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Procedia Computer Science 102 (2016) 418 – 425

Procedia Computer Science

12th International Conference on Application of Fuzzy Systems and Soft Computing, ICAFS 2016, 29-30 August 2016, Vienna, Austria

Supplier selection problem under Z-information

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Abstract

Supplier selection problem is a very important element of Supply Chain Management systems. The existing works are devoted to solving this problem under deterministic, stochastic, interval-based and fuzzy information. Unfortunately, up today no systematic research on supplier selection under partial reliability of information is proposed. In this paper we suggest new method for solving supplier selection problem under fuzzy and partially reliable information formalized by using Z-numbers. The method is based on determination of Z-number valued ideal and negative ideal solutions. A numerical example is provided to illustrate validity of the proposed approach to supplier selection problem.

Peer-review under responsibility of the Organizing Committee of ICAFS 2016

*Keywords:*supplier selection; multicriteria decision making; ideal solution; partial reliability; Z-number

1. Introduction

With globalizing economy, increasing competition, shortening transaction speed and developing communication and transportation technologies decision making problem in supplier selection is becoming more significant and at the same time more complex issue. The complexity of the matter is rooted in the very essence of the selection process, which involves various quantitative and qualitative criteria.

In an involved ecosystem of complicated market-places competitiveness of businesses becomes more and more dependent on the fast decision making regarding selection of right suppliers. Shortening product life cycles demand from industry champions attracts more attention to changing technologies, increasing standards and expanding

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Peer-review under responsibility of the Organizing Committee of ICAFS 2016
doi:10.1016/j.procs.2016.09.421

augmented services. This overall puts more emphasis on the right methodology used in evaluating multiple criteria of a myriad of suppliers.

Multiple criteria involved in the process of decision-making are often uncertain and relative in their nature, as involve expert opinions[16,21], expectations and uncertainties[17,20] and risks. Nevertheless, the pace of current economic activity requires prompt and smart decisions under imperfect information[18,19].

Dickson for the first time provided a framework and laid the foundation of supplier selection problem approach, whereby he identified 23 different criteria for selection of suppliers[1]. Those included criteria such as, quality, delivery, performance history, warranties, price, technical capability, financial position, etc.

On other hand,in Ref. 2 they carried out a review of 74 articles in supplier selection and actually classified them into three categories: linear weighting methods, mathematical programming method and statistical approach.

Although some 50 years passed since foundation was laid for supplier selection problem this topic continues to represent an area of high interest and many scholars address this issue in their papers and research. As an example it is worth to note that www.webofknowledge.com of Thomson Reuters recital database alone returned 471 papers as search result for Fuzzy Approach to Supplier Selection problem since 2013 up to date.

As such the evaluation based on distance from average solution as a method of multi criteria decision making in the context of supplier selection problem is proposed[3]. Authors use a case study in order to demonstrate the suggested method and degree of its use. They also performed a sensitivity analysis by using simulated weights of criteria in order to understand the stability and validity of the results of the method discussed.

Interesting results were proposed on supplier selection problem under vague and incomplete data[4]. They suggested that modern methods used cannot guarantee optimality of the proposed solution as are based upon Analytical Network Process. In order to tackle this issue they suggested combining the above with Dampster-Shafer Evidence theory. In doing so the authors proved the accuracy of the combination by providing a specific numerical example.

Another interesting approach utilizing hesitant fuzzy sets for situations where sets of values are possible in the definition processes of membership of an element[5]. In their work they show how hesitant fuzzy linguistic term sets can determine the computational and linguistic detection based on fuzzy linguistic approach.

A useful method was suggested by Zhang and colleagues to deal at the same time with cardinal and ordinal information in selecting suppliers and making relative decisions[6]. In this method, assessment of alternative criteria and importance weights are both expressed by so-called hesitant fuzzy elements. The conclusion of the research suggests that although the suggested method does not require complicated computation it still yields pretty accurate decisions.

Taking into account that Multi Attribute Decision Making (MADM) as the most common of problems in the area of management, including supplier selection problem are characterized by inevitable uncertainty,a supplier selection in the context of Interval Valued Intuitionistic Fuzzy Sets (IVLFS) was prposed[7].They suggest a new definition and some calculation methods for IVLFS entropy and as such suggested and entropy based decision making in IVLFS and MADM problems. The explained theory is then articulated by showing its deployment in supplier selection problem.

Interval type-2-fuzzy values to explain decision makers' preferences in supplier selection problem was proposed in[8].They also introduced a new formula to compute the distance between two interval type-2 fuzzy sets. Then the performance of the proposed formula is compared to existing ones. Using this formula the authors suggest to use the hierarchy based clustering method to supplier selection problem. Overall results of the study show that not only the proposed formula and hierarchical clustering algorithm provide acceptable results but it also can be successfully used for interval type-2-fuzzy sets in order to obtain proximity of suppliers.

An interesting approach was also proposed to supplier selection problem characterized by fuzzy and partially reliable information[9]. The authors use Z-number-based formalization of sub-criteria and criteria evaluations and importance weights in a hierarchical decision problem. The proposed work is based on a wide analysis. However, the original Z-numbers are reduced to fuzzy numbers and then to crisp numbers that leads to sufficient loss of information that may affect validity of the results.

Unfortunately, up to day there is no a systematic work on supplier selection under Z-number-valued information. In this paper we suggest a new approach to hierarchical multicriteria decision making on supplier selection when information about criteria and sub-criteria evaluations and importance weights are described by Z-numbers. In this approach original Z-number valued information is not converted to fuzzy information. The best alternative (supplier) is considered as that which has the best balance of distances to ideal solution and negative ideal solution.