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PST012 - A PRACTICAL EXCEL SOLUTION FOR MULTI-CRITERIA ANALYSIS USING THE ENTROPY-ARAS APPROACH

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ABSTRACT

In this project, the Entropy-Additive Ratio Assessment (Entropy-ARAS) method is integrated with a user-friendly Microsoft Excel template. Traditionally, the decision maker chooses the best option or the best alternative independently of mathematical analysis. The project used the Entropy-ARAS to resolve the complex multi-criteria decision-making (MCDM) problems. The ARAS method is used to select the best alternative, and the Entropy method is used to establish the weights of the criteria. On the other hand, the Microsoft Excel template is designed to facilitate the complex MCDM problems by offering an organized and transparent framework for assessing the alternatives according to the multiple conflicting criteria. The novelty of this innovation lies in the incorporation of the Entropy-ARAS method into a Microsoft Excel template. Users can make an efficient and transparent decision without programming knowledge. The implementation of this template will guarantee the consistency of the final decisions and minimize the computation errors. In addition, the Excel-based Entropy-ARAS tool helps users comprehend and apply MCDM techniques to real-world problems as well as improve the quality and speed of decision-making.

Keywords – Entropy, ARAS, decision making

INTRODUCTION

Multi-criteria decision making (MCDM) is a branch of operations research (OR) that deals with evaluating and choosing between alternatives that are characterized by multiple conflicting criteria. Choosing the best alternatives is a complex process that requires careful consideration of various criteria. Numerous MCDM methods can be employed to address MCDM problems. Traditionally, decision-makers make decisions based on their subjective preferences without the involvement of mathematical analysis. The application of the MCDM method is expected to reduce bias and guarantee a structured and efficient decision-making process. This project proposes integrating the Entropy method with the Additive Ratio Assessment (ARAS) method. The ARAS method was introduced by Zavadskas and Turskis (2010). This method is based on comparing the ratios of utility function values for the alternatives to the optimal value, which allows for the determination of the proportional similarity of each alternative to the ideal alternative (Yücenur & Maden, 2024). It ranks a finite number of alternatives in relation to an ideal alternative by evaluating the proportionate utility ratio, which significantly improves the decision-making process

(Goswami et al., 2022). This approach not only evaluates the performance of the alternatives but also offers advantageous information concerning the proportional similarity of each alternative to the optimal choice (Yücenur & Maden, 2024).

The determination of the weight values is one of the important steps in the ARAS framework. The weight values are usually determined by the expert evaluation (Zavadskas & Turskis, 2010). Still, in this project, the Entropy method is employed to calculate the weight of the criteria. Entropy is an objective weighting method introduced by Shannon in 1948. This method is used to calculate the criteria weights without taking the decision-maker's opinion into consideration (Goswami et al., 2022). This method is fully independent of the decision maker's involvement and does not require any pairwise comparison matrix. Therefore, this method is free from inconsistency and does not require consistency checking for human judgments (Goswami et al., 2022). This project presents a user-friendly Microsoft Excel template that employs the Entropy-ARAS method to solve an MCDM problem. This tool will not only boost the decision-making process but is also expected to enhance its quality and speed.

OBJECTIVE

The objectives of the project are:

i. To design a user-friendly tool that integrates the Microsoft Excel template with the Entropy-ARAS method.
ii. To facilitate the decision-making process by providing a tool that automates the Entropy-ARAS calculation process.

DESCRIPTION OF THE PROJECT

This decision-making process involves three main phases. The first phase is data collection. The information about the criteria and alternatives is gathered. Then, the data are entered in a Microsoft Excel template. Figure 1 shows the decision matrix, which presents the evaluation of each alternative with respect to each criterion.

The second phase involved the application of the Entropy method to obtain the criteria weight. Once the decision matrix is constructed, it is first normalized. Then, the Entropy values and the degree of divergence for each criterion are calculated. Based on these, the weights of the criteria are determined. Figure 2 illustrates both the normalized decision matrix and the calculated weights.

The final phase involved applying the ARAS method to select the best alternatives. The process begins with the construction of the decision matrix. Next, the minimum and maximum criteria are identified, and any minimum criteria are converted into maximum criteria. Following this, the decision matrix is normalized, and the weighted normalized matrix is calculated. Next, the optimal values for each alternative and their respective degrees of utility are determined. Finally, the best alternative is identified based on the utility degree values. Figure 3 shows the ranking of the alternatives.

Objective	Select the best alternative				
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
	Benefit	Cost	Benefit	Benefit	Benefit
Alternative 1	5	3	5	3	5
Alternative 2	2	12	4	2	5
Alternative 3	2	5	4	5	3
Sum	9	20	13	10	13

Figure 1: Decision matrix

Objective	Select the best alternative					
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	
	Benefit	Cost	Benefit	Benefit	Benefit	
Alternative 1	0.55556	0.15	0.38462	0.3	0.38462	
Alternative 2	0.22222	0.6	0.30769	0.2	0.38462	
Alternative 3	0.22222	0.25	0.30769	0.5	0.23077	
Sum	1	1	1	1	1	
Entropy	0.90571	0.85347	0.99474	0.93723	0.97705	
Degree of divergence	0.09429	0.14653	0.00526	0.06277	0.02295	0.3318
Criteria weight	0.28417	0.44161	0.01586	0.18918	0.06918	1
Ranking	2	1	5	3	4	

Figure 2: Normalized decision matrix and the weights of the criteria

Objective	Select the best alternative							
Criteria weight	0.28417	0.44161	0.01586	0.18918	0.06918			
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5			
	Benefit	Cost	Benefit	Benefit	Benefit	Sum	U	%	Ranking
A0	0.10149	0.15495	0.00441	0.06306	0.01922	0.34312	1	100	
Alternative 1	0.10149	0.15495	0.00441	0.03784	0.01922	0.3179	0.92649	92.6487	1
Alternative 2	0.0406	0.03874	0.00352	0.02522	0.01922	0.1273	0.371	37.1002	3
Alternative 3	0.0406	0.09297	0.00352	0.06306	0.01153	0.21168	0.61692	61.6924	2

Figure 3: The ranking of the alternatives

NOVELTY

This project introduces a customizable and automated Microsoft Excel template that integrates the Entropy and ARAS methods, enabling users to perform MCDM analysis without the need for advanced programming or third-party software.

CONCLUSION

The Excel-based Entropy-ARAS tool is expected to guarantee consistency of the decision-making process and reduce calculation errors. The tool not only enhances the quality and speed of decision-making but also helps users to implement the MCDM techniques in real-world problems with their choices of alternatives and criteria.

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