very often in a situation to organize camp spaces for the life and operation of their units for longer periods.

The camp space selection issue by multi-criteria decision-making methods has not been particularly considered in the literature available to the authors. This issue belongs to the group of the location issues, which have been considered in different ways in the literature. Božanić and Pamučar (2010) perform the selection of the bridge crossing location by applying fuzzy logic system. Tavakkoli-Moghaddam et al. (2011) perform plant location selection using the AHP and VIKOR method. Żak and Węglińsk (2014) perform the selection of the logistics center location base applying ELECTRE method. Bagocius et al. (2014) use several methods (SAW, TOPSIS, COPRAS) for selecting a location for a liquefied natural gas terminal in the Eastern Baltic Sea. Tomic et al. (2014) used AHP as a support in making logistic center location decisions. Tuzkaya et al. (2015), by using the ANP-DEMATEL model, select the location for emergency logistics centers. Božanić et al. (2016a) apply a hybrid model, fuzzy AHP – MABAC, for the selection of the location for preparing laying-up positions. Pamučar et al. (2016a) use a fuzzy AHP-TOPSIS model for the selection of a brigade artillery group firing position in a defensive operation. Di Matteo et al. (2016) propose a methodology for the optimization of the location on the territory of emergency operation centers using the AHP-ELECTRE model. Gigović et al. (2017), by applying GIS and the DEMATEL, ANP and MABAC methods, perform the selection of the location for wind farms in Serbia. Milosavljević et al. (2018) determine the potential macro location of the container terminal in Serbia, by applying the TOPSIS, ELECTRE and MABAC methods. Sennaroglu and Celebi (2018) present a location selection problem for a military airport using the AHP, PROMETHEE and VIKOR methods. Božanić et al. (2019b) use the FUCOM-fuzzy MABAC model for the selection of the location for construction of single-span bailey bridge.

As can be obtained from the analyzed literature, the authors use different methods of multi-criteria decision making in their research. In this paper, a hybrid model based on the LBWA (Level Based Weight Assessment) method and the MAIRCA (Multi-Attributive Ideal-Real Comparative Analysis method) modified by Z-numbers (Z-MAIRCA) is applied.

2. LBWA – Z-MAIRCA Model

The LBWA – Z-MAIRCA model consists of four phases. In Figure 1, it is presented the scheme of the model.

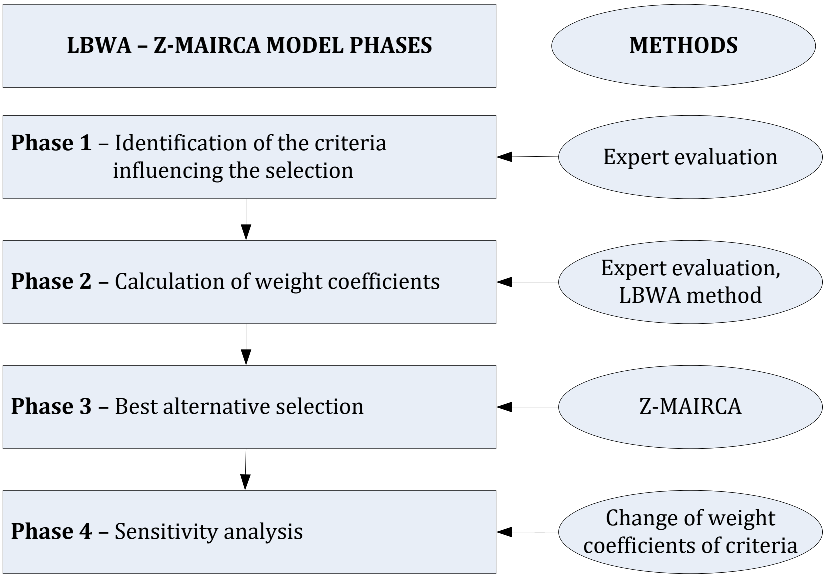

Figure 1. Graphic scheme of the LBWA – Z-MAIRCA model

In the first phase of the model, the criteria on the basis of which the selection is made by expert evaluation are defined. Through the second phase, it is performed the calculation of weight coefficients of the criteria using expert evaluation and the LBWA method. In the third phase, the best alternative is selected using Z-numbers and the fuzzy MAIRCA method. The last phase includes the sensitivity analysis of the developed model.

2.1. The LBWA method

The LBWA method was presented for the first time in the paper by Žižović and Pamučar (2020). The method has a relatively simple mathematical apparatus, and can be used in both individual and group decision making. In the paper by Pamučar et al. (2020), it is presented a fuzzified LBWA method.

At the beginning of the application of the LBWA method, it is defined the set of criteria $S=\{C_1,C_2,\ldots,C_n\}$, where *n* represents the number of criteria influencing the selection. After the set of criteria was defined (*S*), the method is to be applied. The steps of the LBWA method are presented in the following section (Žižović and Pamučar, 2020).

Step 1. Determining the most significant criterion from the set of defined criteria(S), i.e. the criterion with the highest influence on the decision.

Step 2. Grouping the criteria by significance level. The significance levels are defined as follows:

– *Level* S_1: At the level S_1, the criteria from the set S whose significance is equal to or up to twice as lower from the significance of the criterion defined as the most significant are grouped;

– *Level* S_2: At the level S_2, the criteria from the set S whose significance is exactly twice or up to three times as lower from the significance of the criterion defined as the most significant are grouped;

– ...

– *Level* S_k: At the level S_k, the criteria from the set S whose significance is exactly k times as lower from the significance of the criterion defined as the most significant, i.e. up to $k+1$ times as lower from the significance of the most significant criterion, are grouped.

Applying previously presented rules, a decision maker establishes rough classification of the observed criteria. If the significance of the criterion C_j is denoted by $s(C_j)$, where $j \in \{1,2,\dots,n\}$, then $S = S_1 \cup S_2 \cup \dots \cup S_k$, where for every level $i \in \{1,2,\dots,k\}$, it is true that

$$S_i = \{C_{i_1}, C_{i_2}, \dots, C_{i_s}\} = \{C_j \in S : i \le s(C_j) < i+1\} \tag{1}$$

Also, for each $p,q \in \{1,2,\dots,k\}$ such that $p \ne q$ holds $S_p \cap S_q = \varnothing$. Thus, in this way, the partition of the set of criteria S is well defined.

Step 3. Within the formed subsets (levels) of the influence of the criteria, it is performed the comparison of the criteria by their significance. Every criterion $C_{i_p} \in S_i$ in the subset $S_i = \{C_{i_1}, C_{i_2}, \dots, C_{i_s}\}$ is assigned an integer $I_{i_p} \in \{0,1,\dots,r\}$ such that the most important criterion C_i is assigned $I_i = 0$, and if C_{i_p} is more significant than C_{i_q}, then $I_p < I_q$, and if C_{i_p} is equivalent to C_{i_q}, then $I_p = I_q$. The maximum value of the scale for the criteria comparison is defined by applying the expression (2)

$$r = \max\{|S_1|, |S_2|, \dots, |S_k|\} \tag{2}$$

Step 4. Based on the defined maximum value of the scale for the comparison of criteria (*r*), it is defined the elasticity coefficient $r_0 \in N$ (where *N* represents the set of real numbers) which should meet the criteria where $r_0 > r$, $r = \max\{|S_1|, |S_2|, \dots, |S_k|\}$. The creators of the method recommend to define initial values of the weight coefficients based on the elasticity coefficient $r_0 = r+1$. Considering that the parameter r_0 causes smaller changes of the value of the weight coefficients, taking the other value of the elasticity coefficient is recommended for additional settings of the weight coefficients in accordance with the decision makers' own preferences.

Step 5. The calculation of the influence function of the criteria. The influence function $f : S \to R$ is defined in the following way. For every criterion $C_{i_p} \in S_i$, the influence function is defined:

$$f(C_{i_p}) = \frac{r_0}{i \cdot r_0 + I_{i_p}} \tag{3}$$

where i represents the number of the level/subset into which the criterion is classified, r_0 represents the elasticity coefficient, while $I_{i_p} \in \{0,1,\ldots,r\}$ represents the value which is assigned to the criterion C_{i_p} within the observed level.

Step 6. The calculation of the optimum values of the weigh coefficients. By applying the expression (4), it is calculated the weight coefficient of the most influential criterion:

$$w_1 = \frac{1}{1 + f(C_2) + \cdots + f(C_n)} \tag{4}$$

The values of the weight coefficients of other criteria are obtained by applying the expression (5):

$$w_j = f(C_j) \cdot w_1 \tag{5}$$

where $j = 2,3,\ldots,n$, and n represents a total number of criteria.

2.2. Z-MAIRCA

A wide range of uncertainties following decision-making processes influences a number of researchers when they select a model of multi-criteria decision-making and opt for various modifications of classic methods (*e.g*. using fuzzy logic, rough numbers, *etc*.). The selection of a location for a camp space is accompanied by uncertainties and inaccuracies, which is why the MAIRCA method, fuzzified with Z-numbers, is selected. The MAIRCA method was first published in the papers written by Pamučar et al. (2014) and Gigović et al. (2016). Since then, it has been applied in its original form (Pamučar et al., 2018; Tešić and Božanić, 2018; Adar and Delice, 2019, 2020; Ayçin and Orçun, 2019; Ayçin, 2020), but also through various modifications in fuzzy and rough environment (Pamučar et al., 2017b; Chatterjee et al., 2018; Badi and Ballem, 2018; Stević, 2018; Božanić et al., 2019a; Arsić et al., 2019; Hashemkhani et al., 2020; Boral et al., 2020).

Given that the Z-numbers are used for the modification, their most basic description is provided below. Z-numbers represent a type of fuzzy numbers, i.e. two fuzzy numbers, which are in a specific relationship. Triangular fuzzy numbers are used in this paper, as in Figure 2.

Triangular fuzzy numbers have the form $\tilde{T} = (t_1, t_2, t_3)$; t_1 - the left distribution of the confidence interval of fuzzy number T, t_2 - fuzzy number membership function has the maximum value - equal to 1, and t_3 - the right distribution of the confidence interval of fuzzy number $\tilde{T}$ (Pamučar et al., 2012).

A Z-number represents an extension of classic fuzzy number and provides wider opportunities for considering additional uncertainties following decision making. The concept of Z-number was proposed by Zadeh (2011). In 2012, Kang et al. (2012a, 2012b) have already shown in detail the application of Z-numbers in uncertain environment. Later, authors consider the application of Z-numbers with different methods of multi-criteria decision making. Sahrom and Dom (2015) present the use of Z-numbers in the hybrid AHP-Z-number-DEA method. Azadeh and Kokabi (2016) use Z-numbers with the DEA method, Azadeh et al. (2013) with the AHP, Yaakob and Gegov (2015) with the TOPSIS method, Aboutorab et al. (2018) with the Best Worst method, Bobar et al. (2020) and Božanić et al. (2020) with the MABAC method. Salari et al. (2014) elaborate a novel earned value management model using a Z-number.

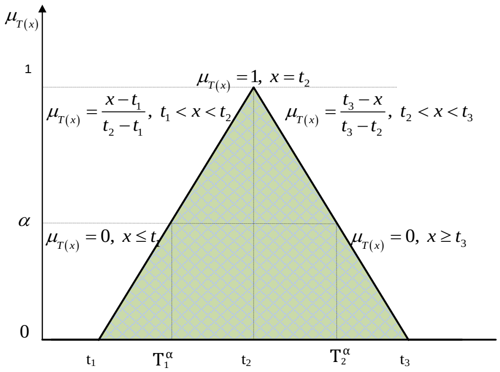

Figure 2. Triangular fuzzy number (Pamučar et al., 2016b)

A Z-number represents an ordered pair of fuzzy numbers that appear as Z = ($\tilde{A}$, $\tilde{B}$) (Zadeh, 2011). The first component, fuzzy number $\tilde{A}$, represents the fuzzy limit of a particular variable *X*, while the second component, fuzzy number $\tilde{B}$, represents the reliability of the first component ($\tilde{A}$). The appearance of the Z-number with triangular fuzzy numbers is shown in Figure 3 (Zadeh, 2011).

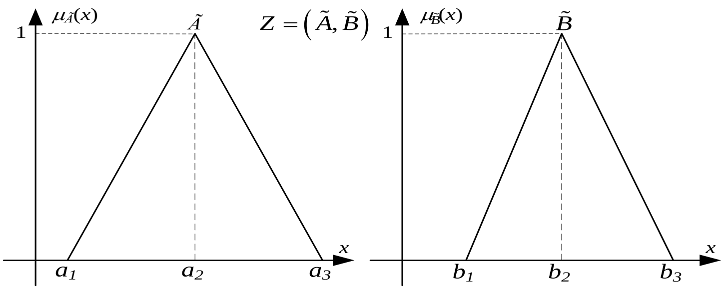

Figure 3. A-Simple Z-number (Kang et al., 2012a)

A general record of triangular Z-numbers can be displayed as

$$\tilde{Z}=\left\{\left(a_1,a_2,a_3;w_{\tilde{A}}\right),(b_1,b_2,b_3;w_{\tilde{B}})\right\} \tag{6}$$

where the values $w_{\tilde{A}}$ and $w_{\tilde{B}}$ represent weight factors of fuzzy number $\tilde{A}$ referring to $\tilde{B}$, which for the initial Z-number, the majority of authors define as $w_{\tilde{A}}=w_{\tilde{B}}=1$, $w_{\tilde{A}},w_{\tilde{B}}\in[0,1]$ ($w_{\tilde{A}}$ is the height of generalized fuzzy number and $0\le w_{\tilde{A}}\le 1$) (Chutia et al., 2013). The transformation of the Z-number into a classic fuzzy number, with the presented evidence, is shown in Kang et al. (2012b). This transformation consists of three steps:

Convert the second part ($\tilde{B}$) into a crisp number using the centered method (Kang et al., 2012b):

$$\alpha=\frac{a_1+a_2+a_3}{3} \tag{7}$$

Add the weight of the second part ($\tilde{B}$) to the first part ($\tilde{A}$). The weighted Z-number can be presented as in Kang et al. (2012b):

$$\tilde{Z}^{\alpha}=\left\{\langle x,\mu_{\tilde{A}^{\alpha}}(x)\rangle \,\middle|\, \mu_{\tilde{A}^{\alpha}}(x)=\alpha\mu_{\tilde{A}}(x)\right\} \tag{8}$$

which can be presented by Figure 4a. This can be written as (Azadeh et al., 2013):

$$\tilde{Z}^{\alpha}=(a_1,a_2,a_3;\alpha) \tag{9}$$

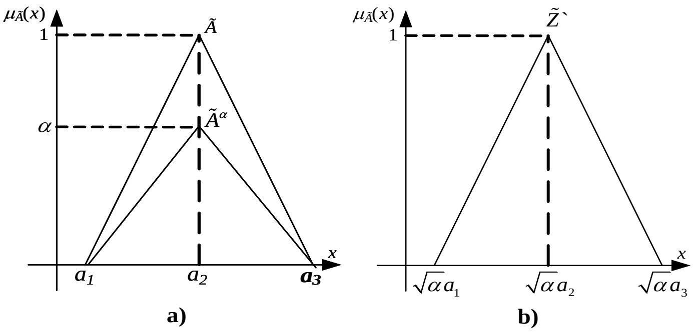

Figure 4. Z-number after multiplying the reliability (a) and the regular fuzzy number transformed from a Z-number (b)

Convert the weighted Z-number into a regular fuzzy number. The regular fuzzy set can be presented as in Kang et al. (2012b)

$$\tilde{Z}'=\left\{\langle x,\mu_{\tilde{Z}'}(x)\rangle \,\middle|\, \mu_{\tilde{Z}'}(x)=\mu_{\tilde{A}}\left(\frac{x}{\sqrt{\alpha}}\right)\right\} \tag{10}$$

$$\tilde{Z}'=\sqrt{\alpha}*\tilde{A}=(\sqrt{\alpha}*a_1,\sqrt{\alpha}*a_2,\sqrt{\alpha}*a_3) \tag{11}$$

and it can be presented as in Figure 4b (Kang et al., 2012b).

The steps of the MAIRCA method modified by Z-numbers are provided as follows:

Step 1. Forming an initial Z decision-making matrix ($\tilde{Z}$) with *m* alternatives and *n* criteria. In this step, decision makers define the value of every alternative by all criteria ($\tilde{a}_{ij}$) and the degree of certainty of the defined value ($\tilde{b}_{ij}$). The arranged pair $[\tilde{a}_{ij}, \tilde{b}_{ij}]$ represents a Z-number, where *i* represents the number of alternatives, $i \in \{1, 2, \ldots m\}$, and *j* the number of criteria, $j \in \{1, 2, \ldots n\}$.

$$\tilde{Z} = \begin{array}{c} \\ A_1 \\ A_2 \\ \cdot \\ \cdot \\ \cdot \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \ldots & C_n \end{array} \\ \begin{bmatrix} \tilde{a}_{11}\tilde{b}_{11} & \tilde{a}_{12}\tilde{b}_{12} & \ldots & \tilde{a}_{1n}\tilde{b}_{1n} \\ \tilde{a}_{21}\tilde{b}_{21} & \tilde{a}_{22}\tilde{b}_{22} & \ldots & \tilde{a}_{2n}\tilde{b}_{2n} \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ \tilde{a}_{m1}\tilde{b}_{m1} & \tilde{a}_{m2}\tilde{b}_{m2} & \ldots & \tilde{a}_{mn}\tilde{b}_{mn} \end{bmatrix} \end{array} \tag{12}$$

The value $\tilde{a}_{ij}$ is defined in accordance with the characteristics of the criteria, while the value $\tilde{b}_{ij}$ is defined by the expressions presented on fuzzy linguistic scale, as in Figure 5.

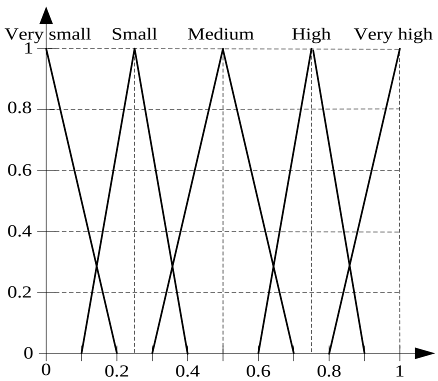

Figure 5. Fuzzy linguistic descriptors for evaluating the degree of conviction of experts (Bobar et al. 2020)

Step 2. Forming an initial decision-making matrix ($\tilde{X}$). The elements of the initial decision-making matrix ($\tilde{X}$) are obtained by converting the elements of the initial Z matrix ($\tilde{Z}$) into the regular fuzzy numbers, by applying the expressions (7)-(11).

$$\tilde{X} = \begin{array}{c} \\ A_1 \\ A_2 \\ \cdot \\ \cdot \\ \cdot \\ A_m \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & & & & C_n \end{array} \\ \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & . & . & . & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & . & . & . & \tilde{x}_{2n} \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ \tilde{x}_{m1} & \tilde{x}_{m2} & . & . & . & \tilde{x}_{mn} \end{bmatrix} \end{array} \tag{13}$$

Step 3. Normalization of the initial decision-making matrix. The calculation of the elements of normalized matrix depends on the type of criteria. For "benefit" type criteria (bigger criterion value is preferable), this calculation is executed according to the expression:

$$\tilde{n}_{ij} = \frac{x_{ij} - x_i^-}{x_i^+ - x_i^-} \tag{14}$$

For "cost" type criteria (lower criterion value is preferable), the calculation is executed according to the expression:

$$\tilde{n}_{ij} = \frac{x_{ij} - x_i^+}{x_i^- - x_i^+} \tag{15}$$

The values x_{ij}, x_i^+, x_i^- represent the elements of the initial decision-making matrix ($\tilde{X}$). The values x_i^+, x_i^- are defined as explained bellow:

– $x_i^+ = \max(x_{1r}, x_{2r}, ..., x_{mr})$ – represents maximal values of the right distribution of fuzzy numbers of the observed criteria alternatives;

– $x_i^- = \min(x_{1l}, x_{2l}, ..., x_{ml})$ – represents minimal values of the left distribution of fuzzy numbers of the observed criteria alternatives.

The normalized initial decision-making matrix has the following form:

$$\tilde{N} = \begin{array}{c} \\ A_1 \\ A_2 \\ \cdot \\ \cdot \\ \cdot \\ A_m \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & & & & C_n \end{array} \\ \begin{bmatrix} \tilde{n}_{11} & \tilde{n}_{12} & . & . & . & \tilde{n}_{1n} \\ \tilde{n}_{21} & \tilde{n}_{22} & . & . & . & \tilde{n}_{2n} \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ \tilde{n}_{m1} & \tilde{n}_{m2} & . & . & . & \tilde{n}_{mn} \end{bmatrix} \end{array} \tag{16}$$

Step 4. Determination of the probability of selection of certain alternatives (P_{A_i}). Decision makers may prefer certain alternatives by assigning different probabilities to the alternatives. In most cases, decision makers are neutral towards the selection of the alternatives. In such case, the preference towards the selection is equal for all the alternatives and it is expressed as follows:

$$P_{A_i} = \frac{1}{m}; \ \sum_{i=1}^{m} P_{A_i} = 1, \ i = 1,2,...,m \tag{17}$$

where *m* represents a total number of alternatives being selected.

Step 5. Forming a theoretical assessment matrix (T_p). In case the condition from Step 4 is met, where the decision maker is neutral in terms of the initial selection of alternatives, so the initial probability (P_{A_i}) of the selection of certain alternatives is the same for all the alternatives, then the theoretical assessment matrix in the form n x 1 is created.

$$T_p = \begin{bmatrix} t_{p1} & t_{p2} & \dots & t_{pn} \end{bmatrix}_{P_{A_i} x W_n} \tag{18}$$

and the matrix elements are calculated as follows:

$$T_p = \begin{bmatrix} P_{A_i} w_1 & P_{A_i} w_2 & \dots & P_{A_i} w_n \end{bmatrix}_{P_{A_i} W_n} \tag{19}$$

where w_n represents the weight coefficient of the criteria.

Step 6. Calculation of real assessment matrix ($\tilde{T}_r$). The calculation of real assessment matrix elements ($\tilde{T}_r$) is performed by applying the expression:

$$\tilde{t}_{rij} = t_{pj} \cdot \tilde{n}_{ij} \tag{20}$$

where t_{pj} represents the elements of the theoretical assessment matrix, and $\tilde{n}_{ij}$ represents the elements of the normalized initial decision-making matrix ($\tilde{N}$). After the calculation, the theoretical assessment matrix is obtained:

$$\tilde{T}_r = \begin{array}{c} \\ A_1 \\ A_2 \\ \dots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} \tilde{t}_{r11} & \tilde{t}_{r12} & \dots & \tilde{t}_{r1n} \\ \tilde{t}_{r21} & \tilde{t}_{r22} & \dots & \tilde{t}_{r2n} \\ \dots & \dots & \dots & \dots \\ \tilde{t}_{rm1} & \tilde{t}_{rm2} & \dots & \tilde{t}_{rmn} \end{bmatrix} \end{array} \tag{21}$$

where *n* represents a total number of criteria, and *m* represents a total number of alternatives.

Step 7. Calculation of the gap matrix between theoretical and real weights ($\tilde{G}$):

$$\tilde{g}_{ij} = t_{pj} - \tilde{t}_{rij} \tag{22}$$

After the calculation, it is obtained the total gap matrix ($\tilde{G}$):

$$\tilde{G}=\begin{bmatrix} \tilde{g}_{11} & \tilde{g}_{12} & \cdots & \tilde{g}_{1n} \\ \tilde{g}_{21} & \tilde{g}_{22} & \cdots & \tilde{g}_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \tilde{g}_{m1} & \tilde{g}_{m2} & \cdots & \tilde{g}_{mn} \end{bmatrix} \tag{23}$$

where n represents a total number of criteria, m represents a total number of alternatives being selected, and $\tilde{g}_{ij}$ represents the obtained gap of the alternative *i* by the criterion *j*.

Step 8. Initial ranking of alternatives. For the purpose of ranking alternatives, it is first calculated the values of the criteria functions ($\tilde{Q}_i$) by alternatives. The values of the criteria functions are obtained by summing the gap - the element of the matrix ($\tilde{G}$) by columns:

$$\tilde{Q}_i=\sum_{j=1}^{n}\tilde{g}_{ij},\ i=1,2,\dots,m \tag{24}$$

where n represents a total number of criteria, m represents a total number of alternatives being selected.

Before defining the initial rank, it is performed defuzzification of the values of the criteria functions ($\tilde{Q}_i$), by applying the expression (Seiford, 1996; Liou and Wang, 1992):

$$q_{ij}=((t_{3ij}-t_{1ij})+(t_{2ij}-t_{1ij}))/3+t_{1ij} \tag{25}$$

$$q_{ij}=\left[\lambda t_{3ij}+t_{2ij}+(1-\lambda)t_{1ij}\right]/2 \tag{26}$$

where λ represents an index of optimism, which can be described as a belief/decision maker's relationship to decision-making risk (Milićević, 2014). The most common optimism index is 0, 0.5 or 1, which corresponds to the pessimistic, average or optimistic view of the decision maker (Milićević, 2014).

Step 9. Final ranking of alternatives. Final rank of alternatives is defined by the application of a dominance index of the first-ranked alternative ($A_{D,1-j}$). It represents the element which defines the value of the first-ranked alternative compared to the remaining alternatives. The dominance index shows the difference between the first-ranked and the other alternatives, and it is defined by the expression:

$$A_{D,1-j}=\left|\frac{|Q_j|-|Q_1|}{|Q_n|}\right|,\ j=2,3,..,m \tag{27}$$

where Q_1 represents the criterion function of the first-ranked alternative, Q_n represents the criterion function of the last-ranked alternative, Q_j represents the criterion function of the alternative being compared with the first-ranked alternative, m represents a total number of alternatives.

For final definition of the first-ranked alternative, it is also necessary to determine a dominance threshold I_D according to the following expression:

$$I_D = \frac{m-1}{m^2} \tag{28}$$

where m represents a total number of alternatives.

If the condition is met where the dominance index $A_{D,1-j}$ is higher or equal to the dominance threshold I_D ($A_{D,1-j} \geq I_D$), then the obtained rank is kept. In case the dominance index $A_{D,1-j}$ is lower than the dominance threshold I_D ($A_{D,1-j} < I_D$), it cannot be certainly concluded that the first-ranked alternative has sufficient advantage compared to the observed alternative.

3. Description of criteria and calculation of weight coefficients of criteria

The selection of a camp space is influenced by a number of criteria. After the analysis of the literature and the survey of experts, seven criteria are defined on which the selection depends.

Criterion 1 (C_1) - **General soil and environmental conditions.** This criterion means the quality of the location where the camp space is planned. The place for the camp space should be clean, dry, drained, slightly sloping, separated from the settlement and away from ponds and swamps at least 2-3 kilometers, in the lee (if the land is exposed to strong winds), out of torrents and floodplains areas (Hristov, 1978). In addition to the above, the camp space should be spacious in order to, under certain conditions, place facilities necessary for the life and operation of the units outside the barracks: residential, economic, medical, recreational, technical, storage, sanitary facilities, *etc*. The criterion is of a linguistic nature.

Criterion 2 (C_2) - **Distance from the road.** In order to ensure uninterrupted life and operation in the field, it is necessary to connect the camp space with local and regional roads (Hristov, 1978). The best variant is that the roads are located right next to the camp space, but very often it will be necessary to build a temporary military road to connect the camp space with the road. The criterion is of a numerical character, where the distance of the camp space from the nearest road is presented in kilometers.

Criterion 3 (C_3) - **Water supply options**. Water supply is a very important component of a camp space. In field conditions, it is necessary to provide sufficient amount of water for normal life and operation of every individual, and thus units, including drinking water, water for cooking food, water for maintaining personal hygiene and cleaning the camp space. The criterion is of a linguistic nature.

Criterion 4 (C_4) - **Scope of works on the arrangement of the camp space**. Regardless of the conditions of the soil on which the organization of the camp space is planned, it is necessary to perform certain works (construction/installation of facilities, construction of temporary roads that connect parts of camp space, *etc*.). The works are carried out in order to arrange the existing land for temporary life and operation of the units. The scope of works depends on a number of factors, such as the type of facilities to be constructed, time planned to be spent by the units in the camp space, the season, and the like (Hristov, 1978). The criterion is of a linguistic nature.

Criterion 5 (C_5) - **Distance from the site where the works are performed**. The main goal of the field conditions is to perform certain works. The site where the unit performs the assigned works should be as close as possible to the camp space. The proximity of the site and the camp space ensures that the people engaged do not waste time traveling to the site and vice versa, that the funds are kept in one place, easier organization of food provision of the unit and the like. The criterion is of a numerical character, where the distance of the camp space from the site is presented in kilometers. In certain cases (*e.g*. construction of a road section), this distance may vary as the work progresses.

Criterion 6 (C_6) - **Direct security of camp space**. Both in peace and during the state of war, the units in the field are obliged to set up direct security of the camp space. The number of persons necessary for the organization of direct security varies and most often depends on the conditions of the land and the layout of the facilities in the camp area. The criterion is of a numerical character, where the minimum number of persons engaged in direct security during one day is defined.

Criterion 7 (C_7) - **Masking conditions**. This criterion exerts its influence on the final decision in situations when the camp space is organized during the implementation of combat operations. The conditions for camouflage include the possibility of hiding or concealing the camp space from enemy reconnaissance (Božanić et al., 2020). Under this criterion, many factors are considered that affect masking, such as the distance from the objects that can be the subject of enemy reconnaissance or action (Hristov, 1978), the possibility of setting up a camp space in the forest, *etc*. The criterion is of a linguistic nature.

All the criteria presented can be divided in two subsets:

- Benefit-type criteria $C^{+} \in \{C_1, C_3, C_7\}$,
- Cost-type criteria $C^{-} \in \{C_2, C_4, C_5, C_6\}$.

The evaluation of the linguistic criteria is performed by applying fuzzy linguistic descriptors, as in Figure 6.

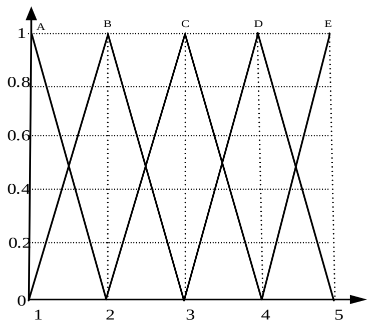

Figure 6. Graphic display of fuzzy linguistic descriptors (Božanić et al. 2016b)

The description of the linguistic criteria is performed by the scale including five fuzzy linguistic descriptors. The marks presented in Figure 6 have the following meanings, depending on the criterion:

- for the criteria C_1, C_3 and C_7: A=very bad (VB), B=bad (B), C=medium (M), D= good (G), E=very good (VG)
- for the criterion C_4: A=very small (VS), B=small (S), C=medium (M), D=large (L), E=very large (VL).

In the second phase of the research, it is performed the calculation of the weight coefficients of the criteria by applying the LBWA method, described in the previous section, on the basis of the input parameters:

- As the most significant criterion it is determined the criterion C_1;
- The criteria are roughly arranged by levels as follows: $S_1=\{C_1,C_7,C_5\}$; $S_2=\{C_3,C_2\}$; $S_3=\{C_6\}$; $S_4=\{C_4\}$;
- Comparing the criteria by levels, the following values are obtained: $S_1: I_1=0$, $I_7=0.8$, $I_5=1.1$; S_2: $I_3=0$, $I_2=2$; S_3: $I_6=0.2$; S_4: $I_4=0.4$.

Applying the expressions (3)-(5), the following weight coefficients of the criteria are obtained:

$$w_j=(0.244,0.098,0.122,0.06,0.192,0.08,0.204).$$

Based on the calculation presented, the conditions for the following phase of the model application, i.e. the selection of the best alternative by the application of the Z-MAIRCA method are created.

4. Testing of the model – selection of the best alternative

In the third phase of the paper, it is performed the testing of the model. Testing is performed with ten alternatives, i.e. potential locations for the organization of a camp space. At the very beginning, it is defined the initial Z decision-making matrix, as in Table 1.

Table 1. Initial Z decision-making matrix

Crit.	C_1		C_2		C_3		C_4		C_5		C_6		C_7	
Alter.	$\tilde{A}$	$\tilde{B}$	$\tilde{A}$	$\tilde{B}$	$\tilde{A}$	$\tilde{B}$	$\tilde{A}$	$\tilde{B}$	$\tilde{A}$	$\tilde{B}$	$\tilde{A}$	$\tilde{B}$	$\tilde{A}$	$\tilde{B}$
A_1	VB	VS	(3,3.5,4.2)	S	VB	M	VL	M	(3,7,13)	H	(3,5,6)	M	M	M
A_2	B	M	(2,2.9,3.9)	VH	M	M	M	VS	(4.2,9,15)	M	(2,5,7)	VS	M	H
A_3	G	S	(3,3.3,3.6)	VS	B	VS	L	M	(1.5,6,11)	S	(6,8,11)	S	VB	VH
A_4	M	H	(0.5,0.5,0.7)	M	VB	S	VL	S	(1.9,7,12)	VS	(4,4,6)	H	B	VS
A_5	VG	VH	(1.3,1.8,2.2)	S	B	VS	VS	H	(6,12,17)	VH	(12,13,13)	VH	VB	H
A_6	G	M	(4.5,5,5)	H	VG	H	S	VH	(5,11,16)	M	(4,5,5)	VS	G	M
A_7	VB	VS	(2.2,2.7,2.9)	VS	G	VH	L	VS	(2,7,13)	H	(3,5,8)	M	B	S
A_8	M	S	(0.4,0.6,1)	H	G	H	M	H	(1,3,7)	VS	(4,9,14)	S	M	VS
A_9	B	H	(0.9,1.5,1.7)	VH	M	S	S	S	(1.5,3,8.5)	S	(3,7,8)	H	VG	VH
A_{10}	VG	VH	(1.8,2.5,2.8)	M	VG	VH	VS	VH	(6,13,21)	VH	(5,11,14)	VH	G	S

After the definition of the initial Z decision-making matrix, it is performed its quantification, as in Table 2.

Table 2. Quantified initial Z decision-making matrix

Crit.	C_1		C_2			C_7	
Alter.	$\tilde{A}$	$\tilde{B}$	$\tilde{A}$	$\tilde{B}$	...	$\tilde{A}$	$\tilde{B}$
A_1	(1,1,2)	(0,0,0.2)	(3,3.5,4.2)	(0.1,0.25,0.4)	...	(2,3,4)	(0.3,0.5,0.7)
A_2	(1,2,3)	(0.3,0.5,0.7)	(2,2.9,3.9)	(0.8,1,1)	...	(2,3,4)	(0.55,0.75,0.95)
A_3	(3,4,5)	(0.1,0.25,0.4)	(3,3.3,3.6)	(0,0,0.2)	...	(1,1,2)	(0.8,1,1)
A_4	(2,3,4)	(0.55,0.75,0.95)	(0.5,0.5,0.7)	(0.3,0.5,0.7)	...	(1,2,3)	(0,0,0.2)
A_5	(4,5,5)	(0.8,1,1)	(1.3,1.8,2.2)	(0.1,0.25,0.4)	...	(1,1,2)	(0.55,0.75,0.95)
A_6	(3,4,5)	(0.3,0.5,0.7)	(4.5,5,5)	(0.55,0.75,0.95)	...	(3,4,5)	(0.3,0.5,0.7)
A_7	(1,1,2)	(0,0,0.2)	(2.2,2.7,2.9)	(0,0,0.2)	...	(1,2,3)	(0.1,0.25,0.4)
A_8	(2,3,4)	(0.1,0.25,0.4)	(0.4,0.6,1)	(0.55,0.75,0.95)	...	(2,3,4)	(0,0,0.2)
A_9	(1,2,3)	(0.55,0.75,0.95)	(0.9,1.5,1.7)	(0.8,1,1)	...	(4,5,5)	(0.8,1,1)
A_{10}	(4,5,5)	(0.8,1,1)	(1.8,2.5,2.8)	(0.3,0.5,0.7)	...	(3,4,5)	(0.1,0.25,0.4)

By converting Z-numbers presented in Table 2, it is formed the initial decision-making matrix ($\tilde{X}$), as in Table 3.

Table 3. Initial decision-making matrix

Alter.	C_1	C_2		C_7
A_1	(0.258,0.258,0.516)	(1.5,1.75,2.1)	...	(1.414,2.121,2.828)
A_2	(0.707,1.414,2.121)	(1.932,2.802,3.768)	...	(1.732,2.598,3.464)
A_3	(1.5,2,2.5)	(0.775,0.852,0.93)	...	(0.966,0.966,1.932)
A_4	(1.732,2.598,3.464)	(0.354,0.354,0.495)	...	(0.258,0.516,0.775)
A_5	(3.864,4.83,4.83)	(0.65,0.9,1.1)	...	(0.866,0.866,1.732)
A_6	(2.121,2.828,3.536)	(3.897,4.33,4.33)	...	(2.121,2.828,3.536)
A_7	(0.258,0.258,0.516)	(0.568,0.697,0.749)	...	(0.5,1,1.5)
A_8	(1,1.5,2)	(0.346,0.52,0.866)	...	(0.516,0.775,1.033)
A_9	(0.866,1.732,2.598)	(0.869,1.449,1.642)	...	(3.864,4.83,4.83)
A_{10}	(3.864,4.83,4.83)	(1.273,1.768,1.98)	...	(1.5,2,2.5)

Further, it is performed the normalization of the initial decision-making matrix, as in Table 4.

Table 4. Normalized initial decision-making matrix

Alter.	C_1	C_2		C_7
A_1	(0,0,0.056)	(0.56,0.648,0.71)	...	(0.253,0.407,0.562)
A_2	(0.098,0.253,0.407)	(0.141,0.384,0.602)	...	(0.322,0.512,0.701)
A_3	(0.272,0.381,0.49)	(0.854,0.873,0.893)	...	(0.155,0.155,0.366)
A_4	(0.322,0.512,0.701)	(0.963,0.998,0.998)	...	(0,0.056,0.113)
A_5	(0.789,1,1)	(0.811,0.861,0.924)	...	(0.133,0.133,0.322)
A_6	(0.407,0.562,0.717)	(0,0,0.109)	...	(0.407,0.562,0.717)
A_7	(0,0,0.056)	(0.899,0.912,0.944)	...	(0.053,0.162,0.272)
A_8	(0.162,0.272,0.381)	(0.87,0.957,1)	...	(0.056,0.113,0.169)
A_9	(0.133,0.322,0.512)	(0.675,0.723,0.869)	...	(0.789,1,1)
A_{10}	(0.789,1,1)	(0.59,0.643,0.767)	...	(0.272,0.381,0.49)

Considering that the decision makers did not have different preferences towards the selection of the alternatives, it is calculated that $P_{A_i} = 1/10 = 0.1$. Based on that, it is performed the calculation of the elements of the theoretical assessment matrix provided in Table 5.

Table 5. Theoretical assessment matrix

Alter.	C_1	C_2		C_7
A_{1-10}	(0.024,0.024,0.024)	(0.01,0.01,0.01)	...	(0.02,0.02,0.02)

The elements of the real assessment matrix are presented in Table 6.

Table 6. Real assessment matrix

Alter.	C_1	C_2		C_7
A_1	(0,0,0.001)	(0.005,0.006,0.007)	...	(0.005,0.008,0.011)
A_2	(0.002,0.006,0.01)	(0.001,0.004,0.006)	...	(0.007,0.01,0.014)
A_3	(0.007,0.009,0.012)	(0.008,0.009,0.009)	...	(0.003,0.003,0.007)
A_4	(0.008,0.012,0.017)	(0.009,0.01,0.01)	...	(0,0.001,0.002)
A_5	(0.019,0.024,0.024)	(0.008,0.008,0.009)	...	(0.003,0.003,0.007)
A_6	(0.01,0.014,0.017)	(0,0,0.001)	...	(0.008,0.011,0.015)
A_7	(0,0,0.001)	(0.009,0.009,0.009)	...	(0.001,0.003,0.006)
A_8	(0.004,0.007,0.009)	(0.009,0.009,0.01)	...	(0.001,0.002,0.003)
A_9	(0.003,0.008,0.012)	(0.007,0.007,0.009)	...	(0.016,0.02,0.02)
A_{10}	(0.019,0.024,0.024)	(0.006,0.006,0.008)	...	(0.006,0.008,0.01)

Further, it is performed the calculation of the total gap matrix, as in Table 7.

Table 7. Total gap matrix

Alter.	C_1	C_2		C_7
A_1	(0.023,0.024,0.024)	(0.003,0.003,0.004)	...	(0.009,0.012,0.015)
A_2	(0.014,0.018,0.022)	(0.004,0.006,0.008)	...	(0.006,0.01,0.014)
A_3	(0.012,0.015,0.018)	(0.001,0.001,0.001)	...	(0.013,0.017,0.017)
A_4	(0.007,0.012,0.017)	(0,0,0)	...	(0.018,0.019,0.02)
A_5	(0,0,0.005)	(0.001,0.001,0.002)	...	(0.014,0.018,0.018)
A_6	(0.007,0.011,0.014)	(0.009,0.01,0.01)	...	(0.006,0.009,0.012)
A_7	(0.023,0.024,0.024)	(0.001,0.001,0.001)	...	(0.015,0.017,0.019)
A_8	(0.015,0.018,0.02)	(0,0,0.001)	...	(0.017,0.018,0.019)
A_9	(0.012,0.017,0.021)	(0.001,0.003,0.003)	...	(0,0,0.004)
A_{10}	(0,0,0.005)	(0.002,0.003,0.004)	...	(0.01,0.013,0.015)

In the further process of application of the Z-MAIRCA model, the gap of alternatives is calculated, and the obtained values are defuzzified, on the basis of which the initial rank of the alternatives is defined. Then, the calculation of the dominance index and the definition of the final rank are performed, as in Table 8.

Table 8. Ranking alternatives

Alter.	Alternative gap $\tilde{Q}_i$	Alternative gap Q_i	Initial rank	$A_{D,1-j}$	Final rank
A_1	(0.052,0.064,0.074)	0.0559	10	0.534	10
A_3	(0.042,0.054,0.063)	0.0465	9	0.365	9
A_4	(0.041,0.05,0.058)	0.0437	7	0.316	7
A_5	(0.038,0.05,0.062)	0.042	6	0.285	6
A_6	(0.027,0.041,0.056)	0.0318	3	0.103	3
A_7	(0.041,0.053,0.065)	0.0454	8	0.345	8
A_8	(0.037,0.047,0.058)	0.0402	5	0.252	5
A_9	(0.023,0.034,0.049)	0.0262	2	0.003	1*
A_{10}	(0.022,0.035,0.057)	0.0261	1	0.000	1

In accordance with the obtained dominance threshold ($I_D = 0.09$), it can be noted that the advantage of the initially first-ranked alternative (A_{10}) is not significant enough, compared to the second-ranked alternative (A_9). Accordingly, a decision maker can select any of the two mentioned alternatives as the first-ranked.

5. Sensitivity analysis

An inevitable section of any model is a sensitivity analysis. There are different approaches to sensitivity analysis (Pamučar et al., 2017a). In this paper, a sensitivity analysis is performed by favoring the significance (weight coefficient) of one criterion in every scenario. For the needs of the analysis, seven scenarios are defined, as in Table 9.

Table 9. Sensitivity analysis scenarios

Criteria	S-0	S-1	S-2	S-3	S-4	S5	S6	S7
C_1	0.244	0.4	0.1	0.1	0.1	0.1	0.1	0.1
C_2	0.098	0.1	0.4	0.1	0.1	0.1	0.1	0.1
C_3	0.122	0.1	0.1	0.4	0.1	0.1	0.1	0.1
C_4	0.06	0.1	0.1	0.1	0.4	0.1	0.1	0.1
C_5	0.192	0.1	0.1	0.1	0.1	0.4	0.1	0.1
C_6	0.08	0.1	0.1	0.1	0.1	0.1	0.4	0.1
C_7	0.204	0.1	0.1	0.1	0.1	0.1	0.1	0.4

By applying the Z-MAIRCA model and the defined weight coefficients by scenarios, the ranks of alternatives shown in Table 10 are obtained. The ranks shown indicate the initial rank, and an asterisk next to certain ranks indicates that in the final ranking, the alternatives marked with an asterisk would be ranked as the first ones.

Table 10. Ranks of alternatives by different scenarios

Alternatives	S-0	S-1	S-2	S-3	S-4	S5	S6	S7
A_1	10	10	9	10	10	10	9	7
A_2	4	6	8	5	3*	4	1	3
A_3	9	8	7	9	9	8	8	8
A_4	7	5	5	7	8	7	7	10
A_5	6	2	6	8	6	9	10	9
A_6	3	3	10	3	5	5	2*	2
A_7	8	9	3*	2	4	3	4*	5
A_8	5	7	2*	4	7	2	5	6
A_9	2*	4	1*	6	1	1	3*	1
A_{10}	1	1	4*	1	2*	6	6	4

The obtained ranks, shown in Table 10, indicate that the favoring of certain criteria affects the differences in ranks, which indicates that the developed model is sensitive to changes in the weight coefficients of the criteria. The rank correlation control is performed using the Spearman's coefficient:

$$S = 1 - \frac{6\sum_{i=1}^{n} D_i^2}{n(n^2 - 1)} \tag{29}$$

where: S - the value of the Spearman's coefficient; D_i - the difference in the rank of the given element in the vector w and the rank of the correspondent element in the reference vector; n - number of ranked elements. The values of the Spearman's coefficient range between -1 and 1, i.e. from the ideal negative to the ideal positive rank correlation.

Table 11 provides the values of the Spearman's coefficient by comparing all the scenarios mutually, based on the initial rank of alternatives.

Table 11. The value of the Spearman's coefficient based on the initial ranks of alternatives

Scenarios	S-0	S-1	S-2	S-3	S-4	S5	S6	S7
S-0	1	0.794	0.285	0.594	0.830	0.606	0.727	0.727
S-1		1	0.091	0.370	0.552	0.055	0.091	0.224
S-2			1	0.000	0.158	0.606	0.048	-0.048
S-3				1	0.685	0.624	0.624	0.564
S-4					1	0.673	0.661	0.770
S-5						1	0.794	0.685
S-6							1	0.830
S-7								1

From Table 11, it can be observed that the rank correlation in most of the cases is very high. However, the most important correlation of ranks is between the scenario S-0 and the others, where a significant deviation from the scenario S-2 is observed. The S-2 scenario has a low correlation with other scenarios as well. This result presents a combination of two factors: the values of the evaluated alternatives by the criterion C_2 and a significant increase in the weight coefficient of the criterion C_2 in the scenario S-2 (by four times). The deviation is also observed in the correlation of the S-1 strategy with almost all other strategies. The analysis of the ranks shows that the most significant part of the non-correlation is the popping up of the alternative A_5 in the second scenario as the second-ranked. Finally, it is pointed out that in all scenarios, the alternatives A_9 or A_{10} are ranked as the first or one of the first-ranked. According to all the above, it can be concluded that the developed model is sufficiently sensitive. Also, the model can tolerate minor errors in defining the weight coefficients of the criteria, i.e. in the evaluation of the alternatives by criteria.

Given the existence of certain minor deviations in the sensitivity analysis, the results obtained by the Z-MAIRCA model are compared with the results obtained by the MABAC and VIKOR methods (classic and modified with Z-numbers - Z-MABAC and Z-VIKOR and fuzzy numbers - f- MABAC and f-VIKOR) and the MAIRCA (classic and modified with fuzzy numbers - f-MAIRCA). In Table 12, the ranks obtained by the above methods are presented.

Table 12. Ranks of alternatives obtained by applying different methods

Alternatives	Z-MAIRCA	Z-VIKOR	Z-MABAC	f-MAIRCA	f-VIKOR	f-MABAC	MAIRCA	VIKOR	MABAC
A_1	10	10	10	10	10	10	10	10	10
A_2	4	8	5	5	9	7	6	8	6
A_3	9	7	8	8	6	8	7	6	7
A_4	7	5	6	6	7	6	5	7	5
A_5	6	3	7	7	4	5	8	5	8
A_6	3	6	3	2	3	2	4	4	4
A_7	8	9	9	9	8	9	9	9	9
A_8	5	4	4	3	5	4	2	3	2
A_9	2	2	1	4	2	3	1	2	1
A_{10}	1	1	2	1	1	1	3	1	3

Figure 7 shows the rank of alternatives using different methods from which the correlation of ranks is more clearly observed.

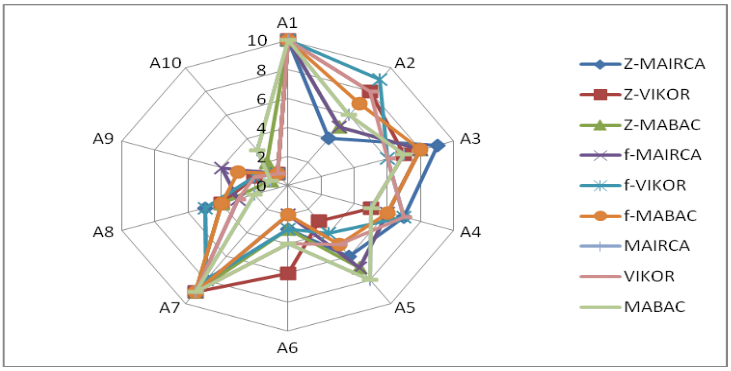

Figure 7. Graphic presentation of the rank of alternatives obtained by applying different methods

From Figure 7 and Table 12, it can be observed a clear dominance of the alternatives A_9 and A_{10}, as well as the rank of the alternatives A_7 and A_1, which are most often ranked as the last ones. Despite the obvious correlation of ranks, in Table 13, the values of the Spearman's correlation coefficient of ranks for different methods and their modifications are provided.

Table 13. Value of the Spearman's coefficient for different methods

Method	Z-MAIRCA	Z-VIKOR	Z-MABAC	f-MAIRCA	f-VIKOR	f-MABAC	MAIRCA	VIKOR	MABAC
Z-MAIRCA	1	0.733	0.952	0.909	0.770	0.903	0.806	0.806	0.806
Z-VIKOR		1	0.770	0.709	0.891	0.855	0.745	0.915	0.745
Z-MABAC			1	0.442	0.309	0.430	0.648	0.867	0.648
f-MAIRCA				1	0.758	0.939	0.867	0.842	0.867
f-VIKOR					1	0.915	0.721	0.952	0.721
f-MABAC						1	0.830	0.927	0.830
MAIRCA							1	0.855	1
VIKOR								1	0.855
MABAC									1

From Table 13, it is clear that there is a high correlation of ranks obtained by different methods and their modifications. It is especially important to point out the high correlation of the ranks of the Z-MAIRCA model with the f-MAIRCA and the classic MAIRCA method. Accordingly, it can be concluded that the developed model provides usable results in conditions of uncertainty. It is also observed that there is an impact of uncertainty treatment on the final ranking of alternatives, and that it can significantly influence the selection, but not to such an extent where the ranks of alternatives are not correlated.

6. Conclusion

The paper explains the phases of development of multi-criteria decision-making model based on the LBWA method and the MAIRCA method modified with Z-numbers. The presented model is successfully applied in the selection of camp space locations. In addition to the description of the model, the paper describes the problem that was being solved, i.e. the selection of a location for a camp space. The highlighted problem belongs to the group of location issues. The analysis of the literature indicates that multi-criteria decision-making methods have a great application in solving this type of problems.

The paper describes in detail the steps of the LBWA method and the MAIRCA method modified with Z-numbers, as well as their previous application in the literature. The paper also presents the basics related to the application of Z-numbers, as a very important way to deal with uncertainty. The model application process itself has followed the definition of the criteria for the selection of the best alternative and the calculation of their weight coefficients using the LBWA method. Seven criteria of different character (benefit and cost-type criteria) are defined, on which the selection of a camp space depends. A part of the criteria, which is of a linguistic nature, clearly indicated the need to apply methods that deal with uncertainty.

The presentation of the model application is performed on ten alternatives. By applying the Z-MAIRCA model, the ranking of alternatives is successfully performed. Finally, sensitivity analysis is done. The results of the sensitivity analysis indicate the possibility of successful application of the model in cases of minor errors in defining the weight coefficients and in evaluating the alternatives according to the criteria.

In the following research, the model presented can be tested in solving other problems as well. On the other hand, it is possible to apply other ways of dealing with uncertainty so as to solve the problem presented in the paper.

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