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Research Article

Smart MCDM Decision Tool: An Intelligent Multi-Criteria Framework for Effective Decision Analysis and Selection

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Abstract:
The Smart MCDM Decision Tool is a web-based system developed using Python and Streamlit to support users in making accurate and efficient decisions. The system combines the Entropy method with several Multiple Criteria Decision Making (MCDM) techniques to evaluate alternatives based on multiple conflicting criteria. Users can enter raw data directly into the system, and the tool automatically generates the ranking results in a short time. The user-friendly interface makes the system suitable for users with limited programming knowledge. By automating the calculation process, the system reduces human error, improves accuracy, and increases the efficiency of decision-making activities.

1. INTRODUCTION

In real-world situations, decision-makers are often required to evaluate several alternatives based on multiple conflicting criteria. According to Zayat et al. (2023), the Multiple Criteria Decision Making (MCDM) methods assist in selecting the best alternatives in situations when various criteria must be considered simultaneously. MCDM methods, which are developed based on the assumption of a complex decision environment, are among the most popular decision-making approaches in scientific, business, and governmental fields (Zavadskas & Turskis, 2011). These methods contribute to better decision quality by making the decision-making process more explicit, rational, and efficient (Zavadskas & Turskis, 2011).

However, decision-making can become complicated and may produce biased outcomes when it relies too much on personal judgment. In addition, performing calculations manually is time-consuming and can increase the risk of errors, which may affect the quality of decisions, especially in situations that require quick responses. To overcome these issues, the Smart MCDM Decision Tool was designed as a web-based decision support system developed with Python and Streamlit. The system is designed to aid decision-makers in producing accurate and reliable results through the implementation of MCDM methods. The system features a user-friendly interface that allows individuals with limited or no programming experience to identify the most suitable alternative easily. By automating the calculation process, the system helps boost the efficiency of the decision-making process by reducing computational errors and generating results more systematically and accurately.

The objectives of the project are to develop a web-based system named the Smart MCDM Decision Tool that combines the Entropy method with various MCDM techniques, namely the Multi-Objective Optimization on The Basis of Ratio Analysis (MOORA), Evaluation based on Distance from Average Solution (EDAS), and Complex Proportional Assessment (COPRAS) and to ease the decision-making process by using the Smart MCDM Decision Tool to automate complex calculations. These techniques are applied to evaluate and rank alternatives under multiple conflicting criteria.

The system allows users to input raw data and instantly generate the ranking of the alternatives, making it easy to select the optimal choice. The uniqueness of this system is reflected in the integration of the Entropy method with multiple MCDM techniques into a single automated, code-free web application. Therefore, integrating multiple MCDM methods into a web-based decision support system significantly improves the decision-making process. This improvement is driven by the inherent strengths of each selected method, making the decision-making process faster, more accurate, and more transparent.

2. LITERATURE REVIEW

This section presents the literature review of the MCDM methods used in this project.

2.1 Entropy method

In this project, the Entropy method proposed by Shannon (1948) is adopted to obtain the criterion weights. The Entropy method evaluates the dispersion of data values in decision-making problems. It is derived based on probability theory to obtain uncertain information or entropy (Chodha et al., 2022). In information theory, entropy refers to the level of uncertainty contained in a set of data. When the amount of information is low, the uncertainty becomes higher, resulting in a lower entropy value. Therefore, entropy values can be used to evaluate the importance of each indicator, as differences in entropy reflect the relative significance of the criteria (Zhang et al., 2022).

The method is widely used for its feature to generate criterion weights without relying on the subjective judgment of the decision-maker. The method determines criteria weights objectively without relying on experts' opinions and judgments, thereby avoiding human interference and reducing bias in the evaluation process (Goswami et al., 2022). It eliminates the need for a pairwise comparison matrix, thus avoiding inconsistency issues and removing the necessity for consistency verification (Goswami et al., 2022). This approach is particularly suitable in situations where the decision-makers have different opinions on the values of weights (Goswami & Behera, 2021). The index weight value generated from the Entropy method has higher reliability and accuracy than the subjective weighting method (Zhang et al., 2022). In this project, the Entropy is integrated with MOORA, EDAS, and COPRAS methods to make the optimal choice.

2.2 MOORA method

Brauers and Zavadskas (2006) introduced the MOORA method as an approach for assessing discrete alternatives in a multi-objective optimization problem. The method employs ratio analysis within a decision matrix and normalizes the data by using the square root of the sum of squared responses as the denominator. The resulting dimensionless values are combined by summing benefit criteria and deducting cost criteria to determine the overall performance of alternatives. The MOORA method is widely recognized for its simplicity, flexibility, and capability to separate subjective influence in decision-making through the assignment of weights to multiple evaluation criteria (Kuppusamy Vellingiri et al., 2025). The flexibility of the MOORA method enables decision-makers to differentiate criteria and alternatives more effectively, which supports a more systematic comparison process (Kuppusamy Vellingiri et al., 2025).

2.3 EDAS method

The EDAS method was established by Ghorabaee et al. (2015). It is widely used for ranking alternatives in complex decision-making environments involving numerous evaluation criteria. A major characteristic that differentiates EDAS from methods such as Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) is its use of average solution-based normalization. While conventional methods rely on ideal and anti-ideal solutions, EDAS evaluates alternatives according to their distance from the average solution, which can provide a more realistic analysis in actual decision-making scenarios (Torkayesh et al., 2023).

To evaluate the performance of each alternative and establish their ranking order, the EDAS method employs two assessment measures known as the Positive Distance from Average (PDA) and the Negative Distance from Average (NDA) (Ghorabaee et al., 2015; Torkayesh et al., 2023). These measures are determined based on the types of criteria, whether they are categorized as cost or benefit (Ghorabaee et al., 2015). A notable characteristic of this method is that the evaluation outcomes are derived from the average solution, which helps eliminate the risk of expert bias toward a particular alternative and minimizes the possibility of significant deviation from the best solution (Aggarwal et al., 2018). Overall, EDAS is recognized for its efficient computational process, moderate calculation complexity, and adaptable decision-making framework (Torkayesh et al., 2023).

2.4 COPRAS method

The COPRAS method was developed by Edmundas Kazimieras Zavadskas and Artūras Kaklauskas in 1996 (Zavadskas et al., 2009). The COPRAS method can assess benefit and cost criteria individually, helping decision-makers understand the effects of ideal and anti-ideal solutions on alternatives (Goswami et al., 2022). The method, which provides more accurate information compared to other methods for evaluating benefit and cost criteria, is used to consider both aspects of the criteria (Mishra et al., 2022). Goswami et al. (2022) also stated that the COPRAS method can produce more trustworthy outcomes in comparison to conventional methods such as Simple Additive Weighting (SAW), TOPSIS, VIKOR, and Analytic Hierarchy Process (AHP), and it is less affected by rank reversal problems. The strength of the COPRAS method lies in its simplicity, as it requires fewer mathematical calculations. It is also capable of analysing both qualitative and quantitative measures and demonstrating the utility degree of each alternative (Manivasagam et al., 2023).

3. METHODOLOGY

The Smart MCDM Decision Tool is developed to support faster and more efficient decision-making. The system is user-friendly and suitable for users with little or no programming knowledge.

The following section explains the step-by-step process of using the system, from data entry to result generation.

Figure 1 depicts the input interface of the Smart MCDM Decision Tool, a web-based system developed using Python and Streamlit. Users can customize the amount of alternatives and criteria based on their specific case study. Additionally, users can rename the alternatives and criteria to suit their needs. As shown in Figure 2, they can also categorize each criterion as either a cost or a benefit.

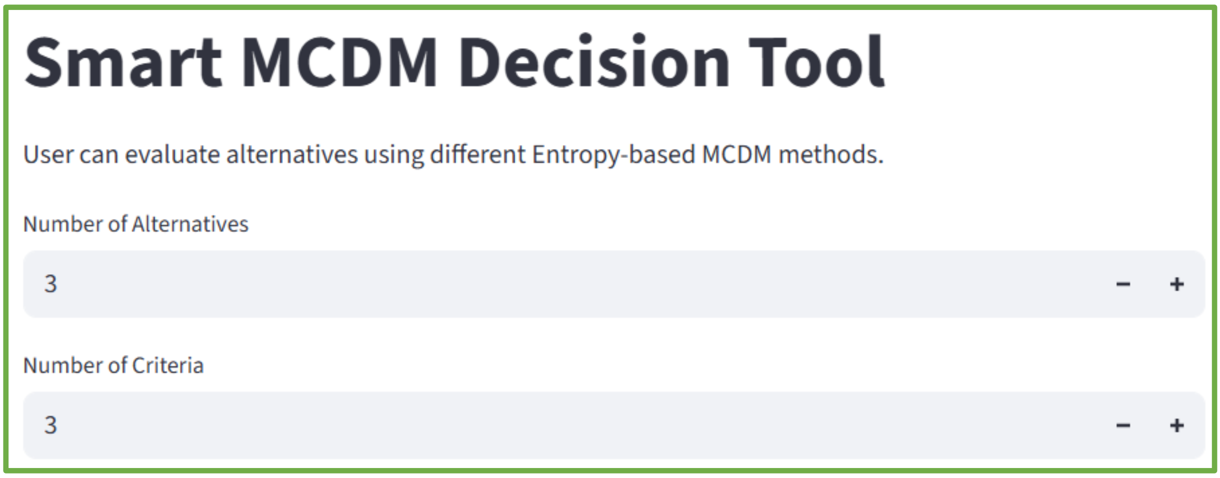

Figure 1. Input interface for the number of alternatives and criteria.

Figure 2. Alternatives and criteria configuration interface.

Furthermore, Figure 3 illustrates how users can input the collected data to construct the decision matrix. Next, users can choose any of the MCDM methods listed in the system to select the best alternative, as illustrated in Figure 4. Finally, the results generated based on the chosen MCDM method are presented in Figure 5.

Figure 3. The decision matrix

Figure 4. Data analysis

Figure 5. The findings

4. FINDINGS

The Smart MCDM Decision Tool enables users to enter the raw data directly into the system to obtain the ranking results automatically without requiring advanced programming skills. The decision matrix can be constructed easily, and the data analysis can be performed within a short period of time compared to manual calculations.

The computation of the criteria weights is a key element of the MCDM methods used in this project. The criteria weights are calculated to identify the relative importance of each criterion. The integration of the Entropy method with multiple MCDM methods will help decision-makers choose the optimal solution.

Meanwhile, the integration of the Entropy method with various MCDM methods into a web-based platform can simplify complex decision-making tasks. The users are able to use the automated system to run analyses even though they are not familiar with the MCDM methodology. The tool helps reduce computational errors and improves the efficiency of the decision-making process since the process is automatic.

5. DISCUSSION

The Smart MCDM Decision Tool was successfully implemented using Python and Streamlit, allowing users to perform decision analysis through a simple and interactive interface. The system supports the application of Entropy-based weighting together with several MCDM methods, which helps users evaluate alternatives in a more systematic manner. By automating the calculation process, the tool minimizes the possibility of human error that may occur during manual computations.

In addition, the web-based design improves accessibility since users can perform evaluations without installing complex software or having strong programming knowledge. The interface was developed to make data entry, criteria weighting, and result interpretation easier for users from different academic or professional backgrounds. The generated rankings also provide a clearer basis for decision-making because the alternatives are evaluated using structured mathematical procedures.

6. CONCLUSION

In conclusion, the Smart MCDM Decision Tool provides an effective platform for solving MCDM problems in a more organized and efficient way. By applying mathematical evaluation methods, the decision-making process becomes more transparent. The results produced through the integration of MCDM methods, and the automated system are less biased because the evaluation process is performed objectively based on the provided data and systematic calculations. Users are able to enter raw data directly, allowing the analysis process to be completed more quickly compared to manual calculation methods. In addition, the combination of Entropy-based MCDM techniques with Python and Streamlit allows users to carry out complex assessments through an accessible interface without the need for programming skills.

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