Fuzzy Multi-Choice Goal Programming for Supplier Selection

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ABSTRACT
Supplier selection decision is an important issue of purchasing management in supply chain management involving multiple objectives; however, it is difficult to solve because objectives are often conflicting in nature. This study integrates multi-choice goal programming (MCGP) and fuzzy approaches as decision aids to help decision makers to choose better suppliers by considering multiple aspiration levels and vague goal relations. According to the function of multiple aspirations provided by the fuzzy MCGP (FMCGP), decision makers can set fuzzy relations among multiple supplier goals with linguistic quantifiers according to their different strategies. Also, decision makers can define the membership function for each linguistic quantifier to describe their ambiguous selection preference in supplier selection. With the FMCGP method, decision makers can obtain the order quantities for suitable suppliers based on different organizations’ supply chain strategies. To demonstrate the usefulness of the proposed method, a real-world case of a Liquid Crystal Display (LCD) monitor and acrylic sheet manufacturer is presented.

Keywords: Decision-Making, Fuzzy Multi-Choice Goal Programming, LCD, Supplier Selection, Supply Chain Management

INTRODUCTION
Supplier selection decision is an important component of purchasing management for many companies (Dobler et al., 1990; Willis et al., 1993). Selecting the right suppliers and determining the appropriate orders from them can bring significant benefit in the reduction in purchasing cost, the decrease in supplying risk and improved product quality. Accordingly, international organizations usually build long-term contracts with main global suppliers and determine the appropriate orders from them based on their characteristics (cost capability, product quality, on-time delivery and service) (Min, 1994; Ghodsypour & O’Brien, 1998; Chan & Kumar, 2007). According to suppliers’ different characteristics, organizations adopt different strategies such as cost leadership strategy (Porter, 1980), differentiation strategy
(Porter, 1980), quick response (Iyer & Bergen, 1997) and Just-in-time strategy (Schonberger, 1982) to cope with different issues.

It is not easy to utilize published supplier selection models because all coefficients of supplier selection models should be recomputed when an organization changes their supply chain strategy according to marketing needs. In order to express decision makers’ (DMs) preference for different supply chain strategies, DMs need the flexibility to determine not only the imprecise target of each goal but also fuzzy relations among goals. In order to find the suitable suppliers that match the organization’s supply chain strategy, this study proposes a new supplier selection method incorporating one goal mapping multiple aspirations, linguistic preference mechanism, and preemptive priority of fuzzy relations among goals. Also, fewer coefficients should be changed in the proposed method when an organization changes their supply chain strategy.

When considering the setting of the priority of goals, a decision maker (DM) usually assigns different weights to each goal that they are concerned with. Traditionally, a DM can use analytic hierarchy process (AHP) to structure the problem and determine the weights of each attribute (Liou & Chuang, 2008; Fazlollahtabar, 2008). However, a DM will suffer from the complicated pair-comparison process between the criteria in AHP hierarchy. With AHP, a DM is asked to estimate pairwise comparison ratios with respect to strength of preference between suppliers by using a long questionnaire. It is too complicated for DMs to conduct pair-wise comparison because many supplier selection criteria and potential suppliers should be considered simultaneously. Moreover, if the housing criteria hierarchy is not carefully designed, the result of the problem will be invalid and biased. Compared with AHP, MCGP is much more suitable for DMs to make decisions because it only requires DMs to set their housing goals and constraints. This can help reduce a DM’s evaluation time, and it can be easily implemented with a computer program.

Also, DMs can set weight or priority among goals using traditional methods such as weighted goal programming (GP), lexicographic GP and MINMAX GP. However, these may be too restrictive to model the relationship between goals in multiple objective decision-making problems, especially when the supplier selection criteria are vague and imprecise, such as the product cost is “slightly more important,” “moderately more important,” or “significantly more important” than product service. Curry and Lazzari (2009) adopted fuzzy concept as linguistic variables to deal consumer preferences. For this, several previous studies (Chen & Tsai, 2001; Lin, 2004; Aköz & Petrovic, 2007) have discussed how to approach the different importance of goals in fuzzy goal programming (FGP). Chen and Tsai (2001) formulated FGP incorporating different importance by using an additive model to maximize the sum of achievement degrees from all fuzzy goals. Aköz and Petrovic (2007) proposed a modified FGP method to handle imprecision of the relative importance relations among goals. However, it is difficult to implement a situation when the multiple aspiration levels appear in a goal by using neither the proposed methods from Chen and Tsai (2001) nor the work of Aköz and Petrovic (2007).

Multi-choice goal programming (MCGP) was original proposed by Chang (2007) for considering situations of one goal mapping multiple aspiration levels to find the best fitting level of achievement of a goal in decision making problems. For the purchasing managers of organizations, determining a specific target value of each goal is not easy because only partial information can be obtained in an uncertain environment. To the best of the authors’ knowledge, no work has been which deals with this problem. This paper integrates MCGP and fuzzy approaches in order to help DMs to choose better suppliers by considering multiple aspiration levels and vague goal relations.

The aim of this study is to add the idea of fuzzy relations to the MCGP method so as to extend the possible solution space of sup-
Bounded Primal Simplex Algorithm for Bounded Linear Programming with Fuzzy Cost Coefficients
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