Applied Mathematical Modelling 34 (2010) 3754–3766

Contents lists available at ScienceDirect

Applied Mathematical Modelling

journal homepage: www.elsevier.com/locate/apm

Comparison of first aggregation and last aggregation in fuzzy group TOPSIS

E. Roghanian *, J. Rahimi, A. Ansari

Department of Industrial Engineering, K.N Toosi University of Technology, Tehran, Iran

ARTICLE INFO

Article history:
Received 25 August 2009
Received in revised form 15 January 2010
Accepted 12 February 2010
Available online 2 March 2010

Keywords:
Group decision making (GDM)
TOPSIS
MADM
Fuzzy set theory
Supply chain management (SCM)

ABSTRACT

The Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS), one of the major multi attribute decision making (MADM) techniques, ranks the alternatives according to their distances from the ideal and the negative ideal solution. In real evaluation and decision making problems, it is vital to involve several people and experts from different functional areas in decision making process. Also under many conditions, crisp data are inadequate to model real-life situations, since human judgments including preferences are often vague and cannot estimate his preference with an exact numerical value. Therefore aggregation of fuzzy concept, group decision making and TOPSIS methods that we denote "fuzzy group TOPSIS" is more practical than original TOPSIS.

There are two approaches for aggregating values including relative importance of evaluation criteria with respect to the overall objective and rating of alternatives with respect to each criterion in fuzzy group TOPSIS: (1) First aggregation, (2) Last aggregation. In first aggregation approach weight of each criterion and rating of alternatives with respect to each criterion gained from decision makers are aggregated at first and TOPSIS method then apply to these aggregate values. In last aggregation approach weight of each criterion and rating of alternatives with respect to each criterion gained from decision makers are used in TOPSIS method directly. Distance of each alternative from the ideal and the negative ideal solution are calculated then aggregated for finding relative closeness of each alternative to the ideal solution. Two examples are presented to highlight the procedure of the proposed methods at the end of this paper. We want to test if variation in decision makers' opinions is high, last aggregation method is more precise than first aggregation and vice versa when this variation is low, first aggregation method is as precise as last aggregation but faster than this method.

© 2010 Published by Elsevier Inc.

1. Introduction

MADM approach is often used to solve various decision making and/or selection problems. This approach often requires the decision makers to provide qualitative and/or quantitative assessments for determining the performance of each alternative with respect to each criterion, and the relative importance of evaluation criteria with respect to the overall objective.

The TOPSIS was first developed by Hwang and Yoon [1] and ranks the alternatives according to their distances from the ideal and the negative ideal solution, i.e. the best alternative has simultaneously the shortest distance from the ideal solution and the farthest distance from the negative ideal solution. The ideal solution is identified with a "hypothetical alternative" that has the best values for all considered criteria whereas the negative ideal solution is identified with a "hypothetical alternative" that has the worst criterion values. In practice, TOPSIS has been successfully applied to solve selection/evaluation problems with a finite number of alternatives because it is intuitive and easy to understand and implement. Furthermore,

* Corresponding author.
E-mail address: E-roghanian@kntu.ac.ir (E. Roghanian).

0307-904X/$ - see front matter © 2010 Published by Elsevier Inc.
doi:10.1016/j.apm.2010.02.039

TOPSIS has a sound logic that represents the rationale of human choice and has been proved to be one of the best methods in addressing the issue of rank reversal.

Real evaluation problems involve assessment of qualitative/quantitative criteria. Moreover, the aggregating function of the TOPSIS method does not produce results such that the highest ranked alternative is simultaneously the closest to the ideal solution and the furthest from the negative ideal solution since these criteria can be conflicting. This issue is faced rather arbitrarily by the original TOPSIS method through the use of the notion of "relative closeness" which is a measure of the relative distance between a certain alternative and ideal and negative ideal solutions.

According to Kim et al. [2], four TOPSIS advantages are addressed:

(I) a sound logic that represents the rationale of human choice;
(II) a scalar value that accounts for both the best and worst alternatives simultaneously;
(III) a simple computation process that can be easily programmed into a spreadsheet;
(IV) the performance measures of all alternatives on attributes can be visualized on a polyhedron, at least for any two dimensions.

These advantages make TOPSIS a major MADM technique as compared with other related techniques such as analytical hierarchical process (AHP) and elimination and choice expressing reality (ELECTRE). In fact, TOPSIS is a utility based method that compares each alternative directly depending on data in the evaluation matrices and weights [3].

Because MADM is a practical tool for selection and ranking of a number of alternatives, its applications are numerous. TOPSIS has been deemed one of the major decision making techniques within the Asian Pacific area. In recent years, TOPSIS has been successfully applied to the areas of human resources management, transportation, product design, manufacturing, water management, quality control, and location analysis. In addition, the concept of TOPSIS has also been connected to multi-objective decision making and group decision making. The high flexibility of this concept is able to accommodate further extension to make better choices in various situations. [3].

Shanian and Savadogo [4] presented an application of the TOPSIS method for solving the material selection problem of metallic bipolar plates for polymer electrolyte fuel cell (PEFC), which often involves multiple and conflicting objectives. Olson [5] reviewed several applications of TOPSIS using different weighting schemes and different distance metrics, and compares results of different sets of weights applied to a previously used set of multiple criteria data. Deng et al. [6] formulated the inter-company comparison process as a multi-criteria analysis model in their paper, and presented an effective approach by modifying TOPSIS for solving the problem. Jahanshahloo et al. [7] in their paper presented a new TOPSIS method for ranking decision making units (DMUs) with interval data yielding the interval score for each alternative.

Under many conditions, crisp data are inadequate to model real-life situations. Since human judgments including preferences are often vague and cannot estimate his preference with an exact numerical value. A more realistic approach may be to use linguistic assessments instead of numerical values, that is, to suppose that the ratings and weights of the criteria in the problem are assessed by means of linguistic variables.

If the assessment values are known to have various types of vagueness/imprecision or subjectiveness, then the classical decision making techniques are not useful for such problems. Usually real evaluation problems are not crisply defined because human judgments are uncertain and thus many researchers have proposed fuzzy extensions of the TOPSIS method in order to grasp the vagueness that is inherent in the corresponding evaluation problems.

A fuzzy multi-criteria decision model was proposed by Seçme et al. [8] to evaluate the performances of banks. In this model fuzzy AHP (FAHP) and TOPSIS methods are integrated. After the weights for a number of criteria are determined based on the opinions of experts using the FAHP method, these weights are inputs to the TOPSIS method to rank the banks.

Gumus [9] structured a two step methodology to evaluate hazardous waste transportation firms containing the methods of FAHP and TOPSIS. Yurdakula and Tansel [10] proposed fuzzy MCDM models to deal with the vagueness and imprecision inherent in the machine tool selection problem. Chamodrakas et al. [11] applied a new class of fuzzy methods for evaluating customers. In their paper they used a new model for the aggregating function of TOPSIS that is based on a fuzzy set representation of the closeness to the ideal and the negative ideal solution. Celik et al. [12] proposed a hybrid approach on ensuring the competitiveness requirements for major Turkish container ports by utilizing fuzzy axiomatic design (FAD) and fuzzy TOPSIS methodologies to manage strategic decision-making with incomplete information. Izadikhah [13] extended the TOPSIS method for dealing with fuzzy data and an algorithm to determine the most preferable choice among all possible choices, when data was fuzzy, was also presented. In this study, to identify the fuzzy ideal solution and fuzzy negative ideal solution one of the Yagers indices which is used for ordering fuzzy quantities in $[0,1]$ is applied. Mahdavi et al. [14] applied a new measurement of fuzzy distance value with a lower bound of alternatives. In their paper similarity degree of each alternative from fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS) was used for ranking of alternatives. Jahanshahloo et al. [15] extended the TOPSIS method to decision-making problems with fuzzy data. In their paper, the rating of each alternative and the weight of each criterion were expressed in triangular fuzzy numbers. The normalized fuzzy numbers were calculated by using the concept of α-cuts. Wang and Elhag [16] proposed a fuzzy TOPSIS method in their paper based on alpha level sets and presented a nonlinear programming (NLP) solution procedure. Chen [17] used linguistic terms represented by triangular fuzzy numbers to describe the rating of each alternative and the weight of each criterion. Chen et al. [18] used linguistic values to assess the ratings and weights for quantitative and qualitative factors. In this work a closeness coefficient is defined to determine the ranking order of all suppliers by calculating the distances to the both FPIS and

Download English Version:

https://daneshyari.com/en/article/1705586

Download Persian Version:

https://daneshyari.com/article/1705586

Daneshyari.com