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Global supplier development considering risk factors using fuzzy extended AHP-based approach☆

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Abstract

Global supplier development is a multi-criterion decision problem which includes both qualitative and quantitative factors. The global supplier selection problem is more complex than domestic one and it needs more critical analysis. The aim of this paper is to identify and discuss some of the important and critical decision criteria including risk factors for the development of an efficient system for global supplier selection. Fuzzy extended analytic hierarchy process (FEAHP) based methodology will be discussed to tackle the different decision criteria like cost, quality, service performance and supplier's profile including the risk factors involved in the selection of global supplier in the current business scenario. FEAHP is an efficient tool to handle the fuzziness of the data involved in deciding the preferences of different decision variables. The linguistic level of comparisons produced by the customers and experts for each comparison are tapped in the form triangular fuzzy numbers to construct fuzzy pair-wise comparison matrices. The implementation of the system is demonstrated by a problem having four stages of hierarchy which contains different criteria and attributes at wider perspective. The proposed model can provide not only a framework for the organization to select the global supplier but also has the capability to deploy the organization's strategy to its supplier.

Keywords: Supply chain; Global supplier selection; Analytic hierarchy process; Fuzzy logic; Multi-attribute decision making problem

1. Introduction

The current globalized market trend identifies the necessity of the establishment of long-term business relationship with competitive global suppliers spread around the world. The selection of different unfamiliar international suppliers is a very critical multi-attribute decision-making problem. It depends on the broad comparison of suppliers using a common set of traditional criteria and measures. Different conflicting selection decisions make the task more complicated and risk prone. Research results indicated that supplier selection process is one of the most significant variables, which has a direct impact on the performance of an organization. As the organization becomes more and more dependent on their suppliers, the direct and indirect consequences of poor decision making will become more critical. In a typical supply chain, coordination between manufacturer and suppliers is the important link in the distribution channel. The global competitive environment drives organizations highly dependent on the success of supplier selection process. Any deficiency in coordination of the process will lead to excessive delays and poor customer service. In fact, suppliers are manufacturer's external organizations or

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business partners, and indeed their performance will decide the future performance of the whole supply chain. An effective methodology for global supplier selection is the demand from the current business scenario.

The supplier development or selection problem considered in this paper is free from any quantity constraints and all the alternative suppliers have the ability to satisfy the manufacturer's minimum criteria of demand, quality level and delivery schedule. Here one supplier is able to satisfy the entire need for a particular product. The problem of global supplier selection of a manufacturing company is formulated using different available literatures and the experience of the experts. The paper considers the important decision criteria like cost, quality, service performance and supplier's profile including the risk factors involved in deciding the best potential supplier. The risk factors discussed in this paper can properly take care of some of the relevant issues like political stability, geographical location, economic condition, and effect of terrorism on supplier selection process which requires much attention. The different decision criteria may vary depending on the need of the organization, its preferences about different criteria and the technological strategy. This may not be easy to convert its needs into useful criteria because needs are often expressed as a general qualitative concepts while criteria should be quantitatively evaluated. The overall objective of the selection is to identify the potential supplier which can stand on the organization's specific decision criteria. The decision criteria should be appropriate to its planned level of effort and many conflicting criteria like low price with high quality, more advanced technology with high purchasing costs and excessive tariffs, etc., should be analyzed properly. During the global supplier selection the knowledge and critical information are taken from the group of experts in the respective areas and according to the priority of the firm the corresponding importance of one criterion over another can be decided.

The analytic hierarchy process (AHP) [1] is widely used for tackling multi-attribute decision-making problems in real situations. In spite of its popularity and simplicity in concept, this method is often criticized for its inability to adequately handle the inherent uncertainty and imprecision associated with the mapping of the decision-maker's perception to exact numbers. In the traditional formulation of the AHP, human's judgements are represented as exact (or *crisp*, according to the fuzzy logic terminology) numbers. However, in many practical cases the human preference model is uncertain and decision makers might be reluctant or unable to assign exact numerical values to the comparison judgements. Since some of the evaluation criteria are subjective and qualitative in nature, it is very difficult for the decision-maker to express the preferences using exact numerical values and to provide exact pairwise comparison judgements. It is more desirable for him to use interval or fuzzy evaluations.

To improve the AHP method and to facilitate global supplier selection process, the paper discusses a fuzzy extended AHP (FEAHP) approach using triangular fuzzy numbers to represent decision makers' comparison judgements and fuzzy synthetic extent analysis [2] method to decide the final priority of different decision criteria. The fuzzy set theory resembles human reasoning in its use of approximate information and uncertainty to generate decisions. It has the advantage of mathematically represent uncertainty and vagueness and provide formalized tools for dealing with the imprecision intrinsic to many problems. The proposed FEAHP uses the triangular fuzzy numbers as a pair-wise comparison scale for deriving the priorities of different selection criteria and attributes. The weight vectors with respect to each element under a certain criterion is developed using the principle of the comparison of fuzzy numbers. As a result, the priority weights of the each supplier is calculated and based on that, the global suppliers are selected. In particular, the approach developed can adequately handle the inherent uncertainty and imprecision of the human decision making process and provide the flexibility and robustness needed for the decision maker to understand the decision problem. These merits of the approach developed would facilitate its use in real-life situations for making effective decisions.

The remainder of the paper is organized as follows: Section 2 discusses the past researches available in the area of the supplier selection and fuzzy decision making approaches. Section 3 contains the discussion about the different decision criteria and attributes considered in the selection of the global supplier. In Section 4, the proposed FEAHP is discussed. Section 5 discusses the complete implementation of the FEAHP approach. The priority weights computed for different criteria, attributes and alternatives are also discussed in this section. Section 6 contains the conclusion and the future direction of the research particularly in context with global supplier selection.

2. Background and motivation

In the past, several methodologies have been proposed for the supplier selection problem but most of