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Research Article

DIBR–DOMBI–FUZZY MAIRCA Model for Strategy Selection in the System of Defense

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Strategic management has applications in many areas of social life. One of the basic steps in the process of strategic management is formulating a strategy by choosing the optimal strategy. Improving the process of selecting the optimal strategy with MCDM methods and theories that treat uncertainty well in this process, as well as the application of other and different selection criteria, is the basic idea and goal of this research. The improvement of the process of the aforementioned selection in the defense system was carried out by applying a hybrid model of multicriteria decision-making based on methods defining interrelationships between ranked criteria (DIBR) and multiattributive ideal-real comparative analysis (MAIRCA) modified by triangular fuzzy numbers–"DIBR–DOMBI–Fuzzy MAIRCA model." The DIBR method was used to determine the weight coefficients of the criteria, while the selection of the optimal strategy, from the set of offered methods, was carried out by the MAIRCA method. This was done in a fuzzy environment with the aim of better treatment of imprecise information and better translation of quantitative data into qualitative data. In the research, an analysis of the model's sensitivity to changes in weight coefficients was performed. Additionally, a comparison of the obtained results with the results obtained using other multicriteria decision-making methods was conducted, which validated the model and confirmed stable results. In the end, it was concluded that the proposed MCDM methodology can be used for choosing a strategy in the defense system, that the results of the MCDM model are stable and valid, and that the process has been improved by making the choice easier for decision makers and by defining new and more comprehensive criteria for selection.

1. Introduction

The basic prerequisite or the "key" for the good business of any organization is quality management. There are different definitions of management, depending on the approach, among them that management is "effective knowledge, which is applied in a continuous process: planning, organizing, leading, and controlling business activities to achieve the organizational purpose and goals, so that an organization can be effective and efficient" [1]. It is also defined as the process of performing certain functions, to provide, distribute and efficiently using human and other resources, to achieve a previously established goal [2]. Considering today's dynamic environment, the organization must ensure vitality; that is, the management must react promptly and influence new changes with its actions, inducing strategic thinking about the goals of the organization, as well as about the ways of their realization. For the organization to successfully respond to environmental challenges and changes, various methods, concepts, tools, and techniques must be used in the process of strategic management, such as portfolio concept, scenario method, cost-benefit analysis, gap analysis, SWOT or TOWS matrices, and different software tools. [3]. Also, the mentioned changes require a strategic vision of organizational development, which leads to a new scientific discipline called strategic management.

Strategic management represents "a management discipline that considers the process of formulating and implementing a strategy to achieve the long-term goals of the organization" [4]. The goal of strategic management is to affirm the company's proactive attitude towards the environment with a strong emphasis on the need for timely recognition and management of changes. Strategic management represents a way to reduce or completely eliminate resistance to changes that do not allow creating a difference between the organization's capabilities and the needs of the environment [5].

Strategic management is an iterative process, and it consists of several steps: (a) strategic assessment, (b) strategic direction, (c) strategy formulation, (d) strategy implementation, and (e) strategic control [6, 7]. In this paper, the focus is on the third step, which is the formulation of the strategy. To develop a quality strategy, the optimal one must be selected from the set offered by the accepted methodology: development of multiple strategy variants, evaluation of strategies, and selection of the optimal strategy. The process of choosing the optimal strategy until now was realized through expert opinions, with the use of a small number of criteria that did not fully consider all the essential characteristics of the optimal strategy and that it did not include the more serious application of MCDM methods. In order to improve the mentioned methodology, the need for this research was created through the implementation of multicriteria decision-making methods in this process and the implementation of more comprehensive criteria for selection.

The objectives of the paper are as follows:

(i) Improvement of the existing process of strategic management in the part related to the selection of the optimal strategy in the defense system, through the introduction of new selection criteria

(ii) Improvement of the aforementioned process through the introduction of the MCDM model based on the DIBR and MAIRCA methods

(iii) Validation of the proposed MCDM model and confirmation of its possible use in the strategic management process for strategy evaluation and optimal selection

In this research, the MCDM hybrid model was developed to choose the optimal defense strategy in the Republic of Serbia (RS), as a "basic document for the projection of development and the functioning of the defense system" [8]. Until now, this choice was usually made based on suitability, feasibility, and acceptability criteria in the seventh phase of strategy development, i.e., in the phase of strategy verification (evaluation) [8], without application or more significant application of MCDM methods. Presented model used the method defining interrelationships between ranked criteria (DIBR) and fuzzification method multiattributive ideal-real comparative analysis (MAIRCA), with the use of the Dombi aggregation operator for aggregating the opinions of experts and new criteria for selection.

The followings are the practical and scientific key contributions of this research:

(i) Systematization of the criteria that influence the choice of optimal strategies in the defense system of the Republic of Serbia was carried out

(ii) The weight of the defined criteria was carried out

(iii) A mathematical model for decision-making support was created, which quantifies the uncertainties accompanying this process

(iv) MCDM methods in group decision-making were used to create the mathematical model

The paper consists of six parts. After the introduction, a brief analysis of the literature related to the research problem and the methods used was performed. The used methods and criteria are described in the third part. In the fourth part, the presentation of the case study is carried out with the definition of the alternatives, the calculation of the weight coefficients, and the selection of the best alternative. In the sixth part, the robustness of the presented model was checked, and at the end of the paper, concluding considerations are given.

2. A Brief Literature Review

The mathematical decision-making models have found application in a large number of different areas of human activity [9–16]. The authors of the presented research used different MCDM methods, in their basic or modified form, both for determining weighted coefficients of the criteria and for choosing the optimal alternative from the set of proposed ones.

The modern development of multicriteria decision-making (MCDM) methods has led not a small number of researchers to study the selection of strategies using various mathematical models. The problem of strategy selection using the MCDM method has been discussed in quite a few works. A part of those works is shown in Table 1.

As can be seen from Table 1 and other researches in the field of strategy selection, for the selection of different strategies from different areas, different MCDM methods were used, among which the TOPSIS method stands out as the most frequent, with different modifications, that is, theories that treat uncertainty well. Also, different criteria were used for this selection. None of these studies use the criteria, neither methods nor methodology presented in this paper. Also, the DIBR–MAIRCA model has not yet been used in any MCDM model. The aforementioned represents a novelty for this article compared to existing studies.

Considering that it is DIBR method a relatively new method for defining the weight coefficients of the criteria, there is not a large number of studies in which this method has been applied. The analysis of the literature considering this method is given in Table 2.

Based on the analysis of the papers listed in Table 2, which include all published papers in which the DIBR method was used, it can be concluded that the DIBR method has not yet been used to determine the weight coefficients of the strategy selection criteria, in any area, and that it has not yet been applied in the model with the MAIRCA method.

The usage of the MAIRCA method is given in Table 3.

3. Research Methodology

To solve the problem of optimal strategy selection from the set proposed in the defense system, the MCDM model was created, which is presented in Figure 1.

Table 1: Selection of strategies in the literature.

Application and reference	Methods
To choose an advertising strategy [17]	FAHP, GREY TOPSIS
For e-tailers' distribution strategy evaluation [18]	DANP with VIKOR
To choose a green marketing strategy [19]	Fuzzy AHP, fuzzy TOPSIS
Choosing a public transport company strategy (Istanbul, Turkey) [20]	Interval type-2 fuzzy AHP and TOPSIS
Design a marketing strategy [21]	Discrete choice analysis (DCA)
Selection of government intervention strategies against the COVID-19 pandemic [22]	SF-AHP, WASPAS-F
Determination of optimal renewable energy growth strategies [23]	SWARA, ARAS-Grey
In agricultural water management for development strategies [24]	AHP, TOPSIS
In research related to science park development strategies [25]	Fuzzy BWM, fuzzy CoCoSo
Green mining strategy selection [26]	SWOT-PEST, fuzzy AHP-MARCOS
Health tourism strategy selection [27]	SWOT, fuzzy linguistic AHP, MABAC
The COVID-19 infodemic management strategies selection [28]	BWM, spherical fuzzy set, CoCoSo

Table 2: DIBR method–a brief literature review.

Application and reference	Methods
Solving the problems of the circular economy concept [29]	DIBR, fuzzy Dombi CoCoSo
Choosing the optimal location for the installation of a heavy launch bridge [30]	DIBR, Fuzzy MARCOS
Selection of antitank missile system [31]	Rough DIBR, rough MABAC
To prioritize sustainable mobility sharing systems in order to promote sustainability and nurture the concept of shared mobility [32]	Fuzzy DIBR, fuzzy-rough EDAS
For the selection of alternative priorities for zero-emission zone logistics [33]	DIBR, CoCoSo, type-2 neutrosophic numbers

The model has three phases, within which two steps were implemented. The initial phase includes the definition of the criteria based on which the evaluation of alternatives (strategies) was performed and defining their weight coefficients to quantitatively determine their impact on the final ranking. In the specific case, to calculate the weight coefficients of the criteria, the DIBR method was used. This method, its mathematical apparatus, uses comparisons of criteria by importance, obtained by the opinions of experts in the subject area.

After the implementation of the previous phase, the second phase was performed to select the optimal alternative (strategy). The aforementioned choice is made using the Fuzzy MAIRCA method, where the values of the alternatives for each criterion are fuzzified.

Given that errors can occur in any decision-making process, a sensitivity analysis of the model was performed by changing the weight coefficients of the criteria and comparing the ranking results with the results of other MCDM methods.

The problem of choosing an optimal strategy required the application of methods that take uncertainties seriously. Considering the simplicity of the mathematical apparatus and the purpose of the methods, the DIBR–Fuzzy MAIRCA model was applied in this study. First of all, it is necessary to define the criteria that condition the subject choice, which is described in the next part of the paper.

3.1. Definition of Criteria. Starting from the fact that a good strategy should balance goals, ways, and means; take care of the strategic environment; properly assess risk; minimize reliance on assumptions; be clear and feasible; and be creative and capable of change. Miller [45] defines six criteria for the selection (evaluation) of proposed strategies, as opposed to established evaluation criteria (suitability, feasibility, acceptability):

Criterion 1 (C1)–Balance: Does the strategy balance ends with ways and means?–It implies answers to the following questions: Does the strategy clearly articulate its goals, which must be measurable? Does the strategy suggest appropriate ways to achieve the goal? Does the strategy have the means to support achieving the goals, i.e., is it feasible? Does the strategy have internal consistency, that is, the alignment with the strategic goals of the organization or the state?

Criterion 2 (C2)–Awareness: Does the strategy include an understanding of the strategic environment?–This criterion provides answers to the following questions: Does the strategy properly evaluate the state's place in the international system? Does the strategy include the interests and potential strategies of other actors? Does the strategy assess trends in the strategic environment?

Criterion 3 (C3)–Honesty: Does the strategy properly assess risk?–It refers to the risks that come from the environment and gives an answer to the following questions: Does the strategy identify the risk and provide options for solving it? Does the strategy identify the risk of doing nothing? Does the strategy count on dramatic success, that is, does it include options for dealing with greater-than-expected success?

Criterion 4 (C4)–Parsimony: Does the strategy minimize its reliance on assumptions?–to get an answer to

Table 3: MAIRCA method–literature review.

Application and reference	Methods
Optimal selection of supplier [34]	BWM, MAIRCA
Optimal choosing of landing operations point [35]	IVFRN MAIRCA
To improve the risk process in failure mode and effect analysis [36]	FAHP, FMAIRCA
Coronavirus vaccine selection in the age of COVID-19 [37]	IF-MAIRCA
For the analysis of the real sector from the economic and financial aspect in Turkey [38]	CRITIC, MAIRCA
Optimal selection of automobile engine oil [39]	BWM, FUCOM, MABAC, MAIRCA
MCDM approach when using powder-mixed electrical discharge machining of cylindrically shaped parts in 90CrSi tool steel [40]	MARCOS, TOPSIS, MAIRCA
For the financial performance measurements of companies in the BIST electricity index [41]	MAIRCA
For selecting an appropriate energy storage technology for India [42]	Linear diophantine hesitant fuzzy sets (LDHFS), SOWIA, MAIRCA
To prioritize the critical success factors of the use of blockchain technology for the agri-food sector [43]	ANP, MAIRCA
To prioritize industrial filtration technologies [44]	q-Rung orthopair fuzzy sets, MAIRCA

Figure 1: DIBR–DOMBI–Fuzzy MAIRCA model.

check whether the strategy is economical from the following questions: Does the strategy identify its assumptions? Does the strategy have to make assumptions about these six evaluation criteria? Does the strategy make the right assumptions?

Criterion 5 (C5)–Elegance: Is the strategy clear and feasible?–The previous four criteria require the expert to be a critical thinker–to analyze the strategy and its constituent parts, while this and the following require the expert to be a more creative thinker, i.e., to answer to the following questions: Does the strategy offer clear choices to decision makers? Does the strategy give clear direction to those who will implement it? Does the strategy require secrecy?

Criterion 6 (C6)–Creativity: Is the strategy innovative and capable of change?–It implies answers to the following questions: Is the strategy creative? (a creative strategy, defined as one that is unexpected, will have a greater chance of success than one that is uncreative); Is the strategy adaptable? Is the strategy flexible? Adaptability refers to incorporating alternative options into the strategy, while flexibility means that the strategy can be adjusted when faced with unexpected change.

The criteria are listed according to their significance, from the most significant to the least significant, based on the agreed opinion of experts. All criteria are qualitative and benefit type of criteria, and the ranking and determination of the significance of the criteria was performed by five subject-matter experts. Qualitative descriptions of the criteria were converted into quantitative data using a three- or four-level scale, depending on the number of questions that need to be answered, as well as the degree of conviction of the decision maker in the statements made. For example, for criterion C4 (Parsimony) to be fully satisfied, the strategy must provide answers to four questions (Does the strategy identify its assumptions? Does the strategy have to make assumptions about these six evaluation criteria? Does the strategy make the right assumptions?). If the proposed strategy answers three questions, the value of the alternative is 3, and if it gives an answer to two questions, the value is 2. The evaluation of alternatives (strategies) according to each of the defined criteria by the experts is shown as, for example, (3 : 70), where 3 represents the previously described evaluations of alternatives, and 70 represents the level of expert confidence in the given evaluation in percentages. The DIBR method was used to define the weight coefficients of the mentioned criteria.

3.2. DIBR Method

3.2. DIBR Method. The DIBR method was first presented by Pamučar et al. [29]. The implementation of the DIBR method is presented as follows [29]:

Step 1. *Ranking of Defined Criteria.* If n indicates the number of defined criteria, then the set of defined criteria can be displayed as a set $C = \{C_1, C_2, \ldots, C_n\}$. For the sake of easier presentation of the method, the following significance of the criteria is assumed $C_1 > C_2 > C_3 > \ldots > C_n$, where the criterion has the greatest importance; that is, the criterion C_n has the lowest importance.

Step 2. *Comparison of Defined Criteria.* The comparison values defined by the decision maker or expert e (where $1 \le e \le \varepsilon$) can be marked as $\vartheta^e_{i-1,i}$, where $i \in (1, 2, 3, \ldots, n)$. In each comparison of criteria, the total value of 100% significance is distributed to the two criteria that are the subject of comparison. For example, if the relationship between the criteria C_2 and C_3 is equal to 0.4, that is, $\vartheta^e_{2,3} = 0.4$, this implies that the importance of the criterion C_2 equals 60%, while the criterion C_3 equals 40%. This relationship between the criteria is also shown mathematically by the following:

$$\frac{w^e_1}{w^e_2} = \frac{1 - \vartheta^e_{1,2}}{\vartheta^e_{1,2}}, \tag{1}$$

$$\frac{w^e_2}{w^e_3} = \frac{1 - \vartheta^e_{2,3}}{\vartheta^e_{2,3}}, \tag{2}$$

$$\ldots$$

$$\frac{w^e_{n-1}}{w^e_n} = \frac{1 - \vartheta^e_{n-1,n}}{\vartheta^e_{n-1,n}}, \tag{3}$$

$$\frac{w^e_1}{w^e_n} = \frac{1 - \vartheta^e_{1,n}}{\vartheta^e_{1,n}}, \tag{4}$$

where equation (4) represents the control relation of the relationship of the other criteria.

Step 3. *Defining Relations.* Using equation (1), the value of the weight coefficient of the criteria C_2 can be defined, which equals

$$w^e_2 = \frac{w^e_1 \vartheta^e_{1,2}}{1 - \vartheta^e_{1,2}}. \tag{5}$$

By applying equations (1) and (2), the weight coefficient of the criteria C_3 can be defined, as follows:

$$w^e_3 = \frac{w^e_1 \vartheta^e_{1,2} \vartheta^e_{2,3}}{\left(1 - \vartheta^e_{1,2}\right)\left(1 - \vartheta^e_{2,3}\right)}. \tag{6}$$

In the end, by applying equations (1) to (4), the value of the criterion C_n is found.

$$w^e_n = \frac{w^e_1 \prod_{i=1}^{n-1} \vartheta^e_{i,i+1}}{\prod_{i=1}^{n-1}\left(1 - \vartheta^e_{i,i+1}\right)}. \tag{7}$$

Step 4. *Calculation of the Weight Coefficient of the Most Significant Criterion.* If it is assumed that the sum of the weight coefficients is equal to one, then according to equations (5)–(7), that relation can be presented as follows:

$$w_1 + \frac{w_1^e \vartheta_{1,2}^e}{\left(1 - \vartheta_{1,2}^e\right)} + \frac{w_1^e \vartheta_{1,2}^e \vartheta_{2,3}^e}{\left(1 - \vartheta_{1,2}^e\right)\left(1 - \vartheta_{2,3}^e\right)} + \ldots + \frac{w_1^e \prod_{i=1}^{n-1} \vartheta_{i,i+1}^e}{\prod_{i=1}^{n-1}\left(1 - \vartheta_{i,i+1}^e\right)} = 1. \quad (8)$$

Equation (8) has one unknown, namely w_1, which is calculated as follows:

$$w_1 = \frac{1}{1 + \vartheta_{1,2}^e/\left(1 - \vartheta_{1,2}^e\right) + w_1^e \vartheta_{1,2}^e \vartheta_{2,3}^e/\left(1 - \vartheta_{1,2}^e\right)\left(1 - \vartheta_{2,3}^e\right) + \ldots + w_1^e \prod_{i=1}^{n-1} \vartheta_{i,i+1}^e/\prod_{i=1}^{n-1}\left(1 - \vartheta_{i,i+1}^e\right)}. \quad (9)$$

After calculating the weight coefficient of the most significant criterion, the conditions were met to define the weight coefficients of the other criteria using equations (5)–(7).

Step 5. *Control of Decision Makers' Preferences*. Based on equation (4), the ratio of the most significant and the least important criterion $(\vartheta_{1,n}^{'})$ can be calculated, which is calculated as follows:

$$\vartheta_{1,n}^{'e} = \frac{w_n^e}{w_1^e + w_n^e}. \quad (10)$$

If the values of the calculated ratio $(\vartheta_{1,n}^{'})$ and the relationship assigned by the decision maker $(\vartheta_{1,n})$ are roughly the same, then there is consistency in the opinions of decision makers in the process of evaluating the importance of the criteria. If the value deviation of $\vartheta_{1,n}$ and $\vartheta_{1,n}^{'}$ is greater than 10%, it can be concluded that the evaluations of the criteria ratio are not consistent. Then, the redefining of the value $\vartheta_{1,n}$ is applied or alternatively, and a re-evaluation of the significance of the criteria is carried out.

For this research, the comparison and definition of the relationship between the criteria were done by experts, and the aggregation of their opinions was conducted using the Dombi weighted geometric averaging (DWGA) operator, applying the following expression [29]:

$$\text{DWGA}_i^{\rho} = \frac{\sum_{e=1}^{\varepsilon} w_{ij}}{1 + \left\{\sum_{e=1}^{\varepsilon} w_j \left(1 - f\left(w_{ij}\right)/f\left(w_{ij}\right)\right)^{\rho}\right\}^{1/\rho}}, \quad (11)$$

where is $\rho > 0$ and describes stabilization parameter of the Dombi function, while $f(w_{ij})$ represents the normalized values of the obtained weight coefficients for each of the experts. The Fuzzy MAIRCA method was used to select the optimal strategy from the set of proposed ones, and the method steps are described as follows.

3.3. Fuzzy MAIRCA Method. Imprecisely defined membership of an element to a set, i.e., membership of an element to a set more or less, represents the main difference between Fuzzy sets and classical sets. This feature of fuzzy logic is closer to human understanding of reality than classical logic [46–48]. Lotfi Zadeh introduced and presented the first principles of fuzzy logic [49].

Fuzzy set L is defined as follows:

$$L = \{(z, \mu_L(z)) | z \in Z, 0 \le \mu_L(z) \le 1\}, \quad (12)$$

where Z is the set on which the fuzzy set is defined L; $0 \le \mu_L(z) \le 1$ is the function of element; z $(z \in Z)$ belongs to the set L. Triangular fuzzy numbers, which have the shape $\widetilde{L} = (l_1, l_2, l_3)$, are most often used ($l_1$–the left distribution, l_2–the place where $\mu_L = 1$, l_3–the right distribution of the confidence interval of the fuzzy number $\widetilde{L}$). There are different approaches to fuzzification, and one of them is presented by Bobar et al. [50]:

$$\widetilde{F} = (l_1, l_2, l_3) = \left\{ \begin{array}{lll} l_1 = \gamma l_2, & l_1 \le l_2, & l_1 \in [1, \infty] \\ l_2 = l_2, & & l_2 \in [1, \infty] \\ l_3 = (2 - \gamma) l_2, & l_3 \le l_2, & l_3 \in [1, \infty] \end{array} \right\}. \quad (13)$$

A fuzzy number $\widetilde{L} = (l_1, l_2, l_3) = (z\gamma, z, (2 - \gamma)z)$, $z \in [1, \infty]$ is defined by the following expressions:

$$\begin{aligned} l_1 &= z\gamma = \begin{cases} z\gamma, \forall 1 \le z\gamma \le z, \\ 1, \forall z\gamma < 1, \end{cases} \\ l_2 &= z, \forall z \in [1, \infty], \\ l_3 &= (2 - \gamma) z, \forall z \in [1, \infty]. \end{aligned} \quad (14)$$

Defuzzification of fuzzy number $\widetilde{L}$:

$$L = \frac{((l_3 - l_1) + (l_2 - l_1))}{3 + l_1}, \quad (15)$$

$$L = \frac{[\lambda l_3 + l_2 + (1 - \lambda) l_1]}{2}, \quad (16)$$

where λ represents an index of optimism $\lambda \in [0, 1]$, that is, the expert's belief in risk when deciding, and it can be pessimistic, moderate, and optimistic [51].

The MAIRCA method was published at the RAILCON international scientific conference [52].

Formation of the initial decision matrix represents the initial step of applying the Fuzzy MAIRCA method:

$$\tilde{X} = \begin{matrix} & C_1 & C_2 & \dots & C_n \\ A_1 & \tilde{x}_{11} & \tilde{x}_{12} & \dots & \tilde{x}_{1n} \\ A_2 & \tilde{x}_{21} & \tilde{x}_{22} & \dots & \tilde{x}_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ A_m & \tilde{x}_{m1} & \tilde{x}_{m2} & \dots & \tilde{x}_{mn} \end{matrix} \quad (17)$$

where m is the total number of alternatives, and n represents the total number of criteria. The initial decision-making matrix is obtained by aggregating the opinions of experts, using equation (11).

The steps of the Fuzzy MAIRCA method are shown as follows [52]:

Step 1. Defining the probability of choosing alternatives P_{Ai}, by expression (18):

$$P_{A_i} = \frac{1}{n};\ n = 1, 2, \dots, m. \quad (18)$$

Mostly, the probability (P_{Ai}) is the identical for all alternatives:

$$P_{A_i} = P_{A_1} = P_{A_2} = \dots = P_{A_n};\ n = 1, 2, \dots, m. \quad (19)$$

Step 2. Derivation of the matrix of theoretical weights and its elements:

$$\begin{aligned} T_p &= \left[t_{p1}\ \ t_{p2}\ \ \dots\ \ t_{pn} \right]_{P_{A_i} x W_n} \\ &= \left[P_{A_i} w_1\ \ P_{A_i} w_2\ \ \dots\ \ P_{A_i} w_n \right]_{P_{A_i} W_n}, \end{aligned} \quad (20)$$

where w_n–weight coefficients of the criteria.

Step 3. Derivation of the matrix of real weights $\tilde{T}_r$:

$$\tilde{T}_r = \begin{matrix} & C_1 & C_2 & \dots & C_n \\ A_1 & \tilde{t}_{r11} & \tilde{t}_{r12} & \dots & \tilde{t}_{r1n} \\ A_2 & \tilde{t}_{r21} & \tilde{t}_{r22} & \dots & \tilde{t}_{r2n} \\ \dots & \dots & \dots & \dots & \dots \\ A_m & \tilde{t}_{rm1} & \tilde{t}_{rm2} & \dots & \tilde{t}_{rmn} \end{matrix} \quad (21)$$

Using the expressions:

$$\tilde{t}_{\mathrm{rij}} = \tilde{t}_{pi} \left(\frac{x_{ij} - x_i^-}{x_i^+ - x_i^-} \right) \text{for Benefit type criteria,} \quad (22)$$

$$\tilde{t}_{rij} = \tilde{t}_{pi} \left(\frac{x_i^+ - x_{ij}}{x_i^+ - x_i^-} \right) \text{for Cost type criteria,} \quad (23)$$

where x_i^+ represents the maximum value of the right distribution, x_i^- is the minimum value of the left distribution, and $x_{ij}, x_i^+ i x_i^-$ represent the elements of the matrix $\tilde{X}$.

Step 4. Derivation of the gap matrix $\tilde{G}$:

$$\tilde{g}_{ij} = \tilde{t}_{pi} - \tilde{t}_{rij}. \quad (24)$$

Step 5. Obtaining the values of criterion functions (Q), expression (25):

$$\tilde{Q}_i = \sum_{j=1}^{n} \tilde{g}_{ij}. \quad (25)$$

The obtained criterion functions of the alternatives are defuzzified by applying the expressions (15) or (16), and then, they are ranked (the lowest value represents the first ranked).

Step 6. Determination of the dominance index ($A_{D,1-j}$), using the expression (26):

$$A_{D,1-j} = \frac{Q_j - Q_1}{Q_n},\ j = 2, 3 \dots, m, \quad (26)$$

where Q_1 is the first-ranked alternative criterion function, Q_j is the criterion function of the alternative which one is compared, Q_n is the last ranked alternative criterion function, and j is the rank of the alternative.

After obtaining the dominance index, the determination of the dominance threshold is calculated, using the following expression (27):

$$I_D = \frac{m - 1}{m^2}. \quad (27)$$

In case, if it is $A_{D,1-j} \geq I_D$, then the initial rank is retained, and otherwise, the ranks should be corrected and denoted by ($1''$).

4. Results

4.1. Definition of Alternatives (Strategies). Alternatives represent opportunities for solving the problem and achieving the set goal, where during the structuring of the problem, a set of alternatives is generated to bridge the differences between the desired and the current state. In the specific case, the alternatives represent differently formulated strategies from a specific area in the defense system. Strategy formulation is the third step in the strategic management process.

The Law on the Planning System of the Republic of Serbia [53] defines "strategy" as "a basic document of public policy, which comprehensively determines the strategic direction of action and public policy in the specific area of planning and implementation of public policies established by Government regulation." It defines the period of adoption of the strategy from five to seven years which should be accompanied by an action plan for the implementation of the strategy. The law [53] divides the strategies into sectoral and intersectoral, while according to the spatial coverage, it divides into national and subnational. It also defines the method of preparation, taking into account the results of ex-ante and ex-post analyses in the observed area.

For this research and presentation of the model of selection of one of the proposed defense strategies, five formulated alternatives (strategies) were used, as shown in Table 4. The listed strategies represent different defense strategy proposals, which have not been adopted but are currently being elaborated in the process of developing the strategy.

Table 4: Alternatives (strategies) for selection.

Alternatives
Strategy 1 (A1)
Strategy 2 (A2)
Strategy 3 (A3)
Strategy 4 (A4)
Strategy 5 (A5)

Based on the established model (Figure 1), first the weight coefficients of the defined criteria are calculated.

4.2. Determination of the Criteria Weights. A set of six criteria (Section 3.1) was defined $C_1, C_2, \ldots, C_6$, ordered by importance, where criterion C_1 is the most significant, and criterion C_6 is the least significant, respectively. Then, the experts defined the values of the mutual relations of the criteria $\vartheta_{1,2}, \vartheta_{2,3}, \ldots, \vartheta_{5,6}$ according to the following (Table 5):

In the following text, the calculation of the weight coefficients of the criteria according to the opinion of expert 1 is given. First, the mutual relations of the criteria are shown as follows:

$$\begin{aligned} w_1^1&: w_2^1 = 0.54: 0.46\\ w_2^1&: w_3^1 = 0.51: 0.49\\ w_3^1&: w_4^1 = 0.55: 0.45\\ w_4^1&: w_5^1 = 0.52: 0.48\\ w_5^1&: w_6^1 = 0.53: 0.47\\ w_1^1&: w_6^1 = 0.60: 0.40. \end{aligned} \quad (28)$$

Next, by applying expressions (5)–(7), the expressions for the values of the weight coefficients of the criteria were defined: $w_2^1 = 0.852 w_1^1$; $w_3^1 = 0,961 w_2^1 = 0,818 w_1^1$; $w_4^1 = 0,818 w_3^1 = 0,670 w_1^1$; $w_5^1 = 0,923 w_4^1 = 0,618 w_1^1$; and $w_6^1 = 0,887 w_5^1 = 0,548 w_1^1$.

Provided that it is $\sum_{j=1}^{6} w_j = 1$ and using the expression (9), the value of the weight coefficient of the most influential criterion C_1 is obtained:

$$w_1 = \frac{1}{1 + 0,852 + 0,818 + 0,670 + 0,618 + 0,548} = 0.2219. \quad (29)$$

By applying expressions (5)–(7), the weight coefficients of the remaining criteria were obtained, $w_2^1 = 0.1890$; $w_3^1 = 0.1816$; $w_4^1 = 0.1486$; $w_5^1 = 0.1372$; and $w_6^1 = 0.1216$.

Using expression (10), the control value was calculated $\vartheta_{1,6}^{\prime 1}$.

$$\vartheta_{1,6}^{\prime 1} = \frac{w_6^1}{w_1^1 + w_6^1} = \frac{0.2219}{0.2318 + 0.1216} = 0.3541. \quad (30)$$

Since $\vartheta_{1,6}^{1} \approx \vartheta_{1,6}^{\prime 1}$ (within 10% of the difference), that is, $\vartheta_{1,6}^{\prime 1} = 0.3541$ and $\vartheta_{16} = 0.35$, the preferences of expert 1 are well defined.

By applying the other steps of the method, the following weight coefficients are reached (Table 6):

The values of the weight coefficients for all experts, obtained in the previously described manner, are given in Table 7.

By applying the expression (11), expert's opinions were aggregated, and the final values of the weight coefficients of the criteria are calculated (Table 8).

Based on the weight coefficients of the criteria obtained, it can be concluded that the initial importance of the criteria was fully respected, as well as that criterion C1 will have the greatest impact on the final decision; that is, criterion C6 will have the least impact.

4.3. Ranking of Alternatives and Selection of Strategy. After the values of the weight coefficients of the criteria were obtained, the optimal alternative was chosen by applying the Fuzzy MAIRCA method.

First of all, applying the MAIRCA method is to form the initial decision matrix (Table 9), which in this case included values for five proposed alternatives (strategies), based on the aggregated opinions of five experts, using expression (11).

The element of the initial decision matrix (3 : 70.19) indicates that the decision maker evaluated the strategy A_1 with a score of 3 with 70.19% confidence in the given statement. After the fuzzification of experts' claims, the fuzzy values of the initial decision matrix (Table 10) were calculated by applying expressions (13) and (14).

In Step 1, by applying expressions (18) and (19), the following value of P_{Ai} was found:

$$P_{Ai} = \frac{1}{n} = \frac{1}{5} = 0.2. \quad (31)$$

The calculation of the elements of the matrix of theoretical weights, in Step 2 (Table 11), was done using the expression (20).

In Step 3, the matrix of real weights (Table 12) was calculated by applying expressions (22) or (23), depending on whether the criterion is benefit or cost type.

The matrix of the gap $\widetilde{G}$ between theoretical and actual weights, in Step 4 (Table 13), was found by applying the expression (24).

Further application of the Fuzzy MAIRCA method led to the following values of the expected solution ($\widetilde{Q}_i$), its defuzzified values using expressions (15) and (16), and for λ, the value is 0.5, and after that, the initial rank of alternatives (strategies) is obtained and shown in Table 14:

Upon obtaining the index and the dominance threshold, by applying expressions (26) to (27), which represent the specifics of this MCDM method, which is 0.16, the final ranking of alternatives is reached (Table 15).

By applying the established model, the final ranking of alternatives (strategies) A1, A2, A3, and A5, which represent the best, from the set of offers, was determined. Considering the initial ranking, strategy A1 represents the best-ranked alternative, but the decision maker can decide to choose between alternatives A2, A3, and A5 if they believe that the first-ranked alternative has certain weaknesses, because MCDM methods represent tools for decision support, while

Table 5: Values of mutual relations of criteria.

	E1	E2	E3	E4	E5
$\vartheta_{1,2}$	0.46	0.47	0.45	0.46	0.46
$\vartheta_{2,3}$	0.49	0.48	0.48	0.48	0.47
$\vartheta_{3,4}$	0.45	0.46	0.46	0.46	0.45
$\vartheta_{4,5}$	0.48	0.47	0.47	0.48	0.49
$\vartheta_{5,6}$	0.47	0.48	0.45	0.47	0.48
$\vartheta_{1,6}$	0.35	0.36	0.32	0.35	0.35

Table 6: The values of weight coefficients of criteria for expert E1.

Criteria	The value of the weight coefficient
C1	0.2219
C2	0.1890
C3	0.1816
C4	0.1486
C5	0.1372
C6	0.1216

Table 7: The values of weight coefficients of criteria for all experts.

	E1	E2	E3	E4	E5
C1	0.2219	0.2178	0.2351	0.2235	0.2290
C2	0.1890	0.1931	0.1923	0.1904	0.1951
C3	0.1816	0.1783	0.1775	0.1757	0.1730
C4	0.1486	0.1519	0.1512	0.1497	0.1415
C5	0.1372	0.1347	0.1341	0.1382	0.1360
C6	0.1216	0.1243	0.1097	0.1225	0.1255

Table 8: The final values of the weight coefficients.

Criteria	The value of the weight coefficient
C1	0.2254
C2	0.1921
C3	0.1773
C4	0.1486
C5	0.1361
C6	0.1205

Table 9: The initial decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6
A_1	(3 : 70.19)	(2.14 : 63.64)	(2 : 85.71)	(2.5 : 85.71)	(2.31 : 79.5)	(1.88 : 83.72)
A_2	(3.53 : 83.72)	(1.25 : 85.71)	(1.76 : 85.71)	(2.31 : 65.12)	(1.25 : 83.72)	(2.73 : 65.63)
A_3	(2.61 : 69.42)	(2.31 : 65.63)	(1.73 : 77.30)	(2.5 : 83.72)	(1.76 : 89.55)	(1.76 : 86.36)
A_4	(2.86 : 91.84)	(1.76 : 71.19)	(1.76 : 69.42)	(1.25 : 87.38)	(1.76 : 89.55)	(1.25 : 83.33)
A_5	(2.61 : 89.55)	(2.73 : 79.5)	(2.5 : 89.55)	(1.76 : 86.78)	(1.43 : 85.31)	(1.25 : 89.55)

Table 10: The fuzzy initial decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6
A_1	(2.1, 3, 3.9)	(1.4, 2.1, 2.9)	(1.8, 2, 2.2)	(2.1, 2.5, 2.9)	(1.8, 2.3, 2.8)	(1.6, 1.9,2.2)
A_2	(3, 3.5, 4.1)	(1.1, 1.3, 1.4)	(1.5, 1.8, 2)	(1.5, 2.3, 3.1)	(1, 1.3, 1.5)	(1.8, 2.7, 3.7)
A_3	(1.8, 2.6, 3.4)	(1.5, 2.3, 3.1)	(2.1, 2.7, 3.3)	(2.1, 2.5, 2.9)	(1.6, 1.8, 1.9)	(1.5, 1.8, 2)
A_4	(2.6, 2.9, 3.1)	(1.3, 1.8, 2.3)	(1.2, 1.8, 2.3)	(1.1, 1.3, 1.4)	(1.6, 1.8, 1.9)	(1, 1.3, 1.5)
A_5	(2.3, 2.6, 2.9)	(2.2, 2.7, 3.3)	(2.2, 2.5, 2.8)	(1.5, 1.8, 2)	(1.2, 1.4, 1.6)	(1.1, 1.3, 1.4)

Table 11: The matrix of theoretical weights.

	C_1	C_2	C_3	C_4	C_5	C_6
$\tilde{T}_{Pi}$	(2.1, 3, 3.9)	(1.4, 2.1, 2.9)	(1.8, 2, 2.2)	(2.1, 2.5, 2.9)	(1.8, 2.3, 2.8)	(1.6, 1.9, 2.2)

Table 12: The matrix of real weights.

	C_1	C_2	C_3	C_4	C_5	C_6
A_1	(0.006, 0.023, 0.041)	(0.005, 0.019, 0.032)	(0.009, 0.013, 0.016)	(0.015, 0.021, 0.026)	(0.012, 0.02, 0.027)	(0.005, 0.008, 0.01)
A_2	(0.022, 0.034, 0.045)	(0, 0.003, 0.006)	(0.005, 0.009, 0.013)	(0.006, 0.018, 0.03)	(0, 0.003, 0.006)	(0.007, 0.015, 0.024)
A_3	(0, 0.016, 0.031)	(0.008, 0.021, 0.035)	(0.015, 0.025, 0.035)	(0.015, 0.021, 0.027)	(0.008, 0.011, 0.014)	(0.004, 0.007, 0.009)
A_4	(0.016, 0.021, 0.025)	(0.003, 0.012, 0.021)	(0, 0.009, 0.018)	(0, 0.002, 0.005)	(0.008, 0.011, 0.014)	(0, 0.002, 0.004)
A_5	(0.01, 0.016, 0.021)	(0.019, 0.029, 0.038)	(0.017, 0.021, 0.026)	(0.006, 0.01, 0.013)	(0.003, 0.006, 0.009)	(0.001, 0.002, 0.003)

Table 13: The matrix of the gap between theoretical and actual weights.

	C_1	C_2	C_3	C_4	C_5	C_6
A_1	(0.039, 0.022, 0.004)	(0.033, 0.02, 0.006)	(0.026, 0.023, 0.019)	(0.014, 0.009, 0.004)	(0.015, 0.007, 0)	(0.019, 0.016, 0.014)
A_2	(0.023, 0.011, 0)	(0.038, 0.035, 0.032)	(0.031, 0.026, 0.022)	(0.024, 0.012, 0)	(0.027, 0.024, 0.021)	(0.017, 0.009, 0)
A_3	(0.045, 0.029, 0.014)	(0.031, 0.017, 0.003)	(0.021, 0.01, 0)	(0.015, 0.009, 0.003)	(0.019, 0.016, 0.013)	(0.02, 0.017, 0.015)
A_4	(0.029, 0.025, 0.02)	(0.035, 0.026, 0.018)	(0.035, 0.026, 0.017)	(0.03, 0.027, 0.025)	(0.019, 0.016, 0.013)	(0.024, 0.022, 0.02)
A_5	(0.035, 0.029, 0.024)	(0.019, 0.01, 0)	(0.019, 0.014, 0.01)	(0.023, 0.02, 0.016)	(0.025, 0.021, 0.018)	(0.023, 0.022, 0.021)

Table 14: Expected solution values and initial ranking of alternatives.

Alternatives	$\tilde{Q}$	Q	Rank
A1	(0.147, 0.097, 0.047)	0.097	1
A2	(0.16, 0.118, 0.075)	0.118	4
A3	(0.15, 0.099, 0.048)	0.099	2
A4	(0.172, 0.143, 0.113)	0.143	5
A5	(0.144, 0.116, 0.089)	0.116	3

Table 15: Final ranking of alternatives.

Alternatives	Final ranking
A1	1″
A2	1″
A3	1″
A4	5
A5	1″

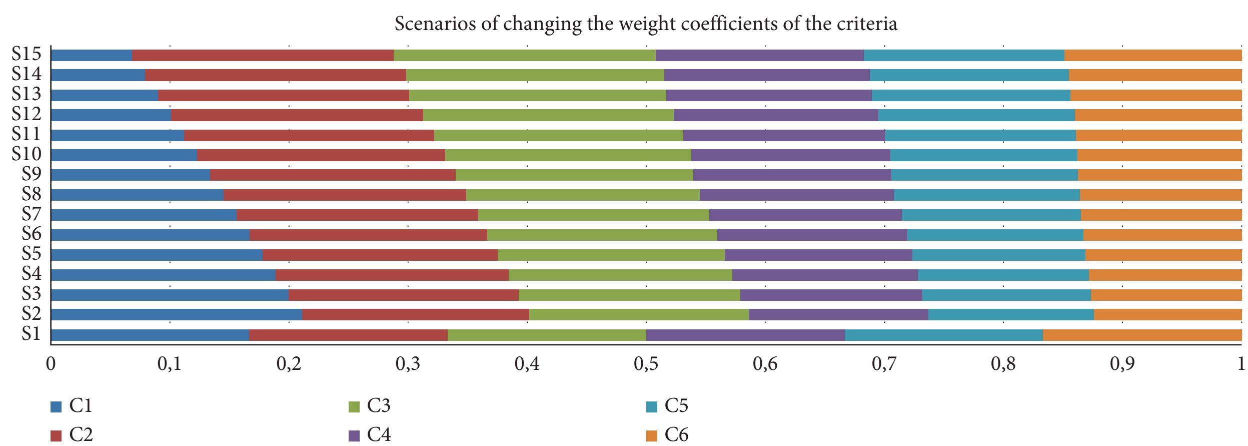

Figure 2: Scenarios of changing the weight coefficients of the criteria.

a human is the one who makes the final decision. Also, alternative A4 cannot in any case be chosen as optimal, by the evaluation criteria.

5. Sensitivity Analysis and Comparative Study

For any MCDM-related analysis, it is important to check the stability of the outcome as it is susceptible to changes in the given conditions [54, 55]. The paper analyzed the sensitivity of the Fuzzy MAIRCA method to changes in weight coefficients as one of the approaches to analyzing the sensitivity of results of the MCDM methods [56–60], through 15 scenarios (Figure 2).

The correlations of the obtained ranks by applying the proposed methodology on the mentioned scenarios were calculated using Spearman's rank correlation coefficient (S_{rcc}), which is calculated according to the following expression [61]:

$$S_{\text{rcc}} = 1 - \frac{6\sum_{i=1}^{m} D_i^2}{m\left(m^2 - 1\right)}, \quad -1 \le S_{\text{rcc}} \le 1, \tag{32}$$

where D_i represents the differences between the ranks [61], and m is number of alternatives.

By applying expression (32), the following values of the Spearman's coefficient (S_{rcc}) were obtained (Figure 3).

From the previous figure, it is concluded that the correlation coefficients in 15 scenarios generally tend towards an ideal positive correlation and that the defined MCDM model is mostly stable about the change in the weight coefficients. However, this should be taken into account when defining them by experts, because favoritism of one criterion directly affects the final choice of alternatives, which is also certified by the value of the Spearman's coefficient in scenario number six. High values of the Spearman's coefficient (0.9–1) indicate a high level of rank correlation. The ranks of alternatives A2 and A5 in scenario S1 underwent a slight change; that is, there was a change in the order of alternatives in the 3rd and 4th place. In scenarios S6–S15, there is a change in the place of the first-ranked and second-ranked alternative in relation to the initial ranking. In all scenarios, alternative A5 is ranked last; that is, its ranking does not change compared to the initial one, which indicates the fact that this alternative must not be chosen as optimal in any case.

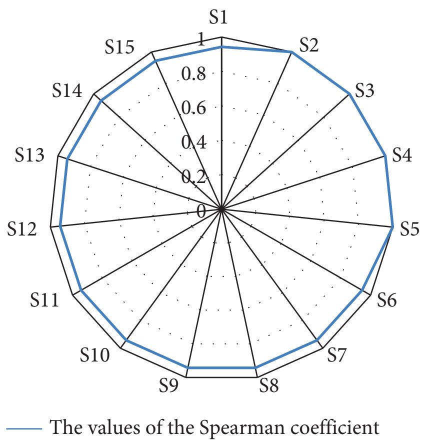

Figure 3: The values of the Spearman's coefficient.

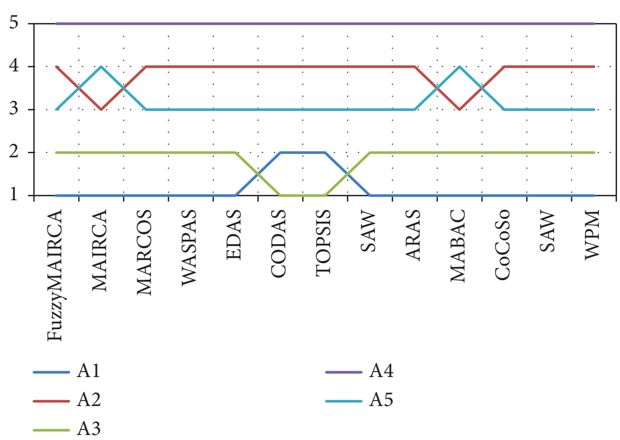

Figure 4: Comparison of results with other methods.

Furthermore, a comparison of the obtained results with the results obtained using other 12 methods was performed, which is shown in Figure 4.

From the previous picture, it can be concluded that the results of the Fuzzy MAIRCA method do not differ much from the results of other methods. They are mostly identical to the results of the presented methodology, and there are no big differences in the results obtained. In most cases, alternative A1 is ranked first, while in all cases, A4 is the last ranked alternative. Also, it can be concluded that the changes in the ranking of the alternatives in relation to the ranking obtained by the Fuzzy MAIRCA method occur in the case of alternatives A2 and A5 as the third ranked and fourth ranked in the MAIRCA and MABAC methods. The reasons for the differences between the Fuzzy MAIRCA method and the crisp MAIRCA method are precisely the improvement of the mentioned methodology, through the implementation of Fuzzy theory, which achieves compliance with the results of most other methods. Also, there are differences in the ranks of the first-ranked and second-ranked alternatives in the CODAS and TOPSIS methods, while in all other cases, the ranking of the alternatives is identical to the rank obtained by the Fuzzy MAIRCA method.

The scientific implications of this research are reflected in the fact that the proposed MCDM model provides stable results and enables the selection of an optimal strategy, which improves the current way of evaluating strategies in the defense system, which constitutes a practical implication of the paper, and enables further upgrading of the same, through the introduction of new areas that treat uncertainties well, as well as other methods for determining weighting coefficients of criteria and choosing the optimal alternative in future research.

6. Conclusions

As a powerful tool for long-term sustainable survival, organizations facing a complex and changing environment embrace strategic management. The concept of strategic management is based on a clearly defined vision, mission, and goals, which have resulted from a detailed analysis of expected changes in the environment.

Strategic management represents a process that includes all the functions of the scientific field of management, adapted to strategy as an output product and its specificities. The defense system recognized the importance of applying strategic management as a basic instrument for change management. The process of strategic management, in its third step, includes the formulation of a strategy. This is focused on the generation of different strategies from one area, their evaluation, and the selection of an optimal strategy from a set of proposed ones.

The aim of this research was to establish a model that would represent the improvement of the decision-making process when selecting an optimal strategy. This was done by implementing the MCDM method in the process of strategic management, with the application of other and new criteria for selection. Guided by the existing methods in the process of formulating the strategy, this study applied the model created according to the following methodology. First, the literature dealing with this area was analyzed, and the criteria and their importance were determined. After that, the weight coefficients of the criteria were obtained using the DIBR method, and the selection of the optimal alternative applying the Fuzzy MAIRCA method, using the level of experts' confidence in the claims when evaluating the alternatives (strategies). By applying the degree of confidence, imprecise qualitative information was transformed into precise quantitative information, using fuzzy theory and fuzzy numbers.

By analyzing the sensitivity of this model, it was confirmed that the Fuzzy MAIRCA method shows good stability of output results and that the model is viable and applicable in practice. Special attention must be paid to the definition of weight coefficients by experts because the defined model is sensitive to changes in them. Also, the results obtained by comparing the results of the Fuzzy MAIRCA method with the results of 12 other methods indicate the fact that the presented methodology provides valid results.

The main limitation of this research is related to the insufficient treatment of uncertainty in the DIBR method, which will be worked on in the future through the implementation of Fuzzy, gray, rough, or other similar theories. Also in future research, the proposed model will be improved by further elaboration of the criteria and the application of other MCDM methods for choosing the optimal alternative from the set of proposed ones, as well as the application of other theories that treat imprecision and uncertainty well. The application of the mentioned MCDM model is possible in all areas of human life, such as for the selection of public policies in different areas, optimal machines for carrying out construction works, suppliers, drones for different purposes, boat sailing directions, different locations, and different means of transport.

Data Availability

The data used to support the findings of this study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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