Abstract

Title of the Thesis: Application of Multi-Criteria Decision Making in Real Life Optimization Problems in Fuzzy Environment

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The thesis is organized into ten chapters, each summarized below to provide an overview of the overall structure and content.

Chapter 1 presents a concise overview of decision-making and multi-criteria decision-making (MCDM). It also summarizes various MCDM tools commonly employed by researchers to address real-world problems. The concept of fuzzy set theory is introduced, along with a discussion on the significance of integrating fuzzy logic with MCDM techniques, as relevant to the objectives of this thesis.

Chapter 2 presents a concise review of the literature relevant to the study.

In Chapter 3, a site selection problem is considered where the MCDM techniques AHP and TOPSIS, integrated with fuzzy logic have been employed. AHP is used to determine the crisp weights of the evaluation factors, while the imprecise linguistic terms provided by decision-makers are translated into fuzzy values. To better capture decision- makers' hesitancy, Triangular Fuzzy Numbers (TFNs) are utilized. The fuzzy weights of sub-factors, derived using Fuzzy AHP (FAHP), are then incorporated into Fuzzy TOPSIS (FTOPSIS) to rank the alternatives.

Chapter 4 explores the risk factors associated with the COVID-19 pandemic. The objective of this study is to evaluate and rank the key factors contributing to the spread of the virus using MCDM techniques. FAHP is employed to determine the relative weights of the identified risk factors, followed by the application of Hesitant Fuzzy Sets (HFS) integrated with TOPSIS to prioritize them. Additionally, a sensitivity analysis is conducted to assess the robustness and reliability of the applied methodology.

Chapter 5 introduces a centroid-based method for the defuzzification and distance measurement between two Hesitant Fuzzy Numbers (HFNs). Geographic Information Systems (GIS) are integrated with MCDM techniques to facilitate the site selection of electric vehicle charging stations. A practical example is considered to demonstrate the applicability and effectiveness of the proposed model.

Chapter 6 highlights on choosing the optimal CSP based on multiple criteria and specific organizational or individual requirements. The study employs Pentagonal Intuitionistic Fuzzy Numbers (PIFNs) in conjunction with the MCDM techniques AHP and TOPSIS. Initially, the weights of the evaluation criteria are determined using AHP under the PIFN environment. These weights are then used in the Fuzzy TOPSIS (FTOPSIS) method to derive the final ranking of CSPs. Moreover, sensitivity and comparative analyses are conducted to evaluate the stability and reliability of the resulting rankings.

Chapter 7 presents a decision-making model specifically designed for identifying optimal location for a women's university, incorporating various uncertainties inherent in the site

selection process. Certain factors that may be less critical for a co-educational university become significantly more relevant when selecting a site for a women's university. To capture the uncertainty of the problem, Trapezoidal Neutrosophic Numbers (TrNNs) are used along with the MCDM tool AHP for obtaining criteria weights. Finally, the TOPSIS and COPRAS are applied for ranking of the alternatives. Comparative and sensitivity analysis are conducted to check the robustness and consistency of the techniques used.

Chapter 8 focuses on the evaluation and ranking of treatment options for COVID-19 using a MCDM approach. To support this process, a Generalized Hexagonal Pythagorean Fuzzy Number (GHPFN) framework is developed, and its properties are thoroughly demonstrated. Two types of GHPFNs are considered in the study. The second type of GHPFN is integrated with the TOPSIS method to rank the available COVID-19 treatment options effectively.

Chapter 9 focuses on identifying and evaluating the key factors contributing to out-of-hospital cardiac arrest. This chapter employs MCDM techniques, specifically AHP and DEMATEL, to assess the importance of each factor and explore their interrelationships. To effectively address the inherent uncertainty and hesitancy in expert evaluations, Hexagonal Pythagorean Fuzzy Numbers (HPFNs), an extension of PFS, are utilized due to their enhanced ability to manage complex real-world decision-making scenarios.

Chapter 10 provides a summary of the key findings and contributions of the thesis. It highlights the methodologies employed, the outcomes derived from the application of MCDM techniques in fuzzy environment, and the practical implications of the research across various real-world scenarios. It also outlines several scopes for future research.

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