Chapter 8
Intuitionistic Fuzzy TOPSIS Model Based on Reliability Criteria and a Dynamic Mathematical Operator for Solving MCGDM Problems

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ABSTRACT

This chapter proposes a model based on the IF-TOPSIS method and the DIFWGϵ operator for the evaluation of renewable power plants. The model uses five reliability-based criteria and addresses the dynamic factors associated with renewable power plant operations. The factors include: the changing energy demand and consumption, the changing environmental conditions, rapidly increasing population, social activities, and awareness. The result from the evaluation shows that the Solar power plant (S3) is the most preferred power source considering the dynamic factors associated with the plant operation, the plant location, and the reliability-based criteria used for the assessment.

INTRODUCTION

Intuitionistic fuzzy set (IFS) was introduced by Atanassov, (1986), who extend the traditional Fuzzy Set (FS) theory to include a non-membership function ($\upsilon_A(x)$) to the ready existing membership function ($\mu_A(x)$) in the FS theory. The IFS which was developed mainly to address and solve problems that cannot be fully expressed with the FS theory, due to complexity and fuzziness in most decision-making information, has remained a very active research theme in industrial engineering and among decision-making researchers (Aikhuele & Turan, 2017b).

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Example of complex decision-making information**;** "during voting, if there are ten persons voting for an issue, and three of them give the "agree'', four of them give the "disagree", and the others abstain, obviously, FS cannot fully express the polling information"(Liu & Zhang, 2014).

IFS which is used for solving complex decision-making problems recently has been integrated to solve Multi-criteria Group Decision-making (MCGDM) problems, which requires the simultaneous consideration of several attributes/criteria before decision alternatives are ranked. In integrating the IFS for MCGDM problems, an intuitionistic fuzzy number(s) (IFNs), which is/are relatively independent and bounded with the conditions that, the summation of the membership and non-membership function must not exceed one (Deschrijver & Kerre, 2007), are used for the mathematical computations in the integrated IFS theory.

An extensive review of the IFS for solving MCGDM problems, however, has shown an increase in their application over the last decade. Some of their applications when integrated with MCGDM techniques include; the use of IFS in the fuzzy analytic network process method (Saeedi & Malek, 2008). IFS in Analytical network process and in intuitionistic fuzzy preference relations (Zhou, et al, 2018). Others include the IFS in the Technique for Order of Preference by Similarity to Ideal Solution (FTOPSIS) (Daneshvar, et al, 2018), IFS in fuzzy data envelopment analysis (Puri & Prasad Yadav, 2015). IFS in the Evaluation based on Distance from Average Solution (EDAS) (Kahraman et al., 2017), IFS in Decision Making Experiment and Evaluation Laboratories (DEMATEL) method (Gan & Luo, 2017) and IFS in the elimination et choice translating reality (ELECTRE) method (Rouyendegh, 2018). IFS in multi-objective optimization on the basis of ratio analysis (MOORA) method (Yazdani, 2015), IFS in Gray relational analysis method (Wei, 2011), IFS in Linear programming method (Parvathi & Malathi, 2012) and the use of IFS in VlseKriterijumska Optimizacija I Kompromisno Resenje (Serbian term) (Wan, et al, 2013) and IFS in C-means clustering method (Chaira, 2001).

Furthermore, IFS has also been applied in several integrated MCGDM methods, some which include, IFS in Grey-Intuitionistic Fuzzy-ELECTRE and VIKOR used for the assessment of contractors in a construction project (Hashemi, et al., 2018). IFS in an integrated GRA Technique and Fuzzy Entropy-Based TOPSIS Method for the selection of sustainable building materials supplier (Chen, 2019). IFS in an integrated model that is based on integrated weighting approach and fuzzy VIKOR (Suh, et al., 2019). IFS in a model based on the integration of fuzzy entropy and distance measure that uses TOPSIS method for decision-making (Joshi & Kumar, 2014).

From the foregoing, it is obvious that IFS has been applied in several MCGDM methods and for solving decision-making problems in literature. The literature review has provided a critical assessment of previous and related work within the research area and scope, by highlighting the research gaps not currently addressed or accounted for by the reviewed methods and approaches. However, in this study, the application of IFS in the MCGDM method is further extended to solve problems that are inherently dynamic, which are problems that required the dynamics of the decisions to be accounted for in the final decision-making process. Hence in this study, an integrated MCGDM model which is based on the Intuitionistic Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (IF-TOPSIS) method and the Dynamic intuitionistic fuzzy Einstein geometric averaging (DIFWGϵ) operator is proposed to address an account for dynamic issues in the decision-making process.

The main advantages and contributions of the integrated MCGDM model are; (1) the model addresses the dynamic issues in the decision-making process and (2) its accounts for the uncertainty in the decision-making process. To the best of my knowledge, this is the first study to present an IFTOPSIS model that addresses dynamic issues in the decision-making process. The rest of the paper is organized

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