Chapter 30

Improved MABAC Method for Multicriteria Group Decision Making With Trapezoidal Fuzzy Neutrosophic Numbers

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ABSTRACT

Many prestigious researchers have been exploring the issues of imprecision, inconsistency, and uncertain information in decision making, which are still challenges in developing a decision support system that is more feasible and efficient. This chapter proposes a new multicriteria group decision-making (MCGDM) strategy to overcome those issues. This strategy integrates the original MABAC method with trapezoidal fuzzy neutrosophic numbers (TrFNNs). First, the proposed method converts independent judgments from experts in the form of linguistic variables into TrFNNs and aggregates them using some aggregation operators. Next, it utilizes the functions of score and accuracy to rank the evaluated alternatives. By using the distance measure between the alternatives and the border approximation area, the proposed MABAC selects the best solution. Finally, the chapter illustrates an example of COVID-19 vaccine selection and a comparative analysis to show that the proposed MABAC has benefits to support indeterminate information and is more reasonable and practicable in handling MCGDM problems.

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1. INTRODUCTION

Zadeh (1965) first proposed the theory of fuzzy set to depict vague information by defining a membership function in which its membership value range between 0 and 1. Atanassov (1986) then initiated an Intuitionistic fuzzy set (IFS) in which each element of the universe of discourse is defined not only by membership function but also by non-membership function and the sum of these membership values is less than or equal one. In fact, it can handle incomplete and vague information but cannot deal with indeterminate and inconsistent information, where often occurs in real-case. Therefore, Smarandache (1998) originally proposed a neutrosophic set (NS) theory to generalize the concepts of FS and IFS. This theory is very victorious in overcoming cases and situations in uncertain, vagueness, indeterminate, and inconsistent information. It can be described by a truth-membership function, an indeterminacy-membership and a falsity-membership. Therefore, many scholars utilized and applied this theory to overcome their real-life research studies such as medical image processing (Akbulut et al., 2017; Guo & Sengur, 2015; Sayed et al., 2015; Zhao et al., 2016), medical diagnosis (Broumi et al., 2015; Elnazer et al., 2016; Jayanthi, 2016; Sayed & Hassanien, 2017; Zhang et al., 2018), investment (Irvanizam et al., 2020a; Liu et al., 2016; Zhang et al, 2016), sciences (Smarandache, 2017, 2018a), etc.

The theory of neutrosophic set has been intensively developed in decision making fields. Most extended areas are to provide novel concepts of neutrosophic sets and numbers in expressing vagueness, indeterminate, and inconsistent information. Some properties, operators, related theorems, and distance measurements between two neutrosophic numbers or sets have also been demonstrated and proved. Afterward, they were used to be applied for Multiple-criteria group decision-making problems.

Multiple-criteria group decision-making (MCGDM) is still a new approach of the decision-making process in evaluating numerous alternatives based on their corresponding criteria weight. It involves many decision-makers (DMs) assigning criterion values for all alternatives based on their different personal opinions. DMs even tend to choose linguistic terms to judge the criteria of alternatives. This makes the concept of linguistic terms can effectively be utilized to deal with indeterminate and inconsistent information. However, recent studies have demonstrated that by integrating MCGDM and a decision-making method can obtain more suitable, feasible, and reliable results.

In decision sciences, some prestigious researchers have proposed conventional decision-making methods such as TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) (Yoon and Hwang, 1980), VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) (Opricovic & Tzeng, 2004), and MABAC (Multi-Attributive Border Approximation area Comparison) (Pamučar & Ćirović, 2015). The TOPSIS method selects the best alternative which is the shortest distance from the positive-ideal solution and the farthest distance from the negative-ideal solution, but it does not contemplate the relative greatness of these distances (Yoon et al., 1989). The VIKOR determines the best solution based on a particular closeness to the positive-ideal solution to find maximum profit without considering the decisions' risk (Cristóbal, 2011; Sanayei et al., 2010). Meanwhile, the MABAC calculates the distance between each alternative and the border approximation area (BAA). Additionally, the MABAC has a large number of valuable features such as: (1) it has stability in obtaining the computing results; (2) the calculating steps of the MABAC method are simple and easy to understand; (3) it considers the potential values of gains and losses; (4) it provides opportunities to integrate this model with other approaches (Wang et al., 2020). Hence, this method is a reliable and suitable instrument to obtain rational decision-making results.

There are existing studies related to MCGDM and decision-making under a neutrosophic environment (Abu-Faty et al., 2019; Akram et al., 2019, 2021; Awang et al., 2019; Bhowmik & Pal, 2009, 2010; Broumi

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