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A combined methodology for supplier selection and performance evaluation

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ABSTRACT

Today, organizations that wish to carry on the sustainable growing need a robust strategic performance measurement and evaluation system because of changing demands of consumers, reduced product life cycle, competitive and globalised markets. In this study, a new methodology is introduced and proposed for increasing the supplier selection and evaluation quality. The new approach considers both qualitative and quantitative variables in evaluating performance for selection of suppliers based on efficiency and effectiveness in one of the biggest car manufacturing factory in Turkey. This new methodology is realized in two steps. In the first stage, qualitative performance evaluation is performed by using fuzzy AHP (Analytical Hierarchical Process) in finding criteria weights and then fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is utilized in finding the ranking of suppliers. So, qualitative variables are transformed into a quantitative variable for using in DEA (Data Envelopment Analysis) methodology as an output called quality management system audit. In the second stage, DEA is performed with one dummy input and four output variables, namely, quality management system audit, warranty cost ratio, defect ratio, quality management. As a result, comparing with the present system applied by the car factory, the new method seems to be some advantages and superiorities for making the decision in buying the quality car luggage side part (panel) by selecting the suitable supplier(s) in an automotive factory of Turkey.

1. Introduction

To choose the right supplier deals, with an important evaluation, and selection problems in the purchasing function of a business. A good supplier selection makes a significant difference to an organization's future to reduce operational costs and improve the quality of its end products. There have been a lot of factors in today's global market in which that influence companies to search for a competitive advantage by focusing on purchasing raw materials and component parts represents the largest percentage of the total product cost. For instance, high technology products such as motor vehicles, railroad&transport equipment, machinery&equipment components, purchased materials and services account for up to 80% of the total product cost. Therefore, selecting the right suppliers is a key to the procurement process and represents a major opportunity for companies to reduce costs. On the other hand, selecting the wrong suppliers can cause operational and financial problems (Weber, Current, & Benton, 1991). The traditional approach to supplier selection has been to select suppliers solely on the basis of price for many years. However, as companies have learned that price as a single criterion for supplier selection is insufficient, they have turned into more comprehensive multi-criteria decision making techniques. Recently, these criteria have become increasingly complex as environmental, social, political, and customer satisfaction concerns have been added to the traditional factors of quality, delivery, cost, and service. Apart from cost reduction, companies continuously work with suppliers to remain competitive by reducing product development time, improving product quality, and reducing lead times. For instance, a qualified base of suppliers helps a company achieve greater innovation through improved product design and increased flexibility. Some authors have identified several criteria for supplier selection, such as the net price, quality, delivery, historical supplier performance, capacity, communication systems, service, and geographic location, among others (Dempsey, 1978). These evaluation criteria involve trade-offs and are a key issue in the supplier assessment process since it measures the performance of suppliers. For example, one vendor may offer inexpensive parts of slightly below average quality, while another vendor may offer higher quality parts, with uncertain delivery thus setting up trade-offs. In addition, the importance of each criterion, varies from one purchase to the next and is complicated further by the fact that some criteria are quantitative (price, quality, etc.), while others are qualitative (service, flexibility, etc.). Thus, a technique is needed that can adjust for the decision maker's attitude toward the importance of each criterion

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and incorporates both qualitative and quantitative factors (Bhutta & Huq, 2002). The overall objective of the supplier evaluation process is to reduce risk and maximize overall value to the purchaser. An effective supplier survey should have certain characteristics such as comprehensiveness, objectiveness, reliability, flexibility and finally, it has to be mathematically straightforward. It can be concluded that important savings can be realized through effective purchasing strategies. This study helps decision makers reduce a base of potential suppliers to a manageable number and make the supplier selection by means of multi-criteria techniques. This new methodology was applied to a car manufacturing facility in Turkey.

2. Literature review

Supplier evaluation is a multi-objective and criteria decision making problem containing many quantitative and qualitative factors because there are typically more than one criterion (attitude) needed to be taken into consideration in evaluating a supply source. All of supply sources are focused on their performance such as delivery, quality, service and price as the main factors that all firms use for evaluating sources of supply (Ha & Krishnan, 2008). Many firms and researchers have been working on the supplier evaluation problem over the past decade to develop decision making models which can effectively deal with this problem. According to Ghodsypour and O'Brien (1998), optimization models for supplier evaluation can be classified into two groups: single objective models which are used to consider one criterion as the objective function and other criteria as constraints. The single objective models have two disadvantages: all criteria are equally weighted, which rarely happens in practice, and they have significant difficulties in considering qualitative factors. In contrast, the multiple objective models have been applied to a supplier evaluation problem. Relying on a single criterion makes the supplier selection process risky. Therefore, a multi-criteria approach is recommended. A pioneering work in supplier selection criteria was that of Dickson in 1966. Despite the multiple criteria nature of the problem, very little work has been devoted to the study of the supplier selection problem by using multi-criteria techniques such as goal programming, multi-objective programming, or other similar approaches. Kahraman, Cebeci, and Ulukan (2003) used fuzzy AHP to select the best supplier for a manufacturer firm established in Turkey. Bevilacqua and Petroni (2002) developed a system for supplier selection using fuzzy logic. Some authors as used in this paper have combined decision models in the supplier selection process, for example, Weber, Current, and Desai (1998) combined DEA and mathematical programming models. This combination provided decision makers with a tool for negotiating with suppliers. Dickson (1966) developed a model combining mathematical programming model and TCO (total cost of ownership). They derived the inventory management policy using activity-based costing information. Ghodsypour and O'Brien (1998) used AHP and mathematical programming to determine the best order quantity allocation while considering qualitative criteria into the analysis. Xia and Wu (2007) presented an integrated approach of AHP improved by rough sets theory and multi-objective mixed integer programming. Dulmin and Mininno (2003) applied a model to a mid-sized Italian firm operating in the field of public road and rail transportation by applying a multi-criteria decision making technique (promethee/gaia) to supplier selection problem. The supplier selection problem is complicated and risky, owing to a variety of qualitative and quantitative factors affecting the decision making process. There have been several supplier selection methods available in the literature. Some authors propose linear weighting models in which suppliers are rated on several criteria and in which these ratings are combined into a single score. These models include the categorical method which relies heavily on the experience and ability of the individual buyer, the weighted point (Timmerman, 1986) and the analytical hierarchical process (Nydick & Hill, 1992). Total cost approaches attempt to quantify all costs related to the selection of a vendor in monetary units, this approach includes cost ratio (Timmerman, 1986) and total cost of ownership (Dulmin & Mininno, 2003). Mathematical programming models often consider only the more quantitative criteria; this approach includes the principal component analysis (Petroni & Braglia, 2000) and neural network (Lovell & Pastor, 1999).

The neural network for supplier selection is another method that has been developed to help selecting the best supplier. Comparing to conventional models for decision support system, neural networks save a lot of time and money of system development. The supplier-selecting system includes two functions: one is the function measuring and evaluating performance of purchasing (quality, quantity, timing, price and costs) and storing the evaluation in a database to provide data sources to neural network. The other is the function using neural network to select suppliers. ANN was also applied to the supplier evaluation problem by imitating the decision process of a buyer for supplier selection (Lovell & Pastor, 1999). Nevertheless, these models are still lacking of the capability to deal with uncertainty which is usually present in the supplier selection problem. Carrera and Mayorga (2008) proposed a Fuzzy Inference System (FIS) approach in supplier selection for new product development. Experts agree that no best way exists to evaluate and select suppliers (Bello, 2003), and thus organizations use a variety of approaches and implements the one that suits best depending on the company's particular requirements. Many previous researches, in vendor evaluation, emphasizes conceptual and empirical decision support models that may suffer from certain shortcomings, such as being mathematically too complex or too subjective. Practical appreciation needs a methodology that is simple to use and understand, but yet it shall produce reasonably accurate results. There have been a lot of hybrid methods employed in the last 10 years at the literature in terms of supplier evaluation and selection methods (Morlacchi, 1999; Simpson, Siguaw, & White, 2003; Weber, Current, & Desai, 2000; Wang, Huang, & Dismukes, 2004; Bello, 2003). Fuzzy AHP, fuzzy TOPSIS and DEA are commonly used in the literature separately or sometimes their combinations can be used at the same time. There has not been any study in the literature about a hybrid fuzzy AHP/fuzzy TOPSIS/DEA approach before. When the literature is widely looked through, MCDM (Multi-Criteria Decision Making) techniques generally used are focused on TOPSIS (or fuzzy TOPSIS), AHP (or fuzzy AHP) and DEA. There have been some advantages and disadvantages when compared with each other, in terms of AHP and TOPSIS (Zeydan & Çolpan, 2009). Also, fuzzy AHP and fuzzy TOPSIS are combined in this study. But, it is the first time in the literature that weights are used by transforming qualitative variables into only one quantitative variable in fuzzy TOPSIS and found as triangular fuzzy numbers with fuzzy AHP. The hybrid method in the first step uses fuzzy AHP to assign criteria weight and then ranks all suppliers for the qualitative selection by using fuzzy TOPSIS. The result obtained from fuzzy TOPSIS is used in DEA as an output variable called quality management system audit (QMSA). In the second step, it uses DEA methodology in order to choose efficient vendors in the final selection process.

3. Proposed hybrid method for supplier selection and evaluation

We used three multi-criteria decision making method to find efficient and inefficient suppliers sensitively. In the first step, these are fuzzy AHP for the determination of criteria weights and fuzzy