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An integrated fuzzy multi criteria group decision making approach for ERP system selection

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ABSTRACT

This paper aims to ease group decision-making by using an integration of fuzzy AHP (analytic hierarchy process) and fuzzy TOPSIS (technique for order preference by similarity to ideal solution) and its application to software selection of an electronic firm. Firstly, priority values of criteria in software selection problem have been determined by using fuzzy extension of AHP method. Fuzzy extension of AHP is suggested in this paper because of little computation time and much simpler than other fuzzy AHP procedures. Then, the result of the fuzzy TOPSIS model can be employed to define the most appropriate alternative with regard to this firm's goals in uncertain environment. Fuzzy numbers are presented in all phases in order to overcome any vagueness in decision making process. The final decision depends on the degree of importance of each decision maker so that wrong degree of importance causes the mistaken result. The researchers generally determine the degrees of importance of each decision maker according to special characteristics of each decision maker as subjectivity. In order to overcome this subjectivity in this paper, the judgments of decision makers are degraded to unique decision by using an attribute based aggregation technique. There is no study about software selection using integrated fuzzy AHP-fuzzy TOPSIS approach with group decision-making based on an attribute based aggregation technique. The results of the proposed approach and the other approaches are compared. Results indicate that our methodology allows decreasing the uncertainty and the information loss in group decision making and thus, ensures a robust solution to the firm.

1. Introduction

An enterprise resource planning (ERP) system is a package of business software that combines a number of modular software implementations to meet all the requirements of a firm. An ERP system is the knowledge framework of a firm that automates and combines whole business tasks like purchase, sales, inventory control, human resource, production planning and finance. Applications of ERP systems are one of the most important investment projects due to the difficulty, high cost and adaptation risks. Firms have spent billions of dollars and utilized many amounts of man-hours for installing detail ERP software systems [1]. Unprecedented market competition has impressed whole facets of business environment with the conclusion that firms need to decrease total costs, be more sensitive to customer requirements and reduce lead times. To overcome these challenges, novel software systems known in the business environment as ERP systems have surfaced in the market targeting primarily large scale organizations [2]. Any ERP software in market cannot fully meet the needs and expectations of companies, because every company runs its business with different strategies and goals. Thus, to increase the chance of success, management must choose an appropriate software that most closely suits its requirements [3]. Therefore, ERP software selection is an extremely serious and difficult decision making problem for managers. Many firms apply their ERP software hastily without exactly understanding the inclusions for requirements of their business strategies and goals. The conclusion of this hurry approach is the failure in ERP software selection that leads to the failure of project or firm performance will get weakened [4]. It is essential to select an appropriate software system for firms because of its difficult and expensive process. Clearly, software selection is not a well-defined or structured decision problem. The presence of multiple criteria (both managerial and technical) and the involvement of multiple decision makers will expand decisions from one to many several dimensions, thus, increasing the complexity of the selection process [5,6].

This paper consists of six sections. The Section 2 presents the related literature review. The Section 3 introduces the integrated fuzzy extension of AHP and fuzzy TOPSIS approach in software

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selection problem (SSP). Section 4 is related with illustrative implementation of the developed decision making approach. The results of this paper are presented in Section 5. The concluding remarks that have been acquired are in the Section 6.

2. Related literature review

Although the software selection has a remarkable significance, there are few studies that consider software selection methodologies in group decision making. Lai et al. [6] focused on the selection of multimedia authorizing systems by using AHP (Analytic Hierarchy Process). Lai et al. [7] recommended that AHP method was used to aid the selection of a multi-media authorizing system. Lee et al. [8] studied on SWOT based ERP software selection. Wei et al. [9] defined AHP model which enables a firm to determine the factors of ERP software selection. Mulebeke and Zheng [10] introduced a method, the AHP as multicriteria decision making technique to support the proper software selection to fit the product development process of a special product. Liao et al. [4] introduced a similarity degree based algorithm about ERP systems, which may be defined by various linguistic statements. A linear programming model is set up for deciding the most convenient ERP software. Ayağ and Ozdemir [3] adopted the fuzzy extension of the analytic network process (ANP) based intelligent approach to select the most convenient ERP software alternative. Sen et al. [11] proposed a novel decision support system for integrating the assessment of both non-functional and functional fitness to determine suitable ERP software. This methodology utilized a fuzzy multi criteria decision making process, a heuristic algorithm and a multi objective programming model to assess the best decision. All the stages of proposed methodology are performed in an electronic firm's ERP software evaluation project. Yazgan et al. [12] presented a new methodology for combining ANP and artificial neural network to determine the most appropriate ERP software. Karsak and Ozogul [2] suggested a comprehensive framework for the proper ERP selection among possible choices based on quality function deployment (QFD), fuzzy linear regression and zero-one goal programming. Ayağ [13] proposed the fuzzy AHP and simulation by integrating them in a computer-aided design SSP. Cebeci [14] recommended the fuzzy AHP and the fuzzy extension of AHP to compare ERP alternatives for a textile production firm. Sen and Baracli [15] adopted fuzzy QFD approach to select the best ERP software. Erdebilli and Erkan [16] and Méxas et al. [17] used the AHP in the ERP SSP. Méxas et al. [18] proposed AHP approach to investigate the opinions of information technology experts about the importance of ERP software evaluation criteria and sub-criteria in the construction industry. Asl et al. [19] proposed an integrated approach, which defines the most important criteria of ERP software using Delphi method and ranks these criteria using Shannon Entropy method. Gürbüz et al. [20] suggested an assessment framework using an integration approach that utilizes ANP, Choquet integral and Measuring Attractiveness by a Categorical Based Evaluation Technique for the evaluation of four ERP software alternatives. Jafarnejad et al. [21] investigated an integrated approach which includes Shannon entropy technique, DEMATEL, and fuzzy AHP. Kara and Cheikhrouhou [5] determined a two phase methodology, fuzzy AHP for criteria weights and TOPSIS (technique for order preference by similarity to ideal solution) for ranking the alternatives, to select the collaborative software.

The decision makers have to define their preferences by using a set of numerical values. Each decision maker might have special goals, opinions, and different evaluation process, although they aim to select the best alternative. A number of decision makers interact to achieve unique decision in group decision making. The equal or unequal degrees of importance of all the decision makers are generally determined by researchers in group decision making according to special characteristics of each decision maker such experience, abilities, and knowledge. The final decision depends on the degree of importance of each decision maker significantly. Inaccurate degree of importance causes the mistaken selection and inherently waste of time and cost loss. We consider an attribute based aggregation technique presented by Olcer and Odabasi [22] in order to overcome this drawback.

The final goal of fuzzy AHP is to acquire the weights of the criteria and rank the criteria accordingly. The relative weights are the output of the fuzzy AHP. However, some researchers often perceive the weights as potential input for other multi criteria decision making methods where integration with other methods could be established and applied in various knowledge domains [23].

TOPSIS method is intuitive, easy to understand and implement in the form of software support tool, and is coherent with rational choices made by a human being [24]. PIS is defined that minimizes the cost criteria and maximizes the benefit criteria, but NIS minimizes the benefit criteria and maximizes the cost criteria. The farthest distance from negative ideal solution (NIS) and the shortest distance from positive ideal solution (PIS) are considered in TOPSIS approach simultaneously. Kara and Cheikhrouhou [5] used TOPSIS to select the collaborative software so that they considered crisp positive and negative ideal solutions. Real world multi criteria problems are usually not crisply defined because of the uncertainty of human judgments and therefore many various extensions and improvements of the classic TOPSIS method have been developed [24]. Fuzzy TOPSIS approach is preferred instead of the classical TOPSIS approach when the decision makers evaluate the alternative/criteria as linguistic variables. Crisp numbers cause information loss in uncertain environment. This paper presents the fuzzy TOPSIS approach in order to overcome this limitation in uncertain environment.

There is no study about software selection using integrated fuzzy AHP-fuzzy TOPSIS approach with group decision making based on an attribute based aggregation technique. Fuzzy numbers are presented in all phases in order to overcome any vagueness in decision making process. This methodology allows decreasing the uncertainty and the information loss in group decision-making. This study purposes to ensure an analytical tool, which integrates fuzzy extension of AHP and fuzzy TOPSIS, to determine the most convenient software for an electronic firm. 15 criteria are clustered into four groups of factors, which are cost, technical specifications, vendor specifications and ease of use, according to the specialists' opinions and the literature. Priority value of criteria in proposed methodology has been determined by employing fuzzy extension of AHP method because of little computation time and much simpler than other fuzzy AHP procedures. The solution of the recommended integrated approach for SSP has been found by employing an attribute based aggregation technique based fuzzy TOPSIS method. The results of TOPSIS methods based on distance and similarity measures are compared according to aggregating the fuzzy opinions with homogeneous and heterogeneous groups of decision makers. The selection problem is also analyzed with other hybrid methods, which are fuzzy AHP-fuzzy PROMETHEE (preference ranking organization method for enrichment of evaluations) method, fuzzy AHP-fuzzy VIKOR (VIsekriterijumska optimizacija i KOm-promisno Resenje) method, fuzzy AHP-fuzzy ELECTRE (ELimination Et Choix Traduisant la REalité) method and fuzzy AHP-fuzzy GRA (grey relational analysis).

3. Proposed methodology

In this paper, the recommended hybrid fuzzy extension of AHP-fuzzy TOPSIS methodology is employed to rank the software options. Firstly, we identified cost, technical specifications, vendor specifications and ease of use as the main criteria in an appropriate