ISSN 1392-3730/eISSN 1822-3605

VILNIUS TECH
Vilnius Gediminas Technical University

JOURNAL of CIVIL ENGINEERING and MANAGEMENT

2026
Volume 32
Issue 6
Pages 886–903
https://doi.org/10.3846/jcem.2026.27816

# COMPARATIVE APPLICATION OF MULTICRITERIA DECISION MAKING/ANALYSIS (MCDM/MCDA) METHODS FOR THE EVALUATION OF PROJECT SUCCESS

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**Article History:**
- received 21 April 2026
- accepted 15 May 2026

**Abstract.** The application of multicriteria decision making/analysis (MCDM/MCDA) methods is widespread for resolving important decision-making problems in the engineering sciences. The main objective of this article is the comparison of prominent MCDM/MCDA methods for the evaluation/assessment of project success. Twenty (20) completed projects are evaluated against seventeen (17) success criteria using a web-based application by ten (10) experts and professionals in the construction sector of Greece. Subsequently, the ten (10) established MCDM/MCDA methods are applied, leading to the final ranking of the twenty (20) examined projects, and the results are compared using Spearman's correlation coefficient. The extracted results demonstrate remarkable deviations in the final rankings mainly justified by the designation of the evaluation criteria and the adoption of different implementation processes. Additionally, the correlation analysis indicates high statistical significance and very strong correlations between the applied MCDM/MCDA methods. Future research should focus on other prominent MCDM/MCDA methods obtaining empirical data from a larger number of projects.

**Keywords:** multicriteria decision-making (MCDM), multicriteria decision analysis (MCDA), project success, project success evaluation, project success assessment, success criteria (SC), civil engineering, construction.

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## 1. Introduction

The multicriteria decision making/analysis (MCDM/MCDA) methods consist a widely discussed topic in various scientific fields since 1950 referring to the mathematical evaluation/assessment process of a set of alternative options under specific multiple criteria. The main objective/goal is the final prioritization in a systematic manner of the examined alternatives and the selection of the ideal/optimal one (Zhu et al., 2021). The multicriteria decision-making process involves four key steps: identifying the assessment criteria and alternatives, gathering data for each alternative against each criterion, calculating the weights of the assessment criteria, and determining the final ranking of the alternatives. Basilio et al. (2024) emphasize that deciding on criterion weights is a key challenge in multicriteria modelling because these weights establish how much importance each criterion has and directly influence the ranking of alternatives. In addition, Pereira et al. (2026) emphasize the significance of comparing and combining multiple MCDA rankings methodologically.

Basilio et al. (2025) highlight the ongoing significance of advanced MCDM methods in operational research, especially for organizing complex decision problems that involve conflicting alternatives and multiple criteria, which rely on the preferences, experience, and other data of the decision-maker. In recent years, MCDM/MCDA methods have been applied across various sectors (e.g., energy, supply chain, sustainability) and various countries worldwide, serving as a versatile decision-support framework that ranks alternatives, integrates criterion weights, and promotes transparent decision-making in complex multidimensional issues. In the field of energy policy, Tekman Ordu et al. (2026) applied a combined Stepwise Weight Assessment Ratio Analysis (SWARA) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach to evaluate Türkiye's Sustainable Development Goal (SDG) 7 energy policy performance for the period 2014–2023, demonstrating how MCDM/MCDA methods are useful for assessing complex policy performance

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across different time periods. Tekman Ordu and Ordu (2026) introduced a hybrid evaluation system for assessing sustainable development in upper-middle-income developing countries, applicable in both non-fuzzy and fuzzy contexts. Analytic Hierarchy Process (AHP) and Fuzzy AHP were used to weight the evaluation criteria, whereas TOPSIS and Fuzzy TOPSIS were used to rank efficient countries. In the automotive sector, Bulut et al. (2024) used SWARA-ARAS, SWARA-EDAS, and SWARA-TOPSIS techniques to evaluate and rank different polymers, offering recommendations focused on safety, performance, and sustainability.

The application of multicriteria decision making/analysis (MCDM) methods is also considered widespread in engineering and construction within the last decades. Project success evaluation can be interpreted as a multicriteria decision problem because a project's success is determined by the combined satisfaction of several criteria, including cost, time, quality, stakeholder satisfaction, technical performance, organizational learning, and broader strategic or contextual objectives. Therefore, completed projects represent alternatives, project success criteria represent evaluation criteria, and the weight assigned to each criterion reflects the preferences and priorities of decision makers. The integration of project success evaluation with MCDM/MCDA methods is therefore grounded in the need to transform a multidimensional and preference-dependent evaluation problem into a structured, transparent, and comparable ranking process. However, the applicability of these methods for the evaluation/assessment of project success and its two fundamental components (success criteria, critical success factors) is not sufficiently developed in the relative literature. The systematic literature review conducted by Lamprou and Vagiona (2025) demonstrates that only a few surveys deal with project success evaluation/assessment through the application of multicriteria decision making/analysis (MCDM/MCDA) methods, most of which refer to critical success factors evaluation/assessment and project prioritization/selection within civil engineering and construction.

Pertaining to the reviewed literature, the AHP method strongly predominates in single/individual and hybrid/combinatorial applications, whilst the fuzzy numbers are gradually integrated into the traditional multicriteria decision-making algorithms (Lamprou & Vagiona, 2025). However, the deployment of comparative evaluation/analysis of multicriteria decision making/analysis (MCDM/MCDA) methods tends to be occasional in engineering and construction.

The adopted methodology of Kaya and Kahraman (2014) encompasses the implementation of fuzzy TOPSIS and fuzzy AHP in a case study for intelligent building assessment. Additionally, the extracted results are compared with the corresponding results of fuzzy multi-attribute utility theory (MAUT) indicating significant convergences. Mulliner et al. (2016) apply five established multicriteria decision making/analysis (MCDM/MCDA) methods (e.g. WSM, WPM, revised AHP, TOPSIS, COPRAS) for the assessment of sustainable housing affordability in England. The extracted results are further investigated through comparative analysis in order to examine the possible divergences between the selected MCDM/MCDA methods leading to significant remarks in their applicability conditions. Valipour et al. (2018) investigate the application of SWARA, COPRAS, fuzzy ANP, fuzzy AHP, fuzzy TOPSIS, SAW, and EDAS methods in terms of risk assessment method selection in construction projects. A comparative analysis, accompanied by sensitivity analysis, are used so as to identify the applicability and appropriateness of the examined methods for project risk assessment. Ghorabaee et al. (2018) present a hybrid multicriteria decision-making application (e.g., fuzzy SWARA, CRITIC, EDAS) for the sustainable evaluation of construction equipment. Subsequently, a sensitivity analysis is executed in order to control possible variations in the evaluation process. The results of the hybrid approach and other MCDM methods (e.g. WASPAS, COPRAS, TOPSIS, VIKOR) are also compared for the examination of the consistency and reliability of the proposed framework. Maghsoodi and Khalilzadeh (2018) propose a combinatorial application of multicriteria decision making/analysis (MCDM/MCDA) methods (e.g., Shannon's Entropy, fuzzy TOPSIS) for the identification and evaluation of critical success factors in construction projects. Finally, a comparative analysis between the results from the application of fuzzy TOPSIS and fuzzy MULTIMOORA in respect with the ranking of the critical success factors is executed reflecting significant divergences. Matić et al. (2019) propose a hybrid multicriteria decision-making (MCDM) model (e.g., full consistency method-FUCOM, rough COPRAS) for sustainable supplier selection in construction. The extracted results are subjected to sensitivity analysis throughout four stages, where the second encloses a comparative analysis among the obtained results and others from precedent surveys (e.g., rough WASPAS, ARAS, SAW, MABAC) using multicriteria decision making/analysis (MCMD/MCDA) methods. A comparative evaluation of four multicriteria decision making/analysis (MCDM/MCDA) methods (e.g., AHP, ELECTRE, TOPSIS, VIKOR) is performed by Nesticò and Somma (2019) aiming at the enhancement of historical buildings. Broniewicz and Ogrodnik (2021) develop a hybrid model of multicriteria decision making/analysis (MCMD/MCDA) methods (e.g., DEMATEL, REMBRANDT, VIKOR) for sustainable development in the field of transport. Subsequently, a comparative analysis is carried out between the extracted results and the ones originated from precedent research (e.g., AHP, fuzzy AHP, TOSPIS, PROMETHEE) leading to significant conclusions. Effatpanah et al. (2022) conduct a comparative analysis through the application of five widespread multicriteria decision making/analysis (MCDM/MCDA) methods (e.g., SAW, TOPSIS, ELECTRE, VIKOR, COPRAS) in order to select clean energy technologies in engineering. The extracted results are also objected to a two-stage sensitivity analysis indicating significant accuracy and reliability. El-Araby et al. (2022) compare the results of the application of four multicriteria

decision making/analysis (MCMD/MCDA) methods (e.g., TOPSIS, GRA, EDAS, CoCoSo) in order to identify the potential variations in the final rankings referring to construction facility location. Mohammadnazari et al. (2022) introduce an integrated application of prominent multicriteria decision making/analysis (MCDM/MCDA) methods (e.g., BWM, TOPSIS, ELECTRE, VIKOR, PROMETHEE) to prioritize reconstruction projects. Additionally, the results of the hybrid application of MCDM/MCDA methods are compared with each other and with the corresponding results of the employment of Artificial Neural Network (ANN) so as to extract further research implications. Rachman et al. (2024) apply five prominent multicriteria decision making/analysis (MCDM/MCDA) methods (e.g., AHP, COPRAS, TOPSIS, VIKOR, WSM) for sustainable building design selection. The obtained rankings are compared using different metrics and sensitivity analysis is also performed to identify the consistency and robustness of the examined MCDM/MCDA methods in potential condition changes.

The present research aims to address a gap in the existing literature by examining the relevance and suitability of multicriteria decision making/analysis (MCDM/MCDA) methods for assessing project success. The literature review on engineering and construction reveals that MCDM/MCDA methods are not methodologically identical, even when applied to the same decision matrix. This study examines ten MCDM/MCDA methods, each employing different decision logics, including various computations, normalization techniques, multiplicative synthesis, ideal-solution distance, compromise ranking, pairwise prioritization, proportional assessment, and outranking. The article makes three main contributions to the fields of project management and MCDM. First, it expands the application of well-established MCDM/MCDA methods to the evaluation of completed projects' success. Second, the study presents a systematic comparative analysis of these methods, focusing not only on their results but also on their consistency, robustness, and practical usefulness for analyzing project success. Comparing ten methods aids decision-making by identifying which rankings are stable, which projects are affected by methodology, and which techniques are best suited for various project evaluation scenarios. This is especially valuable in project management, where assessing project success can inform lessons learned and strategic decision making. Consequently, comparing different MCDM approaches provides a practical tool to enhance transparency, reliability, and understanding of methodologies in evaluating project success. Finally, by applying the proposed framework to projects executed in Greece, the research provides empirical data from a rarely studied context and offers methodological and managerial insights for selecting appropriate MCDM tools in project evaluations.

Section 2 encloses the adopted methodological framework, the determination of the decision-making problem/issue, and the application processes of the selected MCDM/MCDS methods. In Section 3, the application results of this research and the subsequent comparative evaluation are presented, and eventually the most significant concluding remarks and findings are provided.

## 2. Materials and methodology

### 2.1. Methodological framework

The adopted methodological framework (Figure 1) consists of three consecutive implementation steps. The first step encloses the determination of the decision-making problem/issue (objective/goal, evaluation criteria, alternatives), and the allocation of success criteria weights (relative importance) leading to the configuration of the initial decision matrix. In the second step, ten (10) established multicriteria decision making/analysis (MCMD/MCDA) methods are appropriately selected and applied based on the values of the initial decision matrix. The third step encompasses the evaluation and final ranking of the examined alternatives in terms of project success evaluation/assessment.

### 2.2. Decision-making problem/issue and initial decision matrix

The major decision-making problem/issue of the present research deals with the evaluation/assessment of project success through the application of multicriteria decision making/analysis (MCDM/MCDA) methods. A specialized model/framework for the interpretation and evaluation/assessment of project success has been proposed in precedent research (Lamprou & Vagiona, 2022b). The main objective of this research is the investigation of the applicability of multicriteria decision making/analysis (MCDM/MCDA) methods for the evaluation/assessment of project success.

The examined decision-making problem/issue includes 20 individual alternative solutions referring to 20 executed/implemented projects in construction sector, as well as 17 distinct evaluation criteria. The considered evaluation criteria correspond to the 17 most important project success criteria, as systematically identified and evaluated in previous research. Firstly, the examined projects (alternatives) are electronically registered and evaluated/assessed in a web-based application (www.projectsuccess.gr) on behalf of 10 professionals and experts (engineers) in construction sector of Greece, in accordance with the proposed model/framework of project success evaluation (Lamprou & Vagiona, 2022b).

Furthermore, the weights (relative importance) of the 17 distinct project success criteria (evaluation criteria) originate from precedent extensive research (Lamprou & Vagiona, 2022a) allocated in a descending scale as follows (Table 1).

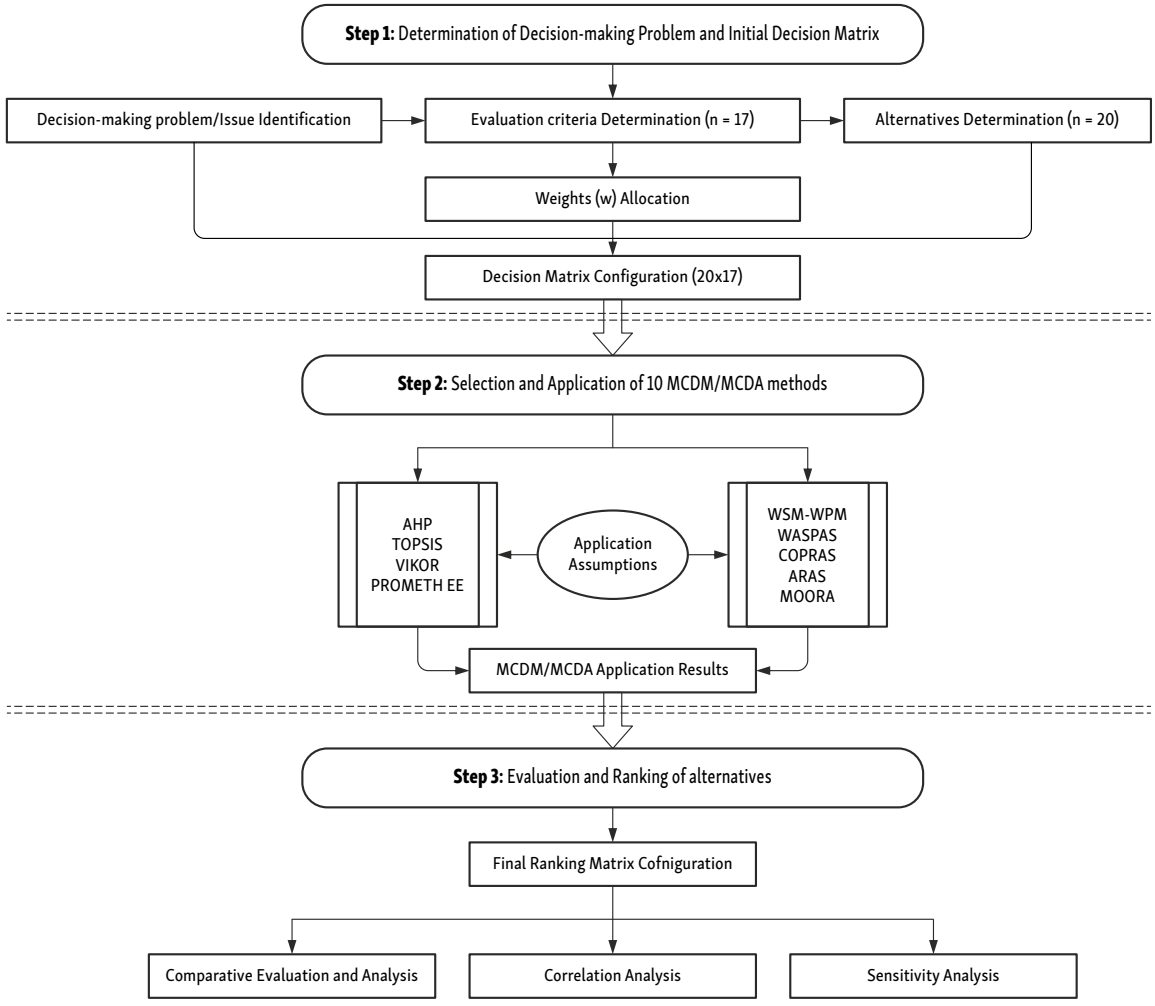



**Figure 1.** The methodological framework

**Table 1.** Determination of success criteria weights (relative importance)

| | Success criteria (SC) | Weight (w) | No | Success criteria (SC) | Weight (w) |
|---|---|---|---|---|---|
| SC1 | Cost – Budget | 0.0672 | SC10 | Business & Commercial performance | 0.0571 |
| SC2 | Time – Schedule | 0.0646 | SC11 | Use – Utilization | 0.0567 |
| SC3 | Client/user/end-user satisfaction | 0.0646 | SC12 | Environmental impact | 0.0566 |
| SC4 | Quality – Technical performance | 0.0642 | SC13 | Other Stakeholders' satisfaction | 0.0552 |
| SC5 | Effectiveness | 0.0619 | SC14 | Strategic goals/objectives & Competitiveness | 0.0551 |
| SC6 | Technical specifications & requirements | 0.0616 | SC15 | Contractor's satisfaction | 0.0540 |
| SC7 | Functionality | 0.0614 | SC16 | Project team/personnel satisfaction | 0.0539 |
| SC8 | Health & Safety | 0.0610 | SC17 | Supplier satisfaction | 0.0475 |
| SC9 | Future perspective | 0.0572 | | | |

Regarding to the decision-making problem/issue hierarchy, the fundamental objective/goal is placed in the highest position (level 0) corresponding to the success evaluation/assessment of executed/implemented projects in construction sector. The subsequent hierarchical level (level 1), encloses the 17 distinct project success criteria (evaluation criteria) that significantly influence the decision-making process based on their weights (relative importance). The lowest level (level 2) refers to the 20 executed/implemented projects (alternatives) aiming at their final evaluation and ranking.

Taking into account all the aforementioned data, the initial decision matrix is appropriately created, which is a prerequisite for the application of the selected multicriteria decision making/analysis (MCDM/MCDA) methods (Table 2). The numerical values of the performances of the examined projects (alternatives) with respect to the corresponding success criteria (evaluation criteria) are converted and exported into common dimensions by the specialized web-based application of project success evaluation/assessment (www.projectsuccess.gr).

**Table 2.** The initial decision matrix

| | SC1 | SC2 | SC3 | SC4 | SC5 | SC6 | SC7 | SC8 | SC9 | SC10 | SC11 | SC12 | SC13 | SC14 | SC15 | SC16 | SC17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project 1 | 3 | 2 | 4 | 4 | 5 | 3 | 5 | 4 | 4 | 5 | 3 | 4 | 4 | 4 | 5 | 4 | 4 |
| Project 2 | 2 | 3 | 5 | 5 | 4 | 3 | 4 | 4 | 3 | 6 | 5 | 3 | 5 | 3 | 5 | 5 | 5 |
| Project 3 | 3 | 3 | 5 | 5 | 5 | 3 | 5 | 4 | 2 | 6 | 5 | 1 | 5 | 4 | 5 | 5 | 5 |
| Project 4 | 1 | 1 | 4 | 5 | 5 | 3 | 4 | 4 | 4 | 6 | 4 | 4 | 4 | 4 | 5 | 4 | 5 |
| Project 5 | 3 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 5 | 4 | 5 |
| Project 6 | 3 | 2 | 4 | 5 | 5 | 3 | 5 | 4 | 2 | 3 | 5 | 1 | 5 | 4 | 5 | 4 | 5 |
| Project 7 | 3 | 3 | 5 | 5 | 5 | 3 | 5 | 4 | 2 | 3 | 5 | 1 | 5 | 4 | 5 | 5 | 5 |
| Project 8 | 2 | 1 | 5 | 4 | 5 | 3 | 5 | 4 | 2 | 4 | 4 | 1 | 4 | 4 | 5 | 3 | 5 |
| Project 9 | 3 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 6 | 5 | 4 | 5 | 4 | 5 | 5 | 4 |
| Project 10 | 3 | 3 | 5 | 5 | 4 | 3 | 4 | 4 | 4 | 6 | 5 | 4 | 4 | 3 | 5 | 5 | 5 |
| Project 11 | 2 | 2 | 5 | 5 | 4 | 3 | 5 | 4 | 4 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 5 |
| Project 12 | 1 | 2 | 5 | 5 | 4 | 3 | 4 | 4 | 3 | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 5 |
| Project 13 | 1 | 3 | 4 | 4 | 5 | 3 | 3 | 2 | 4 | 5 | 5 | 3 | 5 | 3 | 3 | 3 | 5 |
| Project 14 | 3 | 3 | 4 | 5 | 5 | 2 | 5 | 4 | 2 | 1 | 5 | 4 | 5 | 2 | 4 | 5 | 5 |
| Project 15 | 1 | 3 | 4 | 4 | 5 | 3 | 5 | 4 | 4 | 1 | 4 | 3 | 4 | 4 | 5 | 3 | 5 |
| Project 16 | 2 | 1 | 5 | 5 | 5 | 2 | 4 | 4 | 4 | 5 | 5 | 1 | 5 | 3 | 4 | 3 | 4 |
| Project 17 | 2 | 3 | 4 | 4 | 5 | 3 | 4 | 4 | 2 | 5 | 4 | 4 | 3 | 4 | 4 | 5 | 3 |
| Project 18 | 3 | 3 | 4 | 5 | 5 | 2 | 5 | 4 | 2 | 1 | 5 | 4 | 5 | 2 | 4 | 5 | 5 |
| Project 19 | 2 | 3 | 5 | 5 | 5 | 3 | 5 | 2 | 2 | 4 | 5 | 4 | 5 | 2 | 5 | 5 | 4 |
| Project 20 | 2 | 3 | 4 | 5 | 4 | 2 | 4 | 2 | 2 | 3 | 5 | 2 | 4 | 3 | 3 | 3 | 4 |

## 2.3. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) was developed by Saaty (1980) to address complicated multicriteria decision-making problems/issues and is widely applied in various scientific fields. This method contributes to the rational decision-making through various interrelated and possibly contradictory evaluation criteria aiming at the determination of the priorities/weights of a set of alternatives under a predetermined decision objective/goal. The examined decision criteria are evaluated in terms of their relative importance in order to enable the necessary compromises. The AHP initially encloses the configuration of the decision hierarchy, where the ultimate objective/goal constitutes the first level of hierarchy and the evaluation criteria and sub-criteria (second level), and the alternative solutions (third level) are progressively structured at the subsequent levels of hierarchy. Each component of the corresponding decision hierarchy is evaluated by the decision makers as a binary value applying the pairwise comparison technique under a predetermined nine-point scale widely named as Saaty's fundamental scale 1–9. Specifically, value "1" reflects an "equal importance", value "3" a "moderate importance", value "5" a "strong importance", value "7" a "very strong importance", and value "9" an "absolute importance" of the one component over another respectively. The values "2", "4", "6", "8" also correspond to the intermediate values of the aforementioned scales. In case of reverse judgements in pairwise comparisons, the corresponding values should also be reversed.

The AHP method includes the following implementation steps (Saaty, 1980, 1987):

1. Creation of an $n \times n$ initial decision matrix, where $n$ is the number of the components compared. This matrix refers to the evaluation/judgement of the decision maker regarding to the relative importance of the one compared component over another, as a set of ratios $w_i/w_j$.
2. Normalization of the initial decision matrix by dividing each relevant value with the corresponding sum of the vertical column to which it belongs.
3. Calculation of the priority vectors or relative weights $(w)$ of each compared component as the average of the normalized values of the corresponding horizontal row.

The aforementioned steps are performed at each level of the initial decision hierarchy. At the second level, the priority vector or relative weight $(w)$ reflects the hierarchical ranking of the examined evaluation criteria and expresses the degree of contribution of each criterion to the achievement of the ultimate decision objective/goal, whilst at the third level the priority vector or relative weight $(w)$ of each compared alternative reflects its hierarchical ranking for each evaluation criterion respectively. The total priority of each examined alternative solution is defined as the sum of the products of the priority vectors (relative weights) of each evaluation criterion in terms of the ultimate decision objective/goal with the priority vectors (relative weights) of each alternative solution regarding to each criterion respectively.

The pairwise comparisons of the Analytic Hierarchy Process (AHP) include subjective evaluations/judgements by the decision makers. Consequently, the necessary assessment of the validity/reliability of the final decision re-

quires checking the consistency of the decision matrix through the calculation of the consistency index $(CI)$ and consistency ratio $(CR)$.

The consistency index $(CI)$ is defined by the following equation:

$$CI = \frac{\lambda_{max} - n}{n-1}, \quad (1)$$

where $\lambda_{max}$ corresponds to the sum of the products of the column of each criterion of the decision matrix ($n \times n$ size) with the corresponding priority vector (relative weight), and n to the number of evaluation criteria.

Similarly, the consistency ratio $(CR)$ is defined as the ratio of the consistency index $(CI)$ to the random consistency index $(RI)$ as follows:

$$CR = \frac{CI}{RI}, \quad (2)$$

where $(RI)$ is the random consistency index and depends on the corresponding size of the decision matrix ($n \times n$) (Table 3).

The extracted results can be considered correct and reliable, when the consistency ratio $(CR)$ does not exceed the value 0.1 $(CR \leq 0.1)$. Otherwise, the values of the initial decision matrix should be revised by the decision maker.

**Table 3.** Random Index (*RI*) values

| *n* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| *RI* | 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

## 2.4. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) was developed by Hwang and Yoon (1981) and is one of the traditional multicriteria decision-making methods that aims at the prioritization of specific alternative solutions based on predefined criteria and parameters. The concept of the TOPSIS method is based on the evaluation of a set of alternatives, without direct comparison between them, where the preferred alternative should be as close as possible to the best ideal solution and as far as possible to worst ideal solution respectively. Consequently, the TOPSIS method determines the best ideal solution and the worst ideal solution under a set of evaluation criteria and then examines the distances of the corresponding solutions from them. In general, the TOPSIS method constitutes a simple, practical and convenient tool that can be used to prioritize a set of alternatives with wide application in various scientific fields.

Particularly, the TOPSIS method includes the following implementation steps (Hwang & Yoon, 1981):

1. Creation of the initial decision matrix enclosing the numerical values of the alternatives in respect with each evaluation criterion.
2. Normalization of the initial decision matrix in order to retrieve the values of the alternative solutions in terms of the considered evaluation criteria on a common basis and enable the necessary comparisons between them. The normalized values of the alternative solutions $r_{ij}$ are calculated through the following equation:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \quad (3)$$

where $x_{ij}$ is the rating of alternative $i$ under the evaluation criterion $j$.

3. Configuration of the weighted normalized decision matrix based on the relative weights $(w)$ of the examined evaluation criteria. Specifically, the values of the normalized decision matrix of the alternative solutions are multiplied by the relative weight of each column (evaluation criteria), as obtained from another appropriate multicriteria method (e.g., AHP, entropy). The weighted normalized values $v_{ij}$ of the examined alternative solutions are calculated as follows:

$$v_{ij} = w_j * r_{ij}, \quad (4)$$

where $w_j$ corresponds to the relative weight of the evaluation criterion $j$.

4. Determination of two hypothetical variables, the best ideal solution $(A^+)$ and the worst ideal solution $(A^-)$, which encompass the maximum and minimum possible weighted performances of each evaluation criterion. A prerequisite for the determination of the best ideal and worst ideal solution is the distinction between the benefit and cost functions implied by the individual evaluation criteria, which may affect the values included in the two examined ideal solutions.
5. Calculation of the Euclidean distance of each alternative from the best ideal solution $(S_i^+)$ and the worst ideal solution $(S_i^-)$ using the following formulas:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - V_j^+)^2}, \; i = 1, 2, ..., m; \quad (5)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - V_j^-)^2}, \; i = 1, 2, ..., m, \quad (6)$$

where $v_{ij}$ represents the value of the alternative solution $i$ to the evaluation criterion $j$, and $V_j^+$ and $V_j^-$ are the values of the best ideal and worst ideal solution of the evaluation criterion $j$ respectively.

6. Calculation of the relative closeness coefficient of each alternative solution $(C_i)$ to the best ideal and worst ideal solution as follows:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}, \; i = 1, 2, ..., m. \quad (7)$$

7. Ranking of the examined alternative solutions in descending order based on the relative closeness coefficient, where the correspondent alternatives presenting the highest values are considered the most appropriate.

## 2.5. VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR)

The VIKOR method was originally developed by Opricovic (1998), while the detailed algorithm was presented a few years later (Opricovic & Tzeng, 2004). The rationale of this method reflects the selection of the appropriate alternative solution based on its proximity to the optimal ideal solution. The VIKOR method significantly converges to TOPSIS, as both methods investigate the optimal ideal and negative ideal solutions. However, the VIKOR method is differentiated by considering only the relative proximity to the optimal ideal solution.

The initial decision matrix consists of *n* evaluation criteria and *m* alternative solutions defined by the relation $X = f_{ij}(Ai)_{m\times n}$, while the values can be normalized using one of the available methods/techniques.

The algorithm of VIKOR method includes the following steps (Opricovic & Tzeng, 2004):

1. Determination of the best $f_j^*$ and worst $f_j^-$ performance of each considered evaluation criterion separating them into beneficial and non-beneficial criteria respectively:

$$f_j^* = \max_i f_{ij},\ f_j^- = \min_i f_{ij} \text{ (beneficial criteria);} \quad (8)$$

$$f_j^* = \min_i f_{ij},\ f_j^- = \max_i f_{ij} \text{ (non-beneficial criteria).} \quad (9)$$

2. Determination of the measures of utility $S_i$ and regret $R_i$ for each alternative solution using the following equations:

$$S_i = \sum_{j=1}^{n} w_j (f_j^* - f_{ij}) / \left(f_j^* - f_j^-\right),\ i = 1,2,\ldots,m; \quad (10)$$

$$R_i = \max_j \left[w_j \left(f_j^* - f_{ij}\right) / \left(f_j^* - f_j^-\right)\right],\ i = 1,2,\ldots,m, \quad (11)$$

where $w_j$ is the relative weight of the evaluation criterion *j*.

3. Calculation of the VIKOR index $Q_i$ for each alternative solution according to the following equation:

$$Q_i = u\left(S_i - S^*\right) / \left(S^- - S^*\right) + \left(1-u\right)\left(R_i - R^*\right) / \left(R^- - R^*\right),$$
$$i = 1,2,\ldots,m, \quad (12)$$

where $S^* = \min_i S_i, S^- = \max_i S_i, R^* = \min_i R_i, R^- = \max_i R_i$, and *u* is the weight of the decision maker's strategy receiving values between 0 and 1. Normally, the variable *u* is equal to 0.5 $(u = 0.5)$.

4. Ranking of all the considered alternative solutions in terms of the variables $S_i$, $R_i$ and $Q_i$ in ascending order for the final prioritization. It is highlighted that several researchers adopt only the variable $Q_i$ for the final ranking of the examined alternatives.

## 2.6. Preference Ranking Organization METHod for Enrichment of Evaluations (PROMETHEE)

The PROMETHEE method (Preference Ranking Organization Method for Enrichment Evaluation) is one of the established and widespread multicriteria outranking methods, which initially developed by Brans (1982) and gradually expanded into several variants/versions (e.g. PROMETHEE I, II, III, IV, V, VI, PROMETHEE GDSS, GAIA, TRI, CLUSTER).

In particular, PROMETHEE II method for complete ranking encloses the following implementation steps (Brans & Vincke, 1985):

1. Creation of the initial decision matrix, which encompasses the numerical values of the examined alternative solutions regarding to each evaluation criterion. The initial decision matrix can be normalized based on the relative weights $(w)$ of the individual evaluation criteria previously received by the available methods/techniques.
2. Identification of preference function values $P_j(a,b)$ for each evaluation criterion *j*, which expresses the preference difference in the evaluation one alternative $(a)$ over another $(b)$. In PROMETHEE II method, six types of preference functions are distinguished: the usual criterion, the U-shape, the V-shape, the level criterion, the linear with indifference criterion, and the Gaussian respectively. The preference function converts the deviation between the evaluations of two alternatives for each criterion into a preference degree ranging from 0 to 1:

$$P_j(a,b) = F_j\left[d_j(a,b)\right],\ j = 1,2,\ldots,k; \quad (12)$$

$$d_j(a,b) = g_j(a) - g_j(b), \quad (13)$$

where $d_j(a,b)$ is the difference of the evaluations between the alternatives $(a)$ and $(b)$, $g_j(a)$ is the evaluation of alternative *a* to the criterion *j*, and $g_j(b)$ is the evaluation of alternative *b* to the criterion *j* respectively.

It is noted that is also necessary to determine the values of certain thresholds for each evaluation criterion, such as the indifference threshold (q), the preference threshold (p), and the Gaussian threshold (s) depending on the selection of the corresponding preference function.

3. Determination of the aggregate preference index $\Pi(a,b)$, which indicates the degree to which alternative *a* is preferred to alternative *b* against all the evaluation criteria as follows:

$$\Pi(a,b) = \sum_{i=1}^{k} w_j P_j(a,b), \quad (14)$$

where $w_j$ is the weight associated with evaluation criterion *j* and $P_j(a,b)$ is the difference function between the evaluations of alternative *a* and alternative *b*.

When the index $\Pi(a,b)$ approaches the value 0, a weak preference for alternative *a* over alternative *b* is indicated, whilst when the value approaches to 1, a stronger preference is indicated respectively.

4. Calculation of the values of the outranking flows, which are the leaving (positive) flow $\Phi^+(a)$ and the entering (negative) flow $\Phi^-(a)$ using the following equations:

$$\Phi^{+}(a) = \frac{1}{n-1}\sum_{b\in A}\Pi(a,b); \quad (15)$$

$$\Phi^{-}(a) = \frac{1}{n-1}\sum_{b\in A}\Pi(b,a), \quad (16)$$

where $n$ is the number of the examined alternatives.

The leaving (positive) flow $\Phi^{+}(\alpha)$ expresses how much an alternative $a$ dominates all other alternatives, while the entering (negative) flow $\Phi^{-}(\alpha)$ expresses how much alternative $a$ is dominated by all other alternatives respectively. Consequently, the alternative with a higher value of $\Phi^{+}(\alpha)$ and a lower value of $\Phi^{-}(\alpha)$ is considered the best alternative.

5. Calculation of the value of the net outranking flow $\Phi(\alpha)$ for each alternative as follows:

$$\Phi(a) = \Phi^{+}(a) - \Phi^{-}(a). \quad (17)$$

6. Ranking of the examined alternatives based on the net outranking flow. It is highlighted that the alternative with the highest net outranking flow $\Phi(\alpha)$ is considered the ideal/optimal alternative.

## 2.7. Weighted Sum Model (WSM) and Weighted Product Model (WPM)

The Weighted Sum Model (WSM), previously known as Simple Additive Weighting (SAW), is a simplified and widely applied multicriteria decision-making method for single dimensional problems/issues (Fishburn, 1967; MacCrimon, 1968; Triantaphyllou & Mann, 1989; Mateo, 2012). Hypothetically, a multicriteria decision-making problem/issue consists of $m$ alternatives and $n$ evaluation criteria, where in each criterion a specific weight (relative importance) is assigned based on the application of another appropriate technique/method. The total performance of each alternative solution $A_i$, according to WSM method, is calculated using the following equation:

$$A_i^{WSM} = \sum_{j=1}^{n}\bar{x}_{ij}w_j, \quad (18)$$

where $\bar{x}_{ij}$ corresponds to the normalized value of the alternative $i$ to the evaluation criterion $j$ and $w_j$ to the relative weight of the evaluation criterion $j$.

For the normalization of the initial values $x_{ij}$ of the alternatives with respect to each evaluation criterion, the following equations are used (Triantaphyllou & Mann, 1989; Zavadskas et al., 2012; Karande et al., 2016):

$$\bar{x}_{ij} = \frac{x_{ij}}{\max_i x_{ij}} \text{ (beneficial criteria)}; \quad (19)$$

$$\bar{x}_{ij} = \frac{\min_i x_{ij}}{x_{ij}} \text{ (non-beneficial criteria)}. \quad (20)$$

The main assumption of the WSM method is the additive utility assumption, where the total value of each alternative is equal to the sum of the products of the aforementioned equation. Consequently, the ideal/optimal alternative is considered as the one that satisfies the maximization case, namely having the maximum value of the total performance $A_{WSM}^{*}$, whilst the other alternatives are ranked in a descending order. The fundamental assumption of the WSM method may be violated in case of multidimensional decision problems/issues, where the variables have different units.

The Weighted Product Model (WPM) is quite similar to the Weighted Sum Model (WSM) method. The main difference between the two methods is the use of multiplication instead of summation in the adopted calculation process. Specifically, each alternative is compared with the others through the multiplication of a number of ratios, one for each evaluation criterion. Each ratio is raised to an exponent equal to the weight (relative importance) of the corresponding evaluation criterion. In general, the comparison between the alternatives $A_k$ and $A_l(k \neq l)$ is performed via the following formula (Bridgman, 1922; Miller & Starr, 1969; Triantaphyllou & Mann, 1989; Triantaphyllou et al., 1998; Mateo, 2012):

$$R\left(A_k \middle/ A_l\right) = \prod_{j=1}^{n}\left(a_{kj} \middle/ a_{lj}\right)^{w_j}, \quad (21)$$

where $n$ is the number of the evaluation criteria, $a_{ij}$ is the real value of the alternative $i$ to the criterion $j$, and $w_j$ is the weight (relative importance) of the evaluation criterion $j$.

If the above ratio is greater than or equal to 1, then alternative $A_k$ is better than alternative $A_l$ (maximization criterion). Consequently, the optimal/ideal alternative is considered the one that is better or at least equivalent to all other alternatives.

The WPM method is also characterized as a dimensionless analysis and can be applied to single dimensional and multidimensional decision-making problems/issues by eliminating all the examined units (Triantaphyllou & Mann, 1989; Triantaphyllou et al., 1998; Mateo, 2012).

Alternatively, the WPM method can be implemented by calculating the total performance of each alternative as follows (Bridgman, 1922; Miller & Starr, 1969; Triantaphyllou et al., 1998; Zavadskas et al., 2012; Karande et al., 2016):

$$Q_i = \prod_{j=1}^{n}\left(\bar{x}_{ij}\right)^{w_j}, \quad (22)$$

where $\bar{x}_{ij}$ is the normalized value of the alternative $i$ to the criterion $j$ and $w_j$ is the weight (relative importance) of the evaluation criterion $j$ respectively.

The alternative that presents the maximum total performance $Q_i$ is considered the optimal/ideal alternative, followed by the remaining alternatives in a descending scale.

## 2.8. Weighted Aggregated Sum Product Assessment (WASPAS)

The WASPAS method (Weighted Aggregated Sum Product Assessment) is a direct derivative of the third combinatorial optimization criterion in decision-making problems/issues, which originates from the two first optimization criteria respectively (Zavadskas et al., 2013b). The first optimization criterion refers to mean-weighted criterion imple-

mented through the WSM method for the evaluation of a set of alternatives under specific evaluation criteria. The second optimization criterion, called the multiplicative exponential generalized criterion, is performed through the WPM method. The third optimization criterion, namely the weighted summation of the additive (WSM) and multiplicative (WPM) methods, was originally developed by Saparauskas et al. (2011). Considering the improvements in ranking accuracy and in decision-making efficiency, a new methodology for the optimization of the weighted cumulative function is presented leading to the development of WASPAS method as follows (Zavadskas et al., 2012):

$$Q_i = \lambda \sum_{j=1}^{n} \bar{x}_{ij} w_j + (1-\lambda) \prod_{j=1}^{n} \left(\bar{x}_{ij}\right)^{w_j}; \quad (23)$$

$$Q_i = \lambda\ Q_i^1 + (1-\lambda)\ Q_i^2, \quad (24)$$

where λ expresses the optimization coefficient $(0 \le \lambda \le 1)$, $Q_i^1$ is the total performance of alternative $i$ based on WSM method, and $Q_i^2$ is the total performance of alternative $i$ based on WPM method respectively.

Indicatively, if λ = 0 the WASPAS method coincides with WPM method, while if λ = 1 the WASPAS method is transformed into WSM method. Finally, the assessment of the reliability of WASPAS method based on the accuracy of the initial evaluation criteria, as well as for all possible values of the optimization coefficient $(\lambda = 0,\ldots,1)$ is recommended (Zavadskas et al., 2012, 2013a, 2013b).

## 2.9. Complex Proportional Assessment (COPRAS)

The COPRAS method (Complex Proportional Assessment) was introduced by Zavadskas and Kaklauskas (Zavadskas et al., 1994; Zavadskas & Kaklauskas, 1996) and adopts a gradual evaluation and ranking process of the examined alternatives based on their importance and utility degree. An advantage of this method is the application possibility for multicriteria analysis of both maximized and minimized criterion values, the impact of which on the final results is investigated individually. The COPRAS method has been widely applied by various researchers over the years, whilst its occurrence in engineering is considered remarkable (Kaklauskas et al., 2007; Zavadskas et al., 2007; Podvezko, 2011).

The implementation process of COPRAS method consists of the following steps (Zavadskas & Kaklauskas, 1996; Kaklauskas et al., 2007; Zavadskas et al., 1994, 2007):

1. Configuration of the weighted normalized decision matrix $D$ in order to assign dimensionless weighted values for all parameters and compare the considered evaluation criteria. The weighted normalized value $d_{ij}$ is calculated as follows:

$$d_{ij} = \frac{x_{ii} * q_i}{\sum_{j=1}^{n} x_{ij}}, \ i = \overline{1,m},\ j = \overline{1,n}, \quad (25)$$

where $x_{ij}$ is the value of the criterion $i$ for the alternative $j$, $m$ is the number of the valuation criteria, $n$ is the number of the alternatives, and $q_i$ is the weight (relative importance) of the evaluation criterion $i$.

The sum of the dimensionless weighted values $d_{ij}$ of each evaluation criterion $i$ is equal to the weight (relative importance) $q_i$ of the corresponding criterion: $q_i = \sum_{j=1}^{n} d_{ij}$, $i = \overline{1,m}$, $j = \overline{1,n}$.

2. Calculation of the sum of the maximized $S_{+j}$ and minimized $S_{-j}$ indices for all examined alternatives. The highest possible values for the maximized indices, whilst the lowest possible values for the minimized indices are preferred respectively. The values of the maximized $S_{+j}$ and minimized $S_{-j}$ indices express the satisfaction degree of the objectives/goals of the project stakeholders for each alternative as follows:

$$S_{+j} = \sum_{i=1}^{m} d_{+ij}, \ i = \overline{1,m},\ j = \overline{1,n}; \quad (26)$$

$$S_{-j} = \sum_{i=1}^{m} d_{-ij}, \ i = \overline{1,m},\ j = \overline{1,n}. \quad (27)$$

The sums of the maximized $S_{+j}$ and minimized $S_{-j}$ indices of all considered alternatives are respectively equal to the sums of weights of the maximized and minimized evaluation criteria, namely:

$$S_+ = \sum_{j=1}^{n} S_{+j} = \sum_{i=1}^{m}\sum_{j=1}^{n} d_{+ij} \text{ and}$$

$$S_- = \sum_{j=1}^{n} S_{-j} = \sum_{i=1}^{m}\sum_{j=1}^{n} d_{-ij}, \ i = \overline{1,m},\ j = \overline{1,n}.$$

3. Determination of the importance degree of the examined alternatives based on the description of their positive and negative features. The relative importance $Q_j$ of each alternative $j$ is calculated through the following equation:

$$Q_j = S_{+j} + \frac{S_{-\min} * \sum_{j=1}^{n} S_{-j}}{S_{-j} * \sum_{j=1}^{n} \frac{S_{-\min}}{S_{-j}}}, \ j = \overline{1,n}. \quad (28)$$

4. Determination of the relative priority of the examined alternatives, where the higher is the importance degree $Q_j$, the higher is the relative priority of each alternative respectively. The relative importance $Q_j$ of an alternative reflects the satisfaction degree of objectives/goals, needs and requirements of project stakeholders. In case of the maximum value of relative importance $Q_{\max}$, the satisfaction degree of project stakeholders is considered the highest referring to the optimal/ideal alternative solution. Finally, the utility degree $N_j$ is used for the ranking of the examined alternatives:

$$N_j = \frac{Q_j}{Q_{\max}} * 100\%, \quad (29)$$

where $Q_j$ is the relative importance of the alternative $j$, and $Q_{\max}$ is the relative importance of the optimal/ideal alternative respectively.

## 2.10. Additive Ratio Assessment (ARAS)

The ARAS method (Additive Ratio Analysis) was developed by Zavadskas and Turskis (2010) for the assessment of the utility degree of each alternative solution from the optimal/ideal alternative. According to this method, the adopted utility function expresses the complicated relative efficiency of each alternative and is directly proportional to the relative effect of the value and weight (relative importance) of the considered evaluation criteria (Zavadskas & Turskis, 2010; Zavadskas et al., 2010).

The implementation process of the ARAS method is comprised of the following steps (Zavadskas & Turskis, 2010; Zavadskas et al., 2010; Goswami & Behera, 2021):

1. Configuration of the initial decision matrix, which consists of $m$ alternatives and $n$ evaluation criteria. Each evaluation criterion is assigned a specific weight (relative importance), as generated from the evaluations/judgements of professionals or the application of a specialized method/technique.
2. Normalization of the initial decision matrix for the assignment of dimensionless values to all the performances of the alternatives in terms of the examined evaluation criteria. The normalization of the performance values of the evaluation criteria is executed through the following equations:

$$\overline{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}}, \text{ (criteria with maximum values); (30)}$$

$$x_{ij} = \frac{1}{x_{ij}^{*}} \; ; \; \overline{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}},$$

(criteria with minimum values), (31)

where $x_{ij}$ is the initial performance of the alternative $i$ to the criterion $j$, and $\overline{x}_{ij}$ is the normalized performance respectively.

3. Configuration of the weighted normalized decision matrix by assigning the corresponding weights (relative importance) to the normalized values of the evaluation criteria as follows:

$$\hat{x}_{ij} = \overline{x}_{ij} * w_j, \; i = \overline{0,m}, \quad (32)$$

where $\overline{x}_{ij}$ is the normalized value of the evaluation criterion $j$, $w_j$ is the weight (relative importance) of the evaluation criterion $j$, and $\sum_{j=1}^{n} w_j = 1$.

4. Determination of the optimization function $S_i$ of each alternative solution using the equation:

$$S_i = \sum_{j=1}^{n} \hat{x}_{ij}, \; i = \overline{0, \; m}, \quad (33)$$

where $\hat{x}_{ij}$ is the weighted normalized value of the evaluation criterion $j$.

The optimization function $S_i$ is a direct and proportional correlation with variables $x_{ij}$ and $w_j$ of the examined evaluation criteria. Consequently, the higher is the value of the optimization function, the more effective is the corresponding alternative.

5. Determination of the utility degree $K_i$ of each alternative solution by comparing the value of the optimization function $S_i$ with the respective value of the optimal/ideal alternative $S_0$. The calculation of the utility degree of the alternative $i$ is performed using the following equation:

$$K_i = \frac{S_i}{S_0}, \; i = \overline{0, \; m}. \quad (34)$$

The values of the utility degree $K_i$ range from 0 and 1 sorted in ascending or descending order (final ranking). In general, the values of the utility degree express complicated relative efficiency of the examined alternatives.

## 2.11. Multi-Objective Optimization by Ratio Analysis (MOORA)

The MOORA method (Multi-Objective Optimization by Ratio Analysis) was developed by Brauers and Zavadskas (2006) and is a widely applied multicriteria multi-objective optimization method. In general, the MOORA method is conceptually composed of two distinct parts: the ratio system and the reference point theory.

In the first part (ratio system), the implementation process of MOORA method is structured in the following steps (Brauers & Zavadskas, 2006, 2010):

1. Normalization of the initial decision matrix using the equation:

$$\overline{x}_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}}, \quad i = 1,2,\ldots,m, \; j = 1,2,\ldots,n, \quad (35)$$

where $x_{ij}$ is the performance of the alternative $i$ to the evaluation criterion $j$, $\overline{x}_{ij}$ is the normalized performance, and $n$ is the number of the evaluation criteria respectively.

2. Configuration of the weighted normalized decision matrix by assigning the weights (relative importance) of the evaluation criteria to the normalized performance of the corresponding alternative as follows:

$$x_{ij}^{*} = \overline{x}_{ij}^{*} w_j, \quad (36)$$

where $w_j$ is the weight (relative importance) of the evaluation criterion $j$, and $\sum_{j=1}^{n} w_j = 1$.

3. Determination of the normalized evaluation index $y_i$ for the optimization of the results by adding the performance values in maximization case (beneficial criteria) and by subtracting the corresponding performance values in minimization case (non-beneficial criteria):

$$y_j = \sum_{i=1}^{i=g} x_{ij}^{*} - \sum_{i=g+1}^{i=n} x_{ij}^{*}, \quad (37)$$

where $i = 1,2,\ldots,g$ in maximization case, and $i = g+1, g+2,\ldots,n$ in minimization case respectively.

Consequently, the final ranking of the examined alternatives based on $y_i$ index demonstrates the pro-

posed preference order. The alternative that presents the highest $y_i$ index is considered as the optimal/ideal alternative.

Referring to the second part of MOORA method (reference point theory), a specific reference point for maximization is selected presenting the highest performances per evaluation criterion among all the examined alternatives. In minimization case, the reference point with the lowest performances is selected respectively. The calculation of the distance between the considered alternatives and the corresponding reference point is using the Min-Max measure by Tchebycheff as follows:

$$\text{Min}_j \left\{ \max_i \left| r_i - x_{ij}^* \right| \right\}, \quad i = 1, 2, \ldots n, j = 1, 2, ..., m, \qquad (38)$$

where $r_i$ is the $i^{\text{th}}$ performance of the maximum reference point of each evaluation criterion, $x_{ij}^*$ is the weighted normalized performance of the alternative $i$ to the evaluation criterion $j$.

## 3. Results and discussion

### 3.1. Application results of MCDM/MCDA methods

In general context, the implementation processes/algorithms of the ten (10) selected multicriteria decision making/analysis (MCMD/MCDA) methods are thoroughly performed (Sub-sections 2.3 to 2.11), based on the numerical values of the initial decision matrix (Table 2), for the evaluation and final ranking of the 20 examined projects (alternatives). It should be remarked that all evaluation criteria (success criteria) reflect benefit functions (beneficial criteria) influencing the applied processes/algorithms and the extracted results (Table 4). The definition of all evaluation criteria as beneficial in this research originates from the way of configuration and structuring of the project success evaluation model/framework (Lamprou & Vagiona, 2022b). The overall project success score (PSS) results from the individual performances of the examined projects in terms of the 17 success criteria (SC). Each success criterion (SC) consists of specific evaluation classes representing different performances of the examined project. The evaluation classes are accompanied by numerical values (scales) that are used for the computation of the overall project success score (PSS). The way that these numerical values (scales) are initially defined by the authors in the project success evaluation model/framework indicates that all evaluation criteria reflect benefit functions (beneficial criteria).

Consequently, all criteria are treated as maximization criteria in the implementation of the ten (10) selected MCDM/MCDA methods. In each case, some specific assumptions were adopted depending on the corresponding peculiarities in the research sample:

- In AHP method, a reference that encloses the value of the random consistency index $(RI)$ in case of 20 corresponding alternatives $(RI \text{ for } n = 20)$ is systematically investigated. Considering that $RI(20) \approx 1.782$ (Xiao, 2010, p. 10), the extracted values of the consistency ratio $(CR)$ are significantly below 0.1 $(CR \leq 0.1)$.
- In VIKOR algorithm, the weight of the decision maker's strategy receives value 0.5 $(u = 0.5)$ for the optimization of the extracted results.

**Table 4.** The final ranking of the examined projects based on MCDM/MCDA methods

| | AHP | TOPSIS | VIKOR | PROMETHEE | WSM | WPM | WASPAS | COPRAS | ARAS | MOORA |
|---|---|---|---|---|---|---|---|---|---|---|
| Project 1 | 14 | 4 | 11 | 11 | 8 | 7 | 7 | 7 | 7 | 7 |
| Project 2 | 6 | 5 | 7 | 7 | 6 | 4 | 5 | 6 | 6 | 6 |
| Project 3 | 2 | 7 | 3 | 2 | 4 | 6 | 4 | 4 | 4 | 4 |
| Project 4 | 13 | 12 | 14 | 12 | 16 | 12 | 12 | 11 | 11 | 11 |
| Project 5 | 7 | 6 | 2 | 6 | 5 | 5 | 6 | 5 | 5 | 5 |
| Project 6 | 11 | 15 | 9 | 10 | 11 | 13 | 11 | 14 | 14 | 12 |
| Project 7 | 5 | 11 | 4 | 5 | 7 | 8 | 8 | 8 | 8 | 8 |
| Project 8 | 18 | 19 | 16 | 17 | 19 | 19 | 19 | 19 | 19 | 19 |
| Project 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Project 10 | 3 | 2 | 6 | 4 | 2 | 2 | 2 | 2 | 2 | 2 |
| Project 11 | 4 | 3 | 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Project 12 | 12 | 9 | 10 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Project 13 | 19 | 16 | 19 | 19 | 18 | 17 | 17 | 17 | 17 | 17 |
| Project 14 | 9 | 13 | 12 | 14 | 13 | 14 | 14 | 12 | 12 | 13 |
| Project 15 | 15 | 17 | 18 | 15 | 12 | 16 | 16 | 16 | 16 | 16 |
| Project 16 | 16 | 18 | 15 | 16 | 17 | 18 | 18 | 18 | 18 | 18 |
| Project 17 | 17 | 8 | 17 | 18 | 15 | 11 | 13 | 15 | 15 | 15 |
| Project 18 | 10 | 13 | 12 | 13 | 13 | 14 | 14 | 12 | 12 | 13 |
| Project 19 | 8 | 10 | 8 | 8 | 10 | 10 | 10 | 10 | 10 | 10 |
| Project 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

- Regarding to PROMETHEE II algorithm, the usual preference function is selected, which does not include threshold values and corresponds to a binary result.
- The extracted results of the WASPAS method are calculated considering that the optimization coefficient receives value 0.5 $(\lambda = 0.5)$.

### 3.2. Comparative evaluation of the extracted results

The final stage of the research methodology encloses the comparative evaluation and analysis of the results extracted from the consecutive implementation of the most cited multicriteria decision making/analysis (MCDM/MCDA) methods in terms of project success evaluation/assessment (Table 4).

Reviewing the aforementioned table (Table 4), a significant convergence is distinguished in applied MCDM/MCDA methods regrading to the higher and the lower positions in the final ranking of the examined projects. Specifically, "Project 9" predominates in the first position in all the applied MCDM/MCDA methods, whilst "Project 10" follows in the relevant ranking in a remarkable percentage (70%) of application cases. On the contrary, "Project 20" is placed in the last position of the final ranking by the vast majority of the applied MCDM/MCDA methods, while "Project 8" (70%) and "Project 16" (60%) are ranked to a great extent in the two immediately precedent positions. Referring to the superior positions of the final ranking (top ten), the extremely high appearance frequency of "Project 11" (80%) in third place, as well as of "Project 12" (80%) and "Project 19" (70%) in ninth and tenth place is preponderating. In the second part of the final ranking (second ten), the assignment of "Project 16" in eighteenth position in a remarkable percentage (60%) of the applied MCDM/MCDA methods is observed. In the intermediate positions of the final ranking, the balanced distribution (50%) of "Project 3" in fourth place, "Project 5" in fifth place, "Project 1" in seventh place, and "Project 15" in sixteenth place is highlighted, whilst strong differentiations are observed in the final ranking of the applied MCDM/MCDA methods in the remaining cases (Figure 2).

In general, the most significant divergences in the final ranking of the 20 examined projects are identified between AHP, TOPSIS, VIKOR, PROMETHEE methods and WSM, WPM, WASPAS, COPRAS, ARAS, MOORA methods respectively. On the contrary, WSM, WPM, WASPAS, COPRAS, ARAS, and MOORA methods present remarkable convergences in terms of the prioritization of the 20 examined projects, mainly justified by the relative similarity between the individual adopted implementation processes. Additionally, the designation of the 17 success criteria as beneficial criteria potentially affects the extracted results of the applied MCDM/MCDA methods. Defining all criteria as beneficial is an important methodological decision. Many MCDM/MCDA methods (such as TOPSIS, VIKOR, PROMETHEE, WSM, WPM, WASPAS, COPRAS, ARAS, MOORA)

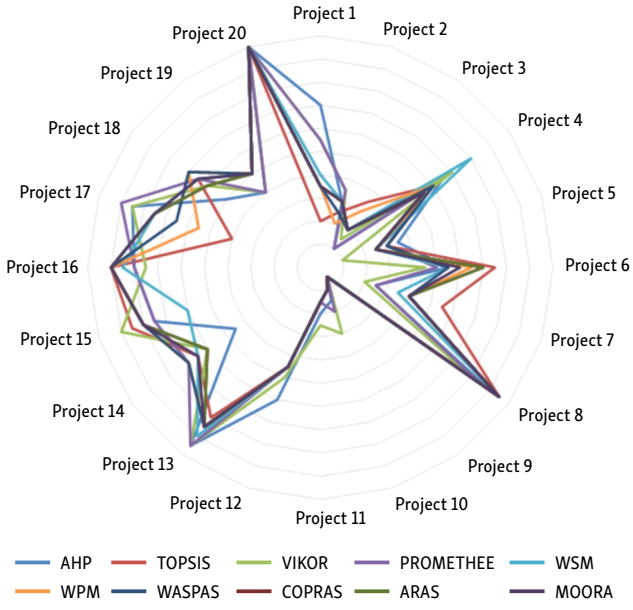



**Figure 2.** Radar chart for projects' ranking based on MCDM/MCDA methods

base their calculation of the final project performances on an initial distinction between beneficial and non-beneficial criteria. Consequently, using only beneficial criteria might partly account for the high agreement seen among various MCDM/MCDA methods.

The above two clusters of methods, namely (i) AHP/TOPSIS/VIKOR/PROMETHEE and (ii) WSM/WPM/WASPAS/COPRAS/ARAS/MOORA, produce different or similar results due to their structural and computational differences. AHP uses hierarchical pairwise comparisons, TOPSIS and VIKOR use ideal-solution distances, and PROMETHEE employs outranking relations along with preference flows. Therefore, the different structures and computations may lead to different rankings of projects. In the second cluster, despite each method using different formulas, they handle the ranking of alternatives in a quite similar manner. This includes normalizing each project's performance values, multiplying them by criterion weights, and synthesizing the results into an overall score or utility index. As all criteria in this research are considered beneficial and the success criteria weights are quite similar, high convergence and identical rankings are observed among the second cluster.

### 3.3. Correlation analysis

For the comparative evaluation of the research results, the correlation analysis is appropriately selected in order to investigate potential relationships or dependencies between the applied MCDM/MCDA methods. The correlation analysis constitutes a statistical method/technique used for the measurement and interpretation of the possible relationship between two variables. A correlation can receive values between –1.00 and 1.00, while the sign of the result indicates the direction of the co-variation between the two variables. If the correlation is positive, the two variable co-

variate in the same direction, whilst a negative correlation indicates that the two variables co-variate in the opposite direction respectively. Furthermore, a correlation is considered stronger when it is closer to the perfect correlation (1.00/–1.00), while weaker when it is closer to zero correlation (0.00). Finally, the correlation of two variables does not necessarily reflect the causality between them and might need further examination Specifically, the bivariate correlation is selected for the 10 applied MCDM/MCDA methods using Spearman's correlation coefficient ($r_s$), as the examined variables include nominal data (Pallant, 2016; Gravetter & Wallnau, 2017).

According to Table 5, the majority of the correlations between the applied MCDM/MCDA methods present high statistical significance (p < 0.001, two-tailed), whilst the Spearman correlation coefficients range from 0.75 to 1.00. Indicatively, a correlation coefficient higher than 0,5 refers to strong correlations, whilst a correlation coefficient between 0.7 and 1.00 corresponds to very strong or perfect correlations respectively (Pallant, 2016).

In particular, perfect correlations $\left(r_s = 1.00\right)$ are identified between the COPRAS, ARAS, and MOORA methods, where the final rankings of the 20 examined projects are absolutely identical. The final importance or utility indices of the specific methods originate from the individual performances of the examined alternatives in the beneficial and non-beneficial criteria, which significantly affects the results depending on the separation of the evaluation criteria. Considering that all success criteria reflect benefit functions, the final indices derive from the maximized performances of the 20 examined projects, whilst the normalization methods/techniques of the initial decision matrix are quite similar. Furthermore, the extremely high correlations $\left(0.96 \le r_s \le 0.99\right)$ between WSM, WPM, WASPAS methods and COPRAS, ARAS, MOORA methods proceeded from the inclusion of the evaluation criteria as beneficial criteria, and the balanced distribution of their weights (relative importance) within the research sample. The expected strong correlation $\left(0.97 \le r_s \le 0.99\right)$ between WASPAS, WSM, and WPM methods should be also reported, as the first method is the product of the weighted summation of the performances of the other two methods.

Regarding to the remaining results, the very high correlations between PROMETHEE and WSM, WPM, WASPAS, COPRAS, ARAS, and MOORA methods $\left(0.90 \le r_s \le 0.95\right)$, as well as between TOPSIS and WSM, WPM, WASPAS, COPRAS, ARAS, and MOORA methods $\left(0.88 \le r_s \le 0.97\right)$ are observed respectively. The identified convergences in the final ranking of the 20 examined projects may be affected by the lack of extreme values in the individual performances of the research sample, even though some of the aforementioned methods enclose completely different algorithms. Alternatively, the performance values of the 20 examined projects in all success criteria present small numerical deviations, whilst comparable normalization methods/techniques are mostly used.

Additionally, high correlations exist between PROMETHEE and VIKOR $\left(r_s = 0.97\right)$ and AHP $\left(r_s = 0.95\right)$ methods, where the final rankings of the 20 examined project are significantly similar due to the lack of extreme values in the performances, and the balanced assignment of the weights (relative importance) in the 17 success criteria. In this case, the three considered methods have different implementation processes, while each of them is classified into the distinct category of multi-attribute decision-making (MADM) methods. The judgement of all evaluation criteria as beneficial criteria significantly justifies the identified convergences between the results of VIKOR method and WASPAS, COPRAS, ARAS, and MOORA methods $\left(0.90 \le r_s \le 0.91\right)$. It is also highlighted that TOPSIS and VIKOR methods are structurally different from all the other multicriteria methods based on the calculation of the relative proximity of a specific reference point, where the absence of extreme values significantly affects the extracted results. Finally, the lowest, but also strong, correlation is observed between AHP and TOPSIS methods $\left(r_s = 0.75\right)$, as both multicriteria methods present completely different implementation algorithms.

The high Spearman's correlation coefficients observed across all method pairs provide empirical evidence that, despite underlying computation differences, the methods generally agree on a stable ordinal structure when applied to a consistent decision matrix with solely beneficial criteria and balanced criterion weights.

**Table 5.** Correlation analysis between the performed MCDM/MCDA methods

| MCDM/MCDA Methods | AHP | TOPSIS | VIKOR | PROMETHEE | WSM | WPM | WASPAS | COPRAS | ARAS | MOORA |
|---|---|---|---|---|---|---|---|---|---|---|
| AHP | 1.00 | 0.75 | 0.93 | 0.95 | 0.91 | 0.85 | 0.88 | 0.90 | 0.90 | 0.90 |
| TOPSIS | | 1.00 | 0.77 | 0.80 | 0.88 | 0.97 | 0.95 | 0.94 | 0.94 | 0.93 |
| VIKOR | | | 1.00 | 0.97 | 0.91 | 0.87 | 0.90 | 0.90 | 0.90 | 0.91 |
| PROMETHEE | | | | 1.00 | 0.95 | 0.90 | 0.94 | 0.94 | 0.94 | 0.95 |
| WSM | | | | | 1.00 | 0.95 | 0.97 | 0.96 | 0.96 | 0.97 |
| WPM | | | | | | 1.00 | 0.99 | 0.97 | 0.97 | 0.98 |
| WASPAS | | | | | | | 1.00 | 0.98 | 0.98 | 0.99 |
| COPRAS | | | | | | | | 1.00 | 1.00 | 1.00 |
| ARAS | | | | | | | | | 1.00 | 1.00 |
| MOORA | | | | | | | | | | 1.00 |

The consistent rankings of the top and bottom choices (Projects 9 and 20, respectively) suggest that when projects either excelled or underperformed according to the success criteria, all examined methods detected them. This finding indicates that MCDM/MCDA methods, despite their different internal processes, generally concur on which alternatives are clearly better or worse. Differences among methods become more significant in the middle ranks, where project performances are more closely matched.

From a practical standpoint, the results have important implications for decision-makers (e.g., project managers, program managers, engineers). When the objective is to identify the single best or worst-performing project, the present findings suggest that the choice of method is unlikely to change the ranking, and simpler aggregative methods such as WSM or ARAS could be preferred for their transparency and ease of calculation. Conversely, when evaluation outcomes will be used for the overall assessment of all projects, the use of several methods from both clusters, followed by a correlation analysis, is recommended to encompass the entire scope of methodological sensitivity and ensure that rankings are not the result of a single algorithmic approach. Finally, the greater variation observed in mid-ranked projects suggests that decision-makers should exercise greater caution with these projects.

Summarizing, the results of correlation analysis demonstrate very strong relationships in the final ranking of the 20 examined projects between the applied MCDM/MCDA methods (Table 5). The main reasons for the remarkable similarities/convergences are the absence of extreme values in the initial decision matrix, the inclusion of the evaluation criteria as beneficial criteria, as well as the adoption of equivalent implementation processes in most cases respectively.

## 3.4. Sensitivity analysis

In the final stage, the sensitivity analysis is implemented in order to check the consistency and robustness of the ten (10) selected multicriteria decision making/analysis (MCDM/MCDA) methods in case of different variations in the evaluation criteria weights.The proposed methodological framework initially categorizes the17 success criteria into primary (SC1, SC2, SC3, SC4) and secondary (SC5, SC6, SC7, SC8, SC9, SC10, SC11, SC12, SC13, SC14, SC15, SC16, SC17) criteria (Lamprou & Vagiona, 2022b) and six scenarios are configurated based on different weight variations. The baseline scenario ($S_0$) corresponds to the main application of the ten (10) selected MCDM/MCDA methods, where the weights of the evaluation criteria are previously allocated by the experts (Table 1). In the first scenario ($S_1$), the 17 distinct evaluation criteria are considered equally important for the evaluation of project success. The common similarity of the four remaining scenarios ($S_2$, $S_3$, $S_4$, $S_5$) lies to allocation of 30% of the aggregate weight to the primary evaluation criteria and 70% percent to the secondary evaluation criteria respectively. In particular, the second scenario ($S_2$) implies that the first evaluation criterion (SC1) receives 50% of the corresponding aggregate weight with the remaining amount equally allocated to the other primary evaluation criteria (SC2, SC3, SC4), also considering that all the secondary evaluation criteria proportionally contribute to their individual aggregate weight. In the other three scenarios ($S_3$, $S_4$, $S_5$) 50% of the corresponding aggregate weight of the primary evaluation criteria is consecutively transposed to the second (SC2), third (SC3) and fourth success criterion (SC4), whilst the rest weight allocations remain consistent (Table 6).

In general context, the results of the sensitivity analysis demonstrate the prevalence of "Project 9" and "Project 20" in the first and the final place respectively, despite the corresponding variations in evaluation criteria weights according to the six different scenarios. However, several divergences are evident in the intermediate positions of the final rankings due to variations in evaluation criterion weights, where performance differences are smaller.

Specifically, the second scenario ($S_2$) encloses the most remarkable divergences in the intermediate positions in the majority of the applied MCDM/MCDA methods, emphasizing the significant precedence of the first evaluation criterion (SC1) in terms of weight allocation. Additionally, the third scenario ($S_3$) includes smaller variations in the final rankings of the applied MCDM/MCDA methods transposing the higher relative importance to the second evaluation criterion (SC2). The remaining application scenarios ($S_0$, $S_1$, $S_4$, $S_5$) present minimal differences in the final rankings in all the applied MCDM/MCDA methods showing higher robustness and consistency. Eventually, the extracted results of the sensitivity analysis indicate the higher impact of the first and second evaluation criteria (SC1, SC2) in the configuration of the final rankings of the examined projects and, by extension, in the context of project success contribution.

**Table 6.** Weight allocation based on the six application scenarios

| | SC1 | SC2 | SC3 | SC4 | SC5 | SC6 | SC7 | SC8 | SC9 | SC10 | SC11 | SC12 | SC13 | SC14 | SC15 | SC16 | SC17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $S_0$ | 0.067 | 0.065 | 0.065 | 0.064 | 0.062 | 0.062 | 0.061 | 0.061 | 0.057 | 0.057 | 0.057 | 0.057 | 0.055 | 0.055 | 0.054 | 0.054 | 0.047 |
| $S_1$ | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 |
| $S_2$ | 0.150 | 0.050 | 0.050 | 0.050 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 |
| $S_3$ | 0.050 | 0.150 | 0.050 | 0.050 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 |
| $S_4$ | 0.050 | 0.050 | 0.150 | 0.050 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 |
| $S_5$ | 0.050 | 0.050 | 0.050 | 0.150 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 | 0.054 |

Spearman's rank correlation analysis results of all the examined scenarios indicate that rankings remain largely consistent despite changes in criteria weights. Across all sensitivity scenarios, Spearman's correlation coefficients remained very strong across nearly all methods. Table 7 presents the minimum, maximum, and average values of these coefficients. Among the methods tested, TOPSIS showed the highest sensitivity, whereas the others generally maintained very strong correlations between the original and adjusted-weight rankings.

**Table 7.** Spearman's rank coefficients based on the six application scenarios

| MCDM/MCDA method | Minimum | Maximum | Average |
|---|---|---|---|
| AHP | 0.88 | 1.00 | 0.94 |
| TOPSIS | 0.56 | 0.99 | 0.79 |
| VIKOR | 0.71 | 0.97 | 0.85 |
| PROMETHEE | 0.89 | 1.00 | 0.95 |
| WSM | 0.90 | 1.00 | 0.94 |
| WPM | 0.90 | 1.00 | 0.95 |
| WASPAS | 0.88 | 1.00 | 0.95 |
| COPRAS | 0.90 | 1.00 | 0.95 |
| ARAS | 0.90 | 1.00 | 0.95 |
| MOORA | 0.91 | 1.00 | 0.95 |

## 4. Conclusions

Multicriteria decision making/analysis (MCDM/MCDA) methods are widely applied for the resolution of significant decision-making problems/issues in engineering sciences during the last decades. However, the employment of these methods for the evaluation/assessment of project success is considered quite limited within the international literature. The primary objective of this article is to compare the application of 10 well-established multicriteria decision making/analysis (MCDM/MCDA) methods for project success evaluation/assessment.

In the first stage, the required data for the application of multicriteria decision making/analysis (MCDM/MCDA) methods are provided by the web-based application (www.projectsuccess.gr) according to the evaluations/judgements of experts and professionals in construction sector. The data refer to the specialized performances of 20 completed projects in Greece under the 17 important project success criteria. The decision-making problem/issue is defined and the initial decision matrix (20×17) is configured based on the numerical values extracted by the web-based application.

Secondly, the 10 prominent multicriteria decision making/analysis (MCDM/MCDA) methods are thoroughly presented and implemented according to the performances of the initial decision matrix. It should be noted that the values of the initial decision matrix are registered in common dimensions and some assumptions are adopted so as to facilitate the implementation of the selected MCCM/MCDA methods.

Finally, the extracted application results are compared in detail indicating specific deviations in the final ranking of the 20 examined projects. In particular, remarkable convergence between the applied MCDM/MCDA methods in the higher and lower positions is presented, where "Project 9" and "Project 10" predominate, and "Project 20" and "Project 8" are degraded respectively. On the contrary, the identified divergences in the final results among AHP, TOPSIS, VIKOR, PROMETHEE methods and WSM, WPM, WASPAS, COPRAS, ARAS, MOORA methods mainly originate from the significant differences in the adopted implementation processes and the inclusion of only beneficial criteria in the research sample. Additionally, the Spearman's rank correlation coefficient is selected for the comparative analysis of the extracted results. The correlation analysis reflects very strong relationships $\left(0.75 \le r_s \le 1.00\right)$ between the 10 applied MCDM/MCDA methods mainly justified by the absence of extreme values in the initial decision matrix, and the designation of the evaluation criteria as beneficial criteria in the adopted calculation processes. Specifically, perfect or almost perfect correlations are indicated between COPRAS, ARAS and MOORA methods, and WSM, WPM and WASPAS methods respectively affected by the similarity of the adopted normalization methods/techniques and the balanced distribution of the weights of the beneficial evaluation criteria. However, lower -but still very strong- correlations are observed between TOPSIS and VIKOR methods, and the remaining applied MCDM/MCDA methods due to the structural differentiations in their implementation algorithms. In general, the small numerical deviations in the research sample, the balanced distribution of the weights (relative importance) of the 17 beneficial criteria, as well as the similarity in the adopted normalization methods/techniques lead to the configuration of the extracted research results.

A sensitivity analysis of the criteria weights is conducted to test the robustness of the rankings under different weighting scenarios. The findings reveal that the overall ranking structure is stable, with high Spearman's rank correlation coefficients in almost all the examined scenarios. "Project 9" consistently is the top choice in all applied scenarios and methods, whereas the most significant ranking fluctuations occur among the mid-ranked projects.

The adopted research methodology demonstrates the usefulness and robustness of the application of multicriteria decision making/analysis (MCDM/MCDA) for the evaluation/assessment of project success in completed projects. The findings prove that no single MCDM/MCDA method yields universally superior results; rather, the choice of method should be guided by the nature of the decision-making problem and the structure of the evaluation criteria. The identification of two distinct methodological clusters: (i) AHP, TOPSIS, VIKOR, and PROMETHEE, and (ii) WSM, WPM, WASPAS, COPRAS, ARAS, and MOORA, offers practitioners a structured basis for selecting methods based on whether compensatory or non-compensatory logic is preferred.

The present research has some important strengths and limitations. Firstly, the comparative application focuses on 10 MCDM/MCDA methods aiming at the success evaluation of 20 completed projects in the construction sector of Greece. The consecutive application of 10 prominent multicriteria decision making/analysis (MCDM/MCDA) methods constitutes a novel and alternative methodology for the evaluation of project success in engineering and construction. The empirical data provided by the present research could contribute to further research or operational objectives in the context of rational and accurate project success evaluation/assessment.

However, the present research has some important limitations. The empirical sample includes 20 completed projects, which is sufficient for demonstrating the proposed framework's applicability and for comparative analysis of selected MCDM/MCDA methods within this specific context. However, this sample size is relatively small, limiting the generalizability of the results. Additionally, ten experts and professionals from Greece's construction sector evaluated these projects. Their judgments may reflect local priorities, experience, national regulatory frameworks, and construction practices, which could restrict the transferability and generalizability of the framework to other countries, project types, or decision-making settings.

Future research should include the application of the proposed framework to a higher number and more diverse samples of projects, including projects from various sectors and countries, and involve broader expert panels representing various stakeholders. Expanding the research sample to include various types of projects, as well as projects form different national contexts, would substantially enhance the generalizability and external validity of the proposed framework. Eventually, further research should focus on the application of other multicriteria decision making/analysis (MCDM/MCDA) methods (e.g. ELECTRE, EDAS, SWARA, DEMATEL, ANP) in order to potentiate the findings of the proposed framework, as well as on the use of quantitative data regarding the success criteria.

## Funding

The present research received no external funding.

## Author contributions

AL and DV conceived the study and were responsible for the conceptualization, design and development of the article. AL and DV were responsible for data collection and analysis. AL and DV were responsible for data interpretation and methodology application. AL wrote the first draft of the article.

## Disclosure statement

The authors declare that they have not any competing financial, professional, or personal interests from other parties.

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