Chapter 7
The Technique for Order of Preference by Similarity to Ideal Solution Method in Fuzzy Environment: Fuzzy TOPSIS Method

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ABSTRACT

Decision-making process is the selection of the most appropriate one among the alternatives. Different selection criteria are considered in the decision-making process. Simultaneous assessment of different evaluation criteria may not always be possible. Multi-criteria decision-making techniques provide an easily applicable mathematical solution in this respect. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is one of the multi-criteria decision-making techniques. This method is used in many problems in literature and allows multiple decision makers to choose the most suitable alternative by evaluating them together with different criteria. Assessments of decision makers may include linguistic statements. In this case, the Fuzzy Logic approach can be used. In this chapter, Fuzzy TOPSIS method is explained with a detailed numerical example.

INTRODUCTION

The decision-making process is carried out at every stage of life. Even in daily life, people constantly decide on specific issues. Basically, the decision-making mechanism works to select the most appropriate one from among a set of feasible alternatives. However, it is not always easy to decide on real-world problems. It may be necessary to evaluate the conflicting objectives together, such as high quality and low cost. Similarly, companies may need to choose between alternatives when seeking solutions to their problems such as supplier selection, personnel selection, product range selection, raw material selec-

DOI: 10.4018/978-1-7998-2216-5.ch007

tion, workbench selection. For instance, in the personnel selection problem, several criteria such as age, experience, and demanded salary are evaluated together. These problems are defined as multi-criteria decision-making (MCDM) problems. MCDM methods provide solutions to researchers in various MCDM problems. These methods develop an analytical solution for the simultaneous evaluation of multiple criteria. In addition to this, MCDM methods provide the flexibility to evaluate multiple decision makers' views at the same time.

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is one of the MCDM techniques that commonly used in literature. It was developed by Hwang & Yoon (1981). In this chapter, the TOPSIS method in the fuzzy environment was investigated. The application steps of the method are described step by step on a numerical example.

When the literature is examined, it is seen that the TOPSIS method is used in many problems such as supplier selection, material selection, personnel selection, and handling equipment selection. Some studies have applied the Fuzzy TOPSIS method with different MCDM methods. For instance, there are studies that use the Fuzzy Analytic Hierarchy Process (AHP) method and Fuzzy TOPSIS method together. In these studies, criterion weights are obtained from Fuzzy AHP method. Afterward, the ranking order of the alternatives can be calculated by the Fuzzy TOPSIS method. Jee & Kang (2000) used Entropy and TOPSIS method in the procedure of the material selection process for a flywheel product. Shanian & Savadogo (2006) used the TOPSIS method to material selection for metallic bipolar plates for polymer electrolyte fuel cell. Boran et al. (2009) proposed Intuitionistic Fuzzy TOPSIS method and applied this method to supplier selection problem. Kelemenis & Askounis (2010) proposed a Fuzzy TOPSIS method and applied on the problem of the top management team selection. Aikhuele & Turan (2017) and Aikhuele & Turan (2018) proposed Intuitionistic Fuzzy TOPSIS method and they introduced modified exponential score function-based separation method to calculate each alternative from the positive ideal solution (PIS) and the negative ideal solution (NIS). Gupta & Barua (2017) proposed a framework for green supplier selection. They ranked the suppliers according to selection criteria by using fuzzy TOPSIS method. Tian et al. (2017) proposed a model for automotive components remanufacturing industry by using fuzzy AHP and combined gray relation analysis with TOPSIS methods. Daneshvar Rouyendegh, Yildizbasi, & Arikan (2018) used Intuitionistic Fuzzy TOPSIS method to select the in wind power plants site in Turkey. Abdel-Basset, Manogaran, Gamal, & Smarandache (2019) analyzed smart medical devices for diabetics' patients by using Neutrosophic TOPSIS method. Nabeeh, Smarandache, Abdel-Basset, El-Ghareeb, & Aboelfetouh (2019) proposed a model by combining Neutrosophic AHP with the TOPSIS method and applied on a personnel selection problem. In summary, TOPSIS method can be used in many problems, including multiple evaluation criteria, multiple decision makers and multiple alternatives.

The aim of this study is to introduce the TOPSIS method which is one of the multi-criteria decision-making techniques to the readers and to explain how to use it in fuzzy environment. The remainder of the study is organized as follows: In the Background section, the fuzzy logic approach is addressed and fundamental definitions and notations of the Fuzzy TOPSIS method are introduced. The Fuzzy TOPSIS method was applied to a problem in the Numerical Example section. The solution of the problem is explained step by step in the Solutions and Recommendations section. Future studies and researches on the Fuzzy TOPSIS method are given in the Future Research Directions section. Finally, in the Conclusions section, an overview of the topic is given and method and problem results are discussed.