

Evaluating and Prioritizing Risks in Infrastructure Projects by Fuzzy Multi-Criteria Decision-Making Methods: A Review

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Abstract - Location selection is one of the most significant difficulties to decision-makers, investors and it can be evaluated using (MCDM) approaches. MCDM techniques are effective tools for resolving decision-making problems because they analyze options from a variety of viewpoints in light of a wide range of conflicting criteria. In this context, MCDM techniques may be employed effectively with (FST), that captures insecurity in people views, to create more sensitive, and precise results. It is suggested to use a fuzzy multi-criteria decision model (FMCDM) to determine the ideal site based on a variety of variables.

The Fuzzy Analytical Hierarchy Process (FAHP) is utilized in the initial stage to estimate the relative criterion classification via the assessment process. In the second step, the prospective alternative locations are rated according to fuzzy (FTOPSIS). According to the study's findings, integrating FAHP and FTOPSIS is the FMCDM technique most frequently utilized to determine the best location for infrastructure projects.

Key Words: FMCDM (fuzzy multi-criteria decision model) FST (fuzzy set theory), Relative criterion classification, FTOPSIS (The fuzzy technique of order preference utilizing similarities to the ideal solution), FAHP (Fuzzy Analytical Hierarchy Process).

1. INTRODUCTION

The process of analyzing a collection of choices in view of several criteria in accordance with the advice of experts is known as (MCDM). It has been extensively employed to address challenging decision-making issues. Decision-makers must compare many choices based on their performance and choose the best option to maximize advantages because the hotel and tourism industries include complicated practical difficulties. In this regard, MCDM methods are practical approaches to deal with decision-making issues in the infrastructure, hospitality, and tourism sectors, assisting tourism institutions, hotel management, and travelers in making logical choices. A number of approaches, including the (AHP), (ANP), Decision-making trial and evaluation laboratory (DEMATEL), (TOPSIS), (MCDM) approach also others, possess been used for examine majority of site selection challenges. The analytic method, mixed integer/linear integer/goal programming,

cloudy sets, (MODM), cluster analysis, and other soft computing techniques were also used.

First, based on the recommendations of experts and literature research, the fuzzy AHP approach is used to assess the weightings of the criterion. Following that, fuzzy TOPSIS is used to rank the sites that can be used instead of the healthy one. Considering the priority ranking of the infrastructure projects, the model's output aids investors in continued development.

2. Literature Review

Long Chen, Wei Pan. [1] In this paper, fuzzy multi-criteria decision making (FMCDM) is gaining popularity as a useful method for dealing with complicated problems that involve a variety of decision-makers, competing goals, and a wealth of information that is both plentiful and unpredictable. Prior studies mostly focused on the concept and application of FMCDM approaches in construction management. Despite the fact that there have been numerous studies of FMCDM techniques and applications to provide summaries also criticisms in the writing absence taking into account the linkages the interval cloudy sets, MCDM, also related applications. In order to summarise the development of FMCDM provide perspectives on relationships between FSs, MCDM, and associated applications, this study will carefully review and analyse the literature on FMCDM in CM from 2007 to 2017 using a network method.

Tulio Silveira Santos, Licinio Da Silva Portugal, et al. [2] The moto of this study is to thoroughly evaluate and assess the assessment on FMCDM from 2007 to 2017 according network method to both summaries the growth of FMCDM and offer perspectives on the connections the interval FSs, MCDM. First, 165 paper publications with a total of 37 single-hybrid and 17 multiple-hybrid FMCDM approaches were selected.

P Baruah, M Kakati. [3] This study introduces and evaluates these methodologies' contemporary application, highlighting their characteristics, advantages, and disadvantages. The next step is to conduct a network meta-analysis according on the assessment to look into the connections between FSs, MCDM methods in order to create an FMCDM-CM profile. From recent FMCDM practice is compiled, based on those networks.

Yunna Wu, Han Chu, Chuanbo Xu. [4] In this paper, contrast to conventional evaluation, which employs only quantitative variables in its applications, this study proposes a method to help analyses the effectiveness of public-private partnerships for highway concessions. This approach combines the use of numerical and linguistic traits. The roadside accommodations, have the rating assessment criteria which makes it simpler to employ the suggested method. The results show a tendency for the operational category to be given more weight in the specialists' evaluations than the other categories, currently in place for the two case studies are not the best way to display categories' consider in view from the specialists' assessment.

Cterina Caprioli, Marta Bottero. [5] Five simple sample fuzzy logic modules have been created in this work to estimate the possibility of numerous important events. The Delphi method has been used to further improve the modules' outputs. '10% + Mode value' has been taken into consideration as the criterion for convergence of crisp value in the Delphi procedure. Data gathered through questionnaires and surveys conducted as part of the research were used to validate the developed modules. With the use of our developed modules, data analysis from a few case study projects has shown that managing "O & M risk" is now most vulnerable in India.

Gokhan Ozkaya, Ceren Erdin. [6] This paper presents, case study of choice aims to highlight the role of spatial multicriteria analysis in aiding Decision Makers (DMs) in the identification of appropriate locations for urban facilities and demonstrates the potential of the method for increasing the participation of various stakeholders through a straightforward visual representation of data and results. Analytic Hierarchical Process (AHP) and Fuzzy AHP (FAHP) are specifically used in this research. The contrast between the two methods demonstrates that they may both be used to locate urban infrastructure in places that are suitable for it. However, this study shows that AHP should be chosen when all of the criteria are highly relevant, but FAHP introduces greater uncertainty in the weighting of the criterion and eases the burden of many geographical analyses with GIS.

Sadoullah Ebrahimnejad, Seyed Meysam, et al. [7] In this study, the cloudy approaches FTOPSIS and FAHP and MCDM were utilized. ways for solutions. which evaluation techniques are optimal for choosing ranks. Five teachers, five software developers, and five factors connected to teachers and software developers are taken into consideration. These data were gathered from various educational or software organizations, and weighted values were assessed. Comparing the ranks attained using FAHP and FTOPSIS, it is determined that they are satisfactory.

Muhammad Saiful Islam, Madhav Prasad Nepal, et al. [8] In this study, weighs the criteria for smart and sustainable cities using the (ANP). The findings show that "smart living" is the most crucial quality, receiving a priority score of

35,459%, and "smart governance" is ranked last, receiving a score of 5,738%. The TOPSIS method utilizes to differentiate results across 44 cities in 44 different countries. The top three cities in the overall list are Tokyo, London, and New York, according to the data. In terms of good governance, mobility, and environmental characteristics, none of these cities rank in the top five. The article offers some suggestions for the cities based on the findings. These findings are intended to assist cities in understanding how they compare to other cities and in identifying areas where stronger policy is needed.

Sheng-Hau Lin, Xiaofeng Zhao, et al. [9] This research attempts to pinpoint common risks in BOT initiatives. The description of a hierarchical diagram of dangers is based on a perspective that is work-focused. Then, few helpful standards for rating risk in BOT projects are provided. The (FMADM) field is then used to define the problem. The (FTOPSIS) and (FLINMAP) are two methods for evaluating BOT work carries a lot dangers, that are detailed in this article. In Iran BOT power plant project uses the suggested approach to detect and assess risks. Based on their findings, a ranking of high hazards is determined at the study's conclusion.

F.H. Abanda, E.L. Chia, et al. [10] The purpose of this study is to study additionally, consider basic concepts and methods currently being used in this subject. A thorough assessment of publications from the years 2005 to 2017 is used to create a content analysis. It has been discovered that the majority of risks are interdependent on one another because of the nature of complicated projects. Consequently, a structured approach, such the (FANP), has been employed regularly for a variety of difficult undertakings. The pairwise comparisons essential for FANP's application, however, must be made using arduous and time-consuming calculations, and the risk structure cannot be updated to account for new information. The (FBBN) have become more popular for risk assessment as a way to get around this restriction. In order to support FBBN's wider application, additional project-specific research is advised.

H.D. Arora, Anjali Naithani. [11] In this paper, The results demonstrate that the (AHP), among the several MCDM techniques in peer-reviewed literature, is most commonly used in research while the most widely used MCDM techniques in practise. In this study, intuitionistic, Pythagorean, and Fermatean fuzzy sets are defined in respect to quartic fuzzy sets. We also study the set operations, scoring function, and accuracy function of quartic fuzzy sets. The proposed Euclidean measured of separation and similarity for quartic cloudy sets will aid from the resolution of numerous real-world situations involving uncertainty. Then, in order to address the issue of numerous criterion decision-making, we create an algorithm. To show the benefits of the suggested quartic fuzzy sets, a comparison of the novel quartic fuzzy sets with the current intuitionistic, Pythagorean, and Fermatean fuzzy sets is given. Finally, a real-world example is given to show how useful and effective

the suggested fuzzy sets are. The study's findings show that the new definition of quartic fuzzy sets produces the most reliable and consistent ranking for dealing with ambiguous and unclear information.

Diogo Silva Costa, Henrique S. Mamede, et al. [12] In this study, a method for choosing processes for automation that combines (TOPSIS) and (AHP) is suggested, illustrated, and assessed. The proposed strategy for choosing processes for automation is applied to a real-world scenario in this study, which adheres to the Design Science Research Methodology (DSRM). The outcome will be a technique to aid in the appropriate selection of business processes for automation, boosting the success of RPA tool implementation in an organization

Mohsen Nezami, Mohammad Reza Adlparvar, et al. [13] In this paper, order to lessen data loss, the study's suggested methodology is expanded on the basis of last aggregation. The developed approach then utilized on a genuine research, and results are cross-checked against those of a current research published in the methodology, to guarantee the validity from conclusions. To determine the parameters that have the most potential to alter the results, a sensitivity analysis is finally tweaked. The DIF-collective criteria approach is used to calculate each criterion's weight, and the established DIF-DEMATEL methodology is used to calculate the interdependencies between criteria.

Abbas Mardani, Ahmad Jusoh, et al. [14] The systematic review of FMCDM methodologies and applications is the main goal of this work. For this analysis, papers in all were published. The study's findings show that 2013 saw a record number of scholarly publications published. In the integrated method, hybrid fuzzy MCDM have been methodologies currently being used, respectively.

3. CONCLUSIONS

The analysis of the aforementioned research papers led to the conclusion that several scholars have looked into various issues pertaining to fuzzy multi-criteria decision-making processes in PPP-based projects. Additionally, it is mentioned according fuzzy MCDM procedures in PPP projects is crucial to the project's success. Numerous techniques are developed, and each risk's rank and RII are examined. Analysis results reveal various RII values depending on the various risk parameters used in various fuzzy decision-making techniques. There was developed a systematic Methodology for assessing in these projects. These initiatives used a thorough analysis of the literature to identify the most important first- and second-level risks. In order to construct the structure. For qualitative and quantitative analysis, fuzzy MCDM techniques were employed to rank the risks that had been discovered in terms of importance.

Future research on this topic will focus on finding the best method for calculating the ideal RII value using mathematical programming models. By adapting the suggested strategy to other kinds of fuzzy sets like VIKOR, WASPAS ANP, and DEMATEL, the research could be furthered. Depending on the degree of uncertainty in the risks and the expertise that must be dealt with, the proposed method can be simply expanded to various fuzzy contexts.

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