Available online at www.sciencedirect.com
ScienceDirect
Int. J. Production Economics 104 (2006) 394–407
international journal of production economics
www.elsevier.com/locate/ijpe

Fuzzy multiobjective linear model for supplier selection in a supply chain

A. Amid[a], S.H. Ghodsypour[a], C. O'Brien[b,*]

[a]Department of I.E., Amirkabir University of Technology, Tehran, Iran
[b]Nottingham University Business School, University Park, Nottingham NG7 2RD, UK

Received 27 April 2004; accepted 15 April 2005
Available online 18 October 2005

Abstract

Within new strategies for purchasing and manufacturing, suppliers play a key role in achieving corporate competition. Hence, selecting the right suppliers is a vital component of these strategies. In practice, vagueness and imprecision of the goals, constraints and parameters in this problem make the decision-making complicated.

In spite of the importance of the problem the literature on this subject is relatively scarce. In this paper a fuzzy multiobjective linear model is developed to overcome the vagueness of the information. For the first time in a fuzzy supplier selection problem, an asymmetric fuzzy-decision making technique is applied to enable the decision-maker to assign different weights to various criteria. The model is explained by an illustrative example.

Keywords: Supplier selection; Fuzzy multiobjective decision making; Supply chain

1. Introduction

Supplier selection is one of the most critical activities of purchasing management in a supply chain, because of the key role of supplier's performance on cost, quality, delivery and service in achieving the objectives of a supply chain.

Supplier selection is a multiple criteria decision-making (MCDM) problem which is affected by several conflicting factors. Consequently, a purchasing manager must analyze the trade off among the several criteria. MCDM techniques support the decision-makers DMs in evaluating a set of alternatives. Depending upon the purchasing situations, criteria have varying mportance and there is a need to weight criteria (Dulmin and Mininno, 2003).

In a real situation for a supplier selection problem, many input information are not known precisely. At the time of making decisions, the value of many criteria and constraints are expressed in vague terms such as "very high in quality" or "low in price". Deterministic models cannot easily take this vagueness into account. In

*Corresponding author.
E-mail address: Chris.OBrien@nottingham.ac.uk (C. O'Brien).

0925-5273/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpe.2005.04.012

these cases the theory of fuzzy sets is one of the best tools for handling uncertainty. Fuzzy set theories are employed due to the presence of vagueness and imprecision of information in the supplier selection problem.

Bellman and Zadeh (1970) suggested a fuzzy programming model for decision-making in fuzzy environments. Zimmermann (1978) first used the Bellman and Zadeh (1970) method to solve fuzzy multiobjective linear programming problems. In his model the fuzzy goals and fuzzy constraints are treated equivalently, which is why the model is called symmetric. It is very common in business activities, such as supplier selection, that the goals importance or weights are different for DMs. Thus, the symmetrical models may not be appropriate for the same multiobjective decision-making problem, because the objectives may not be equally important.

In this paper, for the first time, a fuzzy multiobjective model has been developed for the supplier selection problem, in which different weights can be considered for various objectives.

2. Literature review

The literature in this area discusses either the criteria or the methods of supplier selection.

Dickson (1966) firstly identified and analyzed the importance of 23 criteria for supplier selection based on a survey of purchasing managers. He showed that quality is the most important criterion followed by delivery and performance history. Weber et al. (1991) reviewed 74 articles discussing supplier selection criteria, and showed that net price is the most important criterion for supplier selection. They also concluded that supplier selection is a multicriteria problem and the priority of criteria depends on each purchasing situation. Roa and Kiser (1980) and Bache et al. (1987) identified, respectively, 60 and 51 criteria for supplier selection. A comprehensive review of criteria for supplier selection is presented in Ghodsypour and O'Brien (1996). He concluded that the number and the weights of criteria depend on purchasing strategies.

Gaballa (1974) is the first author who applied mathematical programming to supplier selection in a real case. He used mixed integer programming to minimize the total discounted price of allocated items to the suppliers. Formulated a single-objective, mixed-integer programming to minimize the sum of purchasing, transportation and inventory costs by considering multiple items, multiple time periods, vendors' quality, delivery and capacity. Weber and Current (1993) used a multiobjective approach to systematically analyze the trade-offs between conflicting criteria in supplier selection problems.

Ghodsypour and O'Brien (1997) developed a decision support system (DSS) for reducing the number of suppliers according to supply based optimization strategy. They used an integrated analytical hierarchy process (AHP) with mixed-integer programming and considered suppliers' capacity constraint and the buyers' limitations on budget and quality etc. Ghodsypour and O'Brien (1998) developed an integrated AHP and linear programming model to consider both qualitative and quantitative factors in purchasing activity.

Karpak et al. (1999) used a goal programming model to minimize costs and maximize delivery reliability and quality in supplier selection when assigning the order quantities to each supplier. Degraeve and Roodhooft (2000) developed a total cost approach with mathematical programming to treat supplier selection using activity-based cost information. Ghodsypour and O'Brien (2001) developed a mixed-integer non-linear programming approach to minimize total cost of logistics, including net price, storage, ordering costs and transportation in supplier selection. However, due to the vagueness of the information related to parameters, these deterministic models are unsuitable to obtain an effective solution for supplier selection problem.

In the literature, there are few papers in order to handle imprecise information and uncertainty in supplier selection models (Narasimhan, 1983, Soukup, 1987, Nydick and Hill, 1992). In these papers, for finding the best overall rating supplier, simple linear weighting models have been adapted to deal with uncertainty from incomplete and qualitative data in unstructured purchasing situations.

Based on fuzzy logic approaches, Morlacchi (1997) developed a model that combines the use of fuzzy set theory (FST) with AHP and implements it to evaluate small suppliers in the engineering and machine sectors.

Li et al. (1997) proposed a measure for supplier performance evaluation. They used fuzzy bag method to score qualitative criteria and then all scores for qualitative and quantitative criteria are combined in an intuitive sum of weighted averages. Holt (1998) reviewed of contractor evaluation and selection modeling methodologies including FST method. In these methods, binary decisions (e.g. the contractor does, or does not, have a formal safety policy) can convert to linguistic variables (e.g. No, Minimum, Strong and