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Development of the rough Defining Interrelationships Between Ranked criteria II method and its application in the MCDM model

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Abstract

Although numerous methods of multi-criteria decision-making have been developed so far, there are still those that have not been improved by different theories that deal well with uncertainties and inaccuracies that are a normal occurrence in everyday life. The goal of this research is the development of the Rough Defining Interrelationships Between Ranked Criteria II (Rough DIBR II) method and the presentation of its application in the multi-criteria decision-making (MCDM) problem, specifically in human resource management (HRM). The paper presents the subject-developed method and its practical application in the MCDM model with the Rough Additive Ratio Assessment (Rough ARAS) method. In order to check the consistency and validity of the proposed methodology, a sensitivity analysis and a comparative analysis were performed. The conclusions of this research indicate a stable and valid proposed methodology, as well as the possible application of the Rough DIBR II method for defining weighting coefficients of criteria in real-life decision-making problems.

Keywords: Rough DIBR II, Rough ARAS, MCDM, HRM.

1. Introduction

In the field of MCDM, various methods have been developed so far both for determining the weight coefficients of the criteria and for choosing the optimal alternative (Sahoo et al., 2024). One of the developed methods for determining the weights of criteria is DIBR II. This method is based on determining the importance of adjacent ranked criteria by decision makers or experts (Božanić and Pamucar, 2023). The method is implemented as follows: first, the criteria are ranked according to importance, then the relationships between neighboring criteria are defined and based on the mathematical apparatus, the calculation of the most important criteria is performed first, and then the others, while at the end the quality of the defined relationships is checked (Božanić and

Pamucar, 2023). This approach eliminates certain shortcomings of the previous methods that were used to calculate the weight coefficients of the criteria and is a flexible and reliable tool that can be adapted to different situations. The application of the DIBR II method is shown in various papers. The authors in (Tešić et al., 2023a) select a boat for the needs of conducting military operations, using the DIBR II-BM-CoCoSo MCDM model. The method was also used to determine the weights of the criteria in the military field, specifically for the selection of a complex combat system, in the model with the DIBR method and NWBM and BM operators (Tešić and Marinković, 2023). The application of the mentioned method for the selection of a pontoon park for overcoming water obstacles in the army, in a model with the NWBM operator and the Fermatean fuzzy MAIRCA method, is shown in (Tešić et al., 2023b), while its application for determining weight coefficients of criteria in logistics with the Rough MABAC method was carried out in (Božanić et al., 2024). In order to better treat inaccuracy, incomplete data and uncertainty when making decisions, the method has been improved so far using Fuzzy and Grey theory. The implementation of triangular fuzzy numbers in the subject method was carried out in (Tešić et al., 2024a), and its use is shown on the problem of defining criteria weights when evaluating sustainable mobility measures, while the improvement of the method using spherical fuzzy numbers is shown on the problem of evaluation of the sustainability performance of wind power plants (Kara et al., 2024), in the model with the AROMAN method. The application of interval grey numbers in this method is shown in (Tešić et al., 2024b). As can be concluded from the previous analysis of the literature, rough theory was not implemented in the DIBR II method.

So far, many methods have been improved using rough numbers. During the evaluation of customer requirements in Quality Function Deployment, the Rough AHP method was presented to define the weights of the criteria (Wang and Xiong, 2010), while Badi and Abdulshahe (2021) apply this method in industry. The implementation of rough numbers in the WASPAS method, for the purposes of supplier selection, is presented in (Stojić et al., 2018). The Rough MABAC method was used in (Pamučar et al., 2018) for the evaluation of university websites. Arsić et al. (2019) select dishes for the needs of the restaurant. Authors in (Tešić et al., 2022) apply the Rough DIBR method for defining the weight coefficients of the criteria when choosing an anti-tank missile system. The application of Rough BWM and Rough SAW methods is shown on the problem of choosing railway wagons (Stević et al., 2017). The integration of rough numbers in the TOPSIS method is given in (Song et al., 2014), where it was applied to evaluate the risk of failure mode. Application of Rough theory, specifically interval rough numbers in the CODAS method, is presented in (Regaieg Cherif and Moalla Frikha, 2021), where the authors performed a risk assessment in the gas supply process. The application of the Rough SWARA method in logistics is shown in the model with the COPRAS method (Rosiana et al., 2021). Application of the Rough ARAS method for evaluating measured performance indicators for the needs of transportation companies is presented in (Radović et al., 2018). Qi et al. (2021) selects a design concept using Rough VIKOR, etc. All previously mentioned methods have been improved to better treat uncertainties, insecurities and inaccuracies in input data, when making different decisions.

In order to treat limited or imprecise data well and save as much information as possible from incomplete data, the goal of this research is to implement the rough theory in the DIBR II method and its application for determining the weights of criteria on a real-life problem and specifically on the problem of evaluation of military personal in the MCDM model with the Rough ARAS method, based on existing research (Costa et al., 2022).

The application of MCDM methods for HRM is presented in numerous articles (Stević et al., 2023; Akmaludin et al., 2023; Yenilmezel and Ertuğrul, 2024; etc.). In the military sphere, a greater number of research in this area is also noticeable (Tešić et al., 2023c; Fanaei et al., 2023; Abdillah et al., 2023; etc.). The implementation of MCDM methods in the decision-making process in the field of human resources management gave a new quality.

2. Materials and methods

In the rest of the text, a brief description of rough numbers and their arithmetic operations is given, as well as the developed Rough DIBR II method, with all its application steps, is presented. Also, a brief description of the existing Rough ARAS method is given. In Figure 1, the algorithm of the proposed MCDM model is presented.

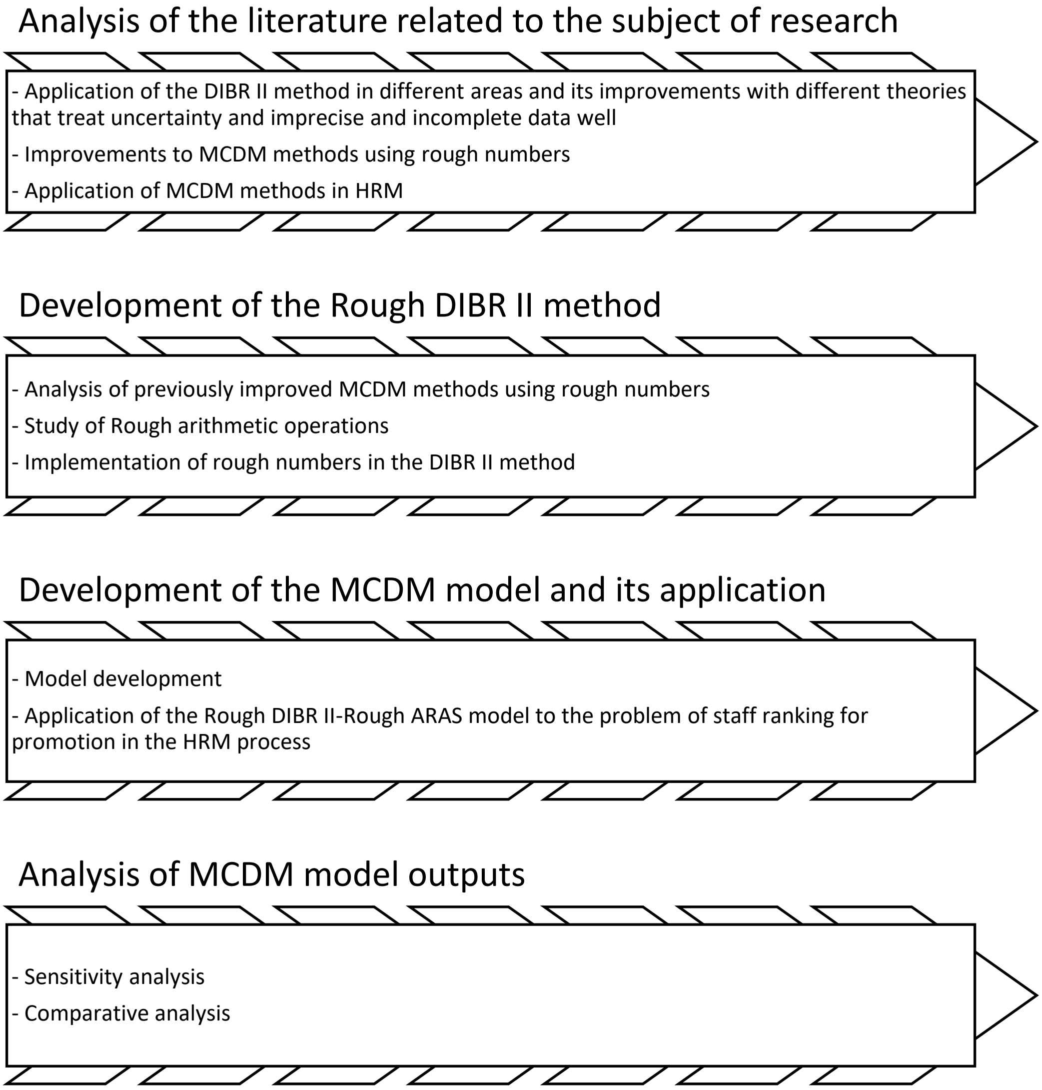

Figure 1. Algorithm of the proposed MCDM model

2.1 Preliminaries

The basic principles of the rough theory were given by the Polish scientist Zdzislaw Pawlak (Pawlak, 1982; Pawlak, 2005), in order to treat vagueness in the data. The basic approximation of this set is a rough number. Let $RN(\omega)=\left[\underline{\omega},\overline{\omega}\right]$ is a rough number. Value $\underline{\omega}$ indicates its lower limit, while value $\overline{\omega}$ represents its upper limit. In addition to the above limits, the rough number has a rough boundary region that can be represented as $BR\left[RN(\omega)\right]=\overline{\omega}-\underline{\omega}$ (Pawlak, 2005). Application of rough numbers requires knowledge of basic arithmetic operations with them, which are given below. Let $RN(\omega)=\left[\underline{\omega},\bar{\omega}\right]$ and $RN(\upsilon)=\left[\underline{\upsilon},\bar{\upsilon}\right]$ be two rough numbers (Zhu et al. 2015):

1) Addition (+):

$$RN(\omega)+RN(\upsilon)=\left[\underline{\omega}+\underline{\upsilon},\ \bar{\omega}+\bar{\upsilon}\right] \tag{1}$$

2) Subtracting (-)

$$RN(\omega)-RN(\upsilon)=\left[\underline{\omega}-\bar{\upsilon},\ \bar{\omega}-\underline{\upsilon}\right] \tag{2}$$

3) Multiplication ($\bullet$)

$$RN(\omega)\bullet RN(\upsilon)=\left[\underline{\omega}\bullet\underline{\upsilon},\ \bar{\omega}\bullet\bar{\upsilon}\right] \tag{3}$$

4) Dividing (/)

$$RN(\omega)/RN(\upsilon)=\left[\underline{\omega}/\bar{\upsilon},\ \bar{\omega}/\underline{\upsilon}\right] \tag{4}$$

5) Scalar multiplication ($s>0$)

$$s\bullet RN(\omega)=\left[s\bullet\underline{\omega},\ s\bullet\bar{\omega}\right] \tag{5}$$

Converting a rough number $RN(\omega_j)=\left[\underline{\omega}_j,\bar{\omega}_j\right]$ into a crisp number is done by applying Eqs. (6)-(8) (Tešić et al., 2022; Roy et al., 2018):

$$RN(\omega_j)=\left[\underline{\omega}_j,\bar{\omega}_j\right]=\left\{\begin{array}{l} \underline{\omega}_j=\dfrac{\underline{\omega}_j-\min\limits_i\left\{\underline{\omega}_j\right\}}{\max\limits_i\left\{\bar{\omega}_j\right\}-\min\limits_i\left\{\underline{\omega}_j\right\}} \\ \bar{\omega}_j=\dfrac{\bar{\omega}_j-\min\limits_i\left\{\underline{\omega}_j\right\}}{\max\limits_i\left\{\bar{\omega}_j\right\}-\min\limits_i\left\{\underline{\omega}_j\right\}} \end{array}\right\} \tag{6}$$

$$\omega_j^{N}=\frac{\underline{\omega}_j\bullet\left\{1-\underline{\omega}_j\right\}+\bar{\omega}_j\bullet\bar{\omega}_j}{1-\underline{\omega}_j+\bar{\omega}_j} \tag{7}$$

$$\omega_j^{crisp}=\min_i\left\{\underline{\omega}_j\right\}+\omega_j^{N}\bullet\left[\max_i\left\{\bar{\omega}_j\right\}-\min_i\left\{\underline{\omega}_j\right\}\right] \tag{8}$$

2.2 Rough DIBR II

The steps of the Rough DIBR II method are given below.

Step 1: Defining a set of a total of c criteria $C=\left\{C_1,C_2,...,C_c\right\}$ and determining their significance $C_1>C_2>...>C_c$.

Step 2: Defining the relationship between the criteria ($RN(\Delta_{c-1,c})$).

$$RN(\omega_1):RN(\omega_2)=RN(\Delta_{1,2}):1\mapsto\frac{RN(\omega_1)}{RN(\omega_2)}=RN(\Delta_{1,2}) \tag{9}$$

$$RN(\omega_2):RN(\omega_3)=RN(\Delta_{2,3}):1\mapsto\frac{RN(\omega_2)}{RN(\omega_3)}=RN(\Delta_{2,3}) \tag{10}$$

…

$$RN(\omega_{c-1}):RN(\omega_c)=RN(\Delta_{c-1,c}):1\mapsto\frac{RN(\omega_{c-1})}{RN(\omega_c)}=RN(\Delta_{c-1,c}) \tag{11}$$

$$RN(\omega_1):RN(\omega_c)=RN(\Omega_{1,c}):1\mapsto\frac{RN(\omega_1)}{RN(\omega_c)}=RN(\Delta_{1,c}) \tag{12}$$

where $RN(\omega_j),\ j=1,2,...,c$ represents the rough value of the weight coefficient of the criterion.

Step 3: Determining the relationship between the most significant and other criteria, Eqs. (13)-(15).

$$RN(\omega_2)=\frac{RN(\omega_1)}{RN(\Delta_{1,2})} \tag{13}$$

$$RN(\omega_3)=\frac{RN(\omega_1)}{RN(\Delta_{1,2})\bullet RN(\Delta_{2,3})} \tag{14}$$

...

$$RN(\omega_c)=\frac{RN(\omega_1)}{RN(\Delta_{1,2})\bullet RN(\Delta_{2,3})\bullet...\bullet RN(\Delta_{c-1,c})} \tag{15}$$

Step 4: Defining the rough value of the most significant criterion, Eq. (16).

$$RN(\omega_1)=\frac{1}{1+\frac{1}{RN(\Delta_{1,2})}+\frac{1}{RN(\Delta_{1,2})\bullet RN(\Delta_{2,3})}+\cdots+\frac{1}{RN(\Delta_{1,2})\bullet RN(\Delta_{2,3})\bullet\ldots\bullet RN(\Delta_{c-1,c})}} \tag{16}$$

Step 5: Determination of weight coefficients of other criteria, Eqs. (5)-(7).

Step 6: Converting the obtained rough values of the criteria weights $RN(\omega_j)=\left[\underline{\omega}_j,\bar{\omega}_j\right]$ into crisp values ω_j^{crisp}, using the Eqs. (6)-(8).

Step 7: Checking the quality of the defined relationships between the criteria. It is performed by calculating the control value (ω_c^L) and deviation values (K_c), using Eqs. (17)-(18).

$$K_c=\left|1-\frac{\omega_c}{\omega_c^L}\right| \tag{17}$$

$$\omega_c^L=\frac{\omega_1}{\Delta_{1,c}} \tag{18}$$

If the value of the deviation satisfies the condition that $0\le K_c\le 0.1$, it can be concluded that the relations between the criteria are well defined. Otherwise, it is necessary to redefine the relations.

2.3 Rough ARAS

The ARAS method was developed to evaluate different alternatives based on defined criteria in different areas (Zavadskas and Turskis, 2010) and so far it has been improved by different theories (Turskis and Zavadskas, 2010a; Turskis and Zavadskas, 2010b) The improved method used in this research uses rough numbers to reduce subjectivity and uncertainty in the decision-making process. The method consists of seven steps, including model formation, data normalization, weighting of normalized values, and ranking of alternatives, based on the degree of utility. Rough ARAS enables more accurate decision-making and reduces uncertainty compared to the classic (crisp) method. More about the method, can be seen in (Radović et al., 2018).

3. Application of the MCDM model

In the management of human resources in a military organization, it is very often necessary to evaluate and rank employees, both for promotion and for other opportunities. In order to perform the subject ranking, it is necessary to define the criteria. For the purpose of demonstrating the application of the MCDM model, the criteria identified in the existing research were used (Costa et al., 2022): C_1-Professional profile, C_2-Moral profile, C_3-Social profile, and C_4-Character. All criteria are benefit type. The authors of the mentioned research gave a detailed description of each of the criteria, so they will not be described here. Also, in the previously mentioned conducted research, the evaluation of alternatives is performed based on the satisfaction of the sub-criteria defined, which is not the subject of this research. In order to illustrate the application of the proposed methodology, a set of alternatives (officers who need to be ranked for promotion) was created $OF_i = \left(OF_1, OF_2, ..., OF_5\right)$. A linguistic scale was defined for the assessment of alternatives according to each criterion (Table 1).

Table 1. Linguistic scale for evaluating alternatives according to each criterion

Comparison of criteria	Rough value
Absolutely not satisfactory (ANS)	[0, 1]
It does not satisfy (DNS)	[1, 2]
Partially unsatisfactory (PUS)	[2, 5]
Partially satisfying (PSA)	[5, 8]
Satisfies (SAT)	[8, 9]
Absolutely satisfying (ASA)	[9, 10]

For the purposes of this research, for defining criteria weights, five experts from the field were engaged. The experts agreed that the significance of the criteria $C_1 > C_2 > ... > C_5$. After that, each of the experts compared the criteria by significance, and the comparison values ($\Delta_{c-1,c}$) are given in Table 2.

Table 2. Criteria comparison values for each of the experts

Comparison of criteria	E1	E2	E3	E4	E5
C_1-C_2	1.10	1.10	1.20	1.10	1.00
C_2-C_3	1.60	1.50	1.60	1.50	1.70
C_3-C_4	1.75	1.80	1.70	1.80	1.70
C_1-C_4	3.10	3.20	3.50	3.20	3.10

Based on the values from Table 1, aggregated rough comparison values were formed ($RN(\Delta_{c-1,c})$), in such a way that the lowest value of the comparison of the criteria given by the experts is the lower limit, while the highest is the upper limit of the rough number. Rough comparison values are presented in Table 3.

Table 3. Rough comparison values

Comparison of criteria	$RN(\Delta_{c-1,c})$
C_1-C_2	[1.0, 1.2]
C_2-C_3	[1.5, 1.7]
C_3-C_4	[1.7, 1.8]
C_1-C_4	[3.1, 3.5]

By applying the steps of the Rough DIBR II method, the following values of criteria weights are reached, Table 4.

Table 4. Rough values of citeria weights

Comparison of criteria	$RN(\omega_j)$
C$_1$	[0.327, 0.385]
C$_2$	[0.272, 0.385]
C$_3$	[0.160, 0.257]
C$_4$	[0.089, 0.151]

By applying the expressions (6)-(8), the crisp values of the weight coefficients of the criteria are obtained (Table 5).

Table 5. Crisp values of citeria weights

Comparison of criteria	ω_j
C$_1$	0.364329
C$_2$	0.343460
C$_3$	0.195441
C$_4$	0.096771

The mentioned weight coefficients (Table 5), together with the evaluations of the alternatives according to each criterion, based on the linguistic scale (Table 1), were entered into the initial decision-making matrix (Table 6).

Table 6. The initial decision-making matrix

Alternative	**C$_1$**	**C$_2$**	**C$_3$**	**C$_4$**
w$_j$	[0.327, 0.385]	[0.272, 0.385]	[0.16, 0.257]	[0.089, 0.151]
OF$_1$	SAT	PSA	ASA	ASA
OF$_2$	ASA	PSA	PSA	PUS
OF$_3$	PSA	ASA	PUS	PSA
OF$_4$	SAT	PSA	ASA	PUS
OF$_5$	ASA	PSA	PUS	ASA
Type	Benefit	Benefit	Benefit	Benefit

By converting the linguistic descriptors into rough values based on Table 1, the following rough initial decision matrix is obtained (Table 7).

Table 7. The rough initial decision-making matrix

Alternative	**C$_1$**	**C$_2$**	**C$_3$**	**C$_4$**
w$_j$	[0.327, 0.385]	[0.272, 0.385]	[0.16, 0.257]	[0.089, 0.151]
OF$_1$	[8, 9]	[5, 8]	[9, 10]	[9, 10]
OF$_2$	[9, 10]	[5, 8]	[5, 8]	[2, 5]
OF$_3$	[5, 8]	[9, 10]	[2, 5]	[5, 8]
OF$_4$	[8, 9]	[5, 8]	[9, 10]	[2, 5]
OF$_5$	[9, 10]	[5, 8]	[2, 5]	[9, 10]
Type	Benefit	Benefit	Benefit	Benefit

By applying the steps of the Rough ARAS method, the next rank of alternatives is reached (Table 8).

Table 8. Rank of defined alternatives

Alternative	Rough values of the degree of utility	Crisp values of the degree of utility	Rank
OF_1	[0.475, 1.546]	1.011	1
OF_2	[0.404, 1.418]	0.911	4
OF_3	[0.371, 1.371]	0.871	5
OF_4	[0.428, 1.436]	0.932	2
OF_5	[0.414, 1.415]	0.915	3

Given that the values are $\omega_c^L = 0.106$ and $K_c = 0.085$, and that is $0 \le K_c \le 0.1$, it can be concluded that the relationships between the criteria are well defined. Based on the data from Table 8, it can be seen that alternative OF_1 is ranked best, while alternative OF_3 is ranked last. Depending on the number of officers who need to be promoted, the obtained rank will be respected, so if three officers need to be promoted, the officers OF_1, OF_4 and OF_5 will be promoted. It is important to note that in a real situation five alternatives will not be ranked, but a much larger number. This number of alternatives is given only as an example of the application of the MCDM model.

4. Analysis of output results

Determining the consistency and validity of the proposed methodology was carried out using sensitivity analysis and comparative analysis. In order to check the consistency of the output results, a sensitivity analysis was performed (Kannan et al., 2025; Biswas et al., 2025a; Biswas et al., 2025b; etc.). The subject analysis was carried out using 20 scenarios of changes in criteria weights (Figure 2). Marks "L" and "U" in the Figure 2, indicate the lower and upper limits of the rough number, respectively.

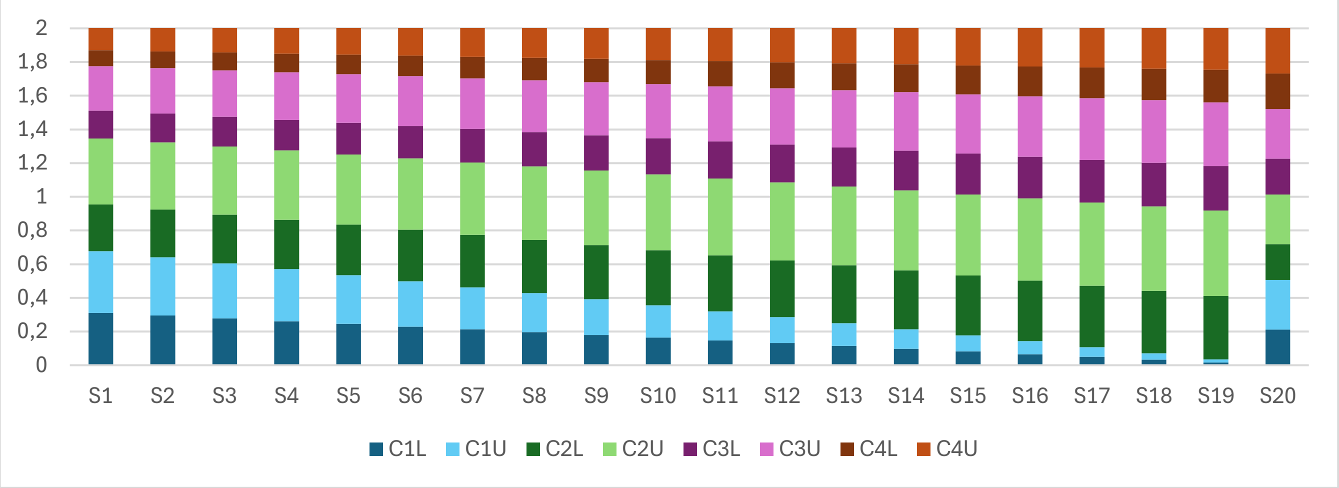

Figure 2. Scenarios of changing criteria weights

By applying the mentioned scenarios in the Rough ARAS method, the ranks of the alternatives were obtained, shown in Figure 3.

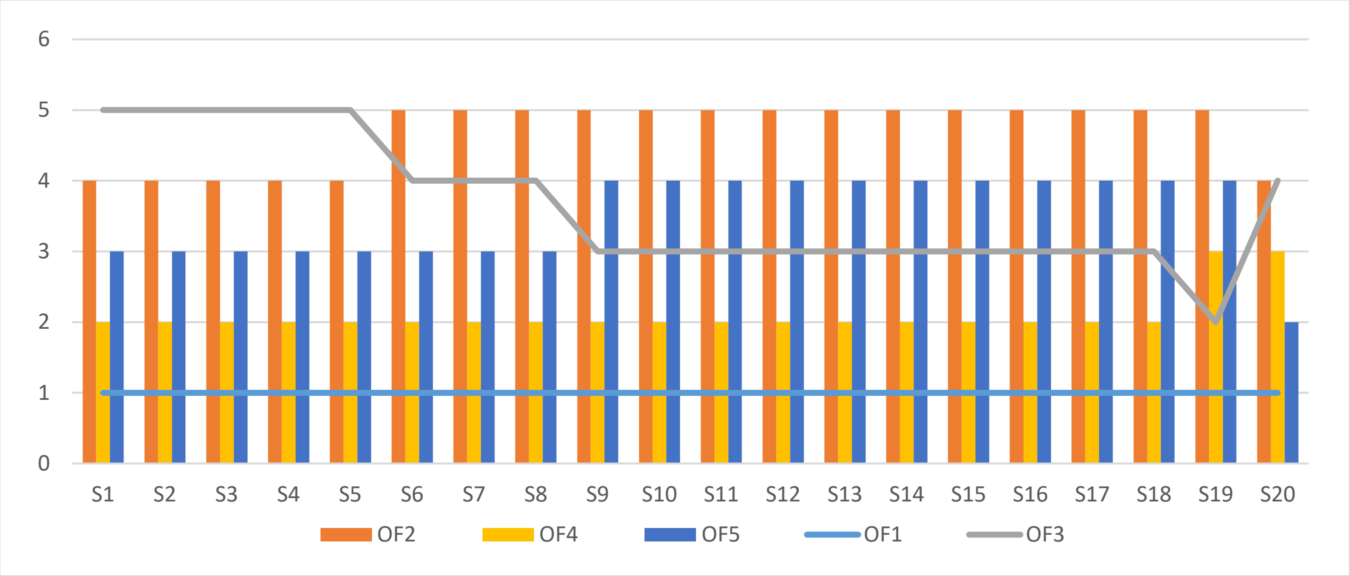

Figure 3. Rankings of the alternatives after applying the scenarios

The results of the sensitivity analysis support the consistency of the proposed methodology. Alternative OF1 is ranked first in all cases, which speaks in favor of the strength of this alternative according to all criteria, while there are changes in the ranking of the other alternatives. Therefore, it is necessary to take special care when defining the weight coefficients of the criteria (Bouraima et al., 2024).

In order to validate the output results of the methodology, a comparative analysis (Biswas et al., 2024; Nedeljković et al., 2023) was performed, with the aim of comparing the results obtained by the proposed methodology with the results obtained by other methods (Madić et al., 2024). The results of the proposed methodology are compared with the results of methods Rough CRADIS (Puška et al., 2023), Rough TOPSIS (Song et al., 2014), Rough SAW (Stević et al., 2017) and Rough MARCOS (Vojinović et al., 2021). In Figure 4, the ranks of the alternatives for each of the methods are shown.

Figure 4. Rankings of the alternatives for each of the methods.

As can be concluded from Figure 4, the proposed model is valid, that is, the results obtained with the Rough MARCOS and Rough SAW methods are identical to the results of the proposed methodology, while with the Rough CRADIS and Rough TOPSIS methods, the third-ranked and fourth-ranked alternative change places, in relation to the results of this research.

5. Conclusions

The aim of this paper is to improve the DIBR II method for determining the weight coefficients of criteria, in situations where the input data are imprecise and incomplete, as well as to demonstrate its application in the MCDM model to a real-life problem. Based on previous research in the field of MCDM, especially the Rough theory and its implementation in other methods, the Rough DIBR II method was developed.

In order to demonstrate the application of this method in a real-life example, the Rough DIBR II-Rough ARAS model was created for ranking military personnel for promotion, based on criteria taken from existing research. Using the Rough DIBR II method, the weight coefficients of each criterion were defined. By further implementing the specified weights of the criteria in the Rough ARAS method and evaluating the five defined alternatives according to each of the criteria, the final ranking of the alternatives was reached.

To check the stability and validity of the model, sensitivity analysis and comparative analysis were performed. The results of the analysis of the sensitivity to changes in the weight coefficients of the criteria speak in favor of the consistency of the output results of the methodology, as well as the need to take care when defining the weights of the criteria. A comparative analysis was carried out by comparing the results of the proposed methodology with the results of four other methods in which rough numbers were implemented. The results of this analysis indicate the validity of the proposed methodology.

Given that the DIBR II method was successfully applied to the problem of personnel ranking in the field of HRM, it can be concluded that it is applicable in real-life situations and that it copes well with the problems of incompleteness and inaccuracy in input data. Also, in future research, the mentioned method will be applied to other decision-making problems, in order to further confirm its applicability in real situations.

References

Abdillah, A. I. J., Rimbawa, H. D., & Asnar, Y. (2023). Evaluation of the determination of it infrastructure personnel in the AL navy using a combination of AHP and VIKOR methods. Antivirus: Jurnal Ilmiah Teknik Informatika, 17(1), 144-154.

Akmaludin, A., Sihombing, E. G., Dewi, L. S., & Arisawati, E. (2023). Comparison of Selection for Employee Position Recommended MCDM-AHP, SMART and MAUT Method. Sinkron: jurnal dan penelitian teknik informatika, 7(2), 603-616.

Arsić, S. N., Pamučar, D., Suknovic, M., & Janošević, M. (2019). Menu evaluation based on rough MAIRCA and BW methods. Serbian journal of management, 14(1), 27-48.

Badi, I., & Abdulshahed, A. (2021). Sustainability performance measurement for Libyan Iron and Steel Company using Rough AHP. Journal of Decision Analytics and Intelligent Computing, 1(1), 22-34.

Biswas, A., Gazi, K. H., Bhaduri, P., & Mondal., S. P. (2025a). Site Selection for Girls Hostel in a University Campus by MCDM based Strategy. Spectrum of Decision Making and Applications, 2(1), 68-93.

Biswas, A., Gazi, K. H., Sankar, P. M., & Ghosh, A. (2025b). A Decision-Making Framework for Sustainable Highway Restaurant Site Selection: AHP-TOPSIS Approach based on the Fuzzy Numbers. Spectrum of Operational Research, 2(1), 1-26.

Biswas, S., Pamucar, D., Dawn, S., & Simic, V. (2024). Evaluation based on Relative Utility and Nonlinear Standardization (ERUNS) Method for Comparing Firm Performance in Energy Sector. Decision Making Advances, 2(1), 1-21.

Bouraima, M. B., Jovčić, S., Dobrodolac, M., Pamucar, D., Badi , I., & Maraka, N. D. (2024). Sustainable Healthcare System Devolution Strategy Selection Using the AROMAN MCDM Approach. Spectrum of Decision Making and Applications, 1(1), 46-63.

Božanić, D., & Pamucar, D. (2023). Overview of the Method Defining Interrelationships Between Ranked Criteria II and Its Application in Multi-criteria Decision-Making. In: Chatterjee, P., Pamucar, D., Yazdani, M., & Panchal, D. (eds) Computational Intelligence for Engineering and Management Applications. Lecture Notes in Electrical Engineering, vol 984. Singapore: Springer.

Božanić, D., Epler, I., Puška, A., Biswas, S., Marinković, D. & Koprivica, S. (2024). Application of the DIBR II – Rough MABAC decision-making model for ranking methods and techniques of Lean organization systems management in the process of technical maintenance. Facta Universitatis. Series: Mechanical Engineering, 22(1), 101-123.

Costa, I. P. D. A., Terra, A. V., Moreira, M. Â. L., Pereira, M. T., Fávero, L. P. L., Santos, M. D., & Gomes, C. F. S. (2022). A systematic approach to the management of military human resources through the ELECTRE-MOr multicriteria method. Algorithms, 15(11), 422.

Fanaei, S., Zareiyan, A., Shahraki, S., & Mirzaei, A. (2023). Determining the key performance indicators of human resource management of military hospital managers; a TOPSIS study. BMC Primary Care, 24(1), 47.

Kannan, J., Jayakumar, V., & Pethaperumal, M. (2024). Advanced Fuzzy-Based Decision-Making: The Linear Diophantine Fuzzy CODAS Method for Logistic Specialist Selection. Spectrum of Operational Research, 2(1), 41-60.

Kara, K., Yalçın, G. C., Simic, V., Yıldırım, A. T., Pamucar, D., & Siarry, P. (2024). A spherical fuzzy-based DIBR II-AROMAN model for sustainability performance benchmarking of wind energy power plants. Expert systems with applications, 253, 124300.

Madić, M., Petrović, G., Petković, D., & Janković, P. (2024). Traditional and Integrated MCDM Approaches for Assessment and Ranking of Laser Cutting Conditions. Spectrum of Mechanical Engineering and Operational Research, 1(1), 250-257.

Nedeljković, M., Puška, A., Jeločnik, M., Božanić, D., Subić, J., Štilić, A., & Maksimović, A. (2023). Enhancing Fruit Orchard Establishment: A Multicriteria Approach for Plum Variety Selection. Yugoslav Journal Of Operations Research, 34(2), 355-380.

Pamučar, D., Stević, Ž., & Zavadskas, E. K. (2018). Integration of interval rough AHP and interval rough MABAC methods for evaluating university web pages. Applied soft computing, 67, 141-163.

Pawlak, Z. (1982). Rough sets. International Journal of Information and Computer Sciences, 11(5), 341-356.

Pawlak, Z. (2005). Rough sets. International Journal of Computer & Information Sciences, 11, 341-356.

Puška, A., Štilić, A., Božanić, D., Đurić, A., & Marinkovic, D. (2023). Selection of EVs as Tourist and Logistic Means of Transportation in Bosnia and Herzegovina's Nature Protected Areas Using Z-Number and Rough Set Modeling. Discrete Dynamics in Nature and Society, 2023(1), 5977551.

Qi, J., Hu, J., & Peng, Y. (2021). Modified rough VIKOR based design concept evaluation method compatible with objective design and subjective preference factors. Applied Soft Computing, 107, 107414.

Radović, D., Stević, Ž., Pamučar, D., Zavadskas, E. K., Badi, I., Antuchevičiene, J., & Turskis, Z. (2018). Measuring performance in transportation companies in developing countries: a novel rough ARAS model. Symmetry, 10(10), 434.

Regaieg Cherif, M., & Moalla Frikha, H. (2021). An extension of the CODAS method based on interval rough numbers for multi-criteria group decision making. Multiple Criteria Decision Making, 16, 23-43.

Rosiana, E., Garside, A. K., & Amallynda, I. (2021). Integration of Rough SWARA and COPRAS in the Performance Evaluation of Third-Party Logistics Providers. Jurnal Teknik Industri, 22(1), 31-42.

Roy, J., Adhikary, K., Kar, S., & Pamucar, D. (2018). A rough strength relational DEMATEL model for analysing the key success factors of hospital service quality. Decision Making: Applications in Management and Engineering, 1(1), 121-142.

Sahoo, S. K., Choudhury, B. B., & Dhal, P. R. (2024). A Bibliometric Analysis of Material Selection Using MCDM Methods: Trends and Insights. Spectrum of Mechanical Engineering and Operational Research, 1(1), 189-205.

Song, W., Ming, X., Wu, Z., & Zhu, B. (2014). A rough TOPSIS approach for failure mode and effects analysis in uncertain environments. Quality and Reliability Engineering International, 30(4), 473-486.

Stević, Ž., Novarlić, B., & Kchaou, M. (2023). Assessment of human resources performance in urban maintenance tasks: An MCDM approach. Journal of Organizations, Technology and Entrepreneurship, 2(1), 39-51.

Stević, Ž., Pamučar, D., Kazimieras Zavadskas, E., Ćirović, G., & Prentkovskis, O. (2017). The selection of wagons for the internal transport of a logistics company: A novel approach based on rough BWM and rough SAW methods. Symmetry, 9(11), 264.

Stojić, G., Stević, Ž., Antuchevičienė, J., Pamučar, D., & Vasiljević, M. (2018). A Novel Rough WASPAS Approach for Supplier Selection in a Company Manufacturing PVC Carpentry Products. Information, 9(5), 121.

Tešić, D., & Marinković, D. (2023). Application of fermatean fuzzy weight operators and MCDM model DIBR-DIBR II-NWBM-BM for efficiency-based selection of a complex combat system. Journal of Decision Analytics and Intelligent Computing, 3(1), 243-256.

Tešić, D., Božanić, D., & Khalilzadeh, M. (2024a). Enhancing Multi-Criteria Decision-Making with Fuzzy Logic: An Advanced Defining Interrelationships Between Ranked II Method Incorporating Triangular Fuzzy Numbers. Journal of intelligent management decision, 3(1), 56-67.

Tešić, D., Božanić, D., & Khalilzadeh, M. (2024b). Enhancement of the Defining Interrelationships Between Ranked Criteria II method using interval grey numbers for application in the grey-rough MCDM Model. International Journal of Knowledge and Innovation Studies, 2(2), 81-91.

Tešić, D., Božanić, D., Radovanović, M., & Petrovski, A. (2023a). Optimising Assault Boat Selection for Military Operations: An Application of the DIBR II-BM-CoCoSo MCDM Model. Journal of Intelligent Management Decision, 2(4), 160-171.

Tešić,D., Božanić, D., & Milić, A. (2023b). A Multi-Criteria Decision-Making Model for Pontoon Bridge Selection: An Application of the DIBR II-NWBM-FF MAIRCA Approach. Journal of Engineering Management and Systems Engineering, 2(4), 212-223.

Tešić, D., Delibašić, B., Božanić, D., Lojić, R., Pamučar, D., & Balassa, B. E. (2023c). Application of the FUCOM-Fuzzy MAIRCA Model in Human Resource Management. Acta Polytechnica Hungarica, 20(3), 231-249.

Tešić, D., Radovanović, M., Božanić, D., Pamucar, D., Milić, A., & Puška, A. (2022). Modification of the DIBR and MABAC methods by applying rough numbers and its application in making decisions. Information, 13(8), 353.

Turskis, Z., & Zavadskas, E. K. (2010a). A new fuzzy additive ratio assessment method (ARAS-F). Case study: The analysis of fuzzy multiple criteria in order to select the logistic centers location. Transport, 25(4), 423-432.

Turskis, Z., & Zavadskas, E. K. (2010b). A novel method for multiple criteria analysis: grey additive ratio assessment (ARAS-G) method. Informatica, 21(4), 597-610.

Vojinović, N., Sremac, S., & Zlatanović, D. (2021). A Novel Integrated Fuzzy-Rough MCDM Model for Evaluation of Companies for Transport of Dangerous Goods. Complexity, 2021(1), 5141611.

Wang, X. T., & Xiong, W. (2010). Rough AHP approach for determining the importance ratings of customer requirements in QFD. Computer Integrated Manufacturing System, 16(04), 763-771.

Yenilmezel, S., & Ertuğrul, İ. (2024). Human Resources Management Application Selection with fuzzy MAIRCA Method Based on fuzzy PIPRECIA. Pamukkale Üniversitesi İşletme Araştırmaları Dergisi, 11(1), 67-81.

Zavadskas, E. K., & Turskis, Z. (2010). A new additive ratio assessment (ARAS) method in multicriteria decision-making. Technological and economic development of economy, 16(2), 159-172.

Zhu, G.-N., Hu, J., Qi, J., Gu, C.-C., & Peng, Y.-H. (2015). An integrated AHP and VIKOR for design concept evaluation based on rough number. Advanced Engineering Informatics, 29(3), 408-418.