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Optimizing whole supply chain benefit versus buyer's benefit through supplier selection

J. Gheidar Kheljani[a], S.H. Ghodsypour[a,*], C. O'Brien[b]

[a]Department of Industrial Engineering, Amirkabir University of Technology, No. 424, Hafez Ave., Tehran, Iran
[b]Nottingham University Business School, Jubilee Campus, Wollaton Road, Nottingham NG8 1BB, UK

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Abstract

A number of mathematical models have been developed for modeling the supplier selection problem. Most of these models have considered the buyer's viewpoint and maximized only the buyer's benefit. This does not necessarily lead to an optimal situation for all members of a supply chain. Co-ordination models have been presented to optimize the benefits of all the members and alignment of decisions between entities of a supply chain. In this paper, the issue of coordination between one buyer and multiple potential suppliers in the supplier selection process has been considered. On the other hand, in the objective function of the model, the total cost of the supply chain is minimized rather than only the buyer's cost. The total cost of the supply chain includes the buyer's cost and suppliers' costs. The model has been solved by applying mixed-integer nonlinear programming. Finally, the proposed method is illustrated by a numerical example.

Keywords: Supplier selection; Supply chain coordination; Nonlinear programming

1. Introduction

Recently, many researchers have paid attention to total optimization in the supply chain. In the supply chain literature, two types of optimization have been defined: local optimization and global or total optimization. Local optimization of each member does not guarantee optimization of the total supply chain. In total supply chain optimization, all members of a supply chain attempt to maximize a chain's revenue or minimize the cost of a chain in close collaboration with each other. Total optimization is very complex because of the large numbers of the supply chain's members and difficulties in their relationships. Narasimhan and Carter (1998) in their paper have presented that a well-integrated supply chain involves coordinating the flows of materials and information between suppliers, manufactures, retailers and any other intermediaries. Thomas and Griffin (1996) have stated that to achieve effective supply chain management, planning and coordination among all entities in a supply chain is needed. Several models such as quantity discounts, credit option and buy-back/return policies are applied to align and coordinate the decisions between members of a supply chain. Most

*Corresponding author. Tel.: +98 21 66413034; fax: +98 21 66413025.
E-mail addresses: Kheljani@aut.ac.ir (J. Gheidar Kheljani), Ghodsypo@aut.ac.ir (S.H. Ghodsypour), Chris.Obrien@nottingham.ac.uk (C. O'Brien).

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of these models are used to improve the effectiveness of an existing supply chain. When a supply chain is being designed and structured, the coordination and alignment of decisions between entities are of great importance. Supplier selection and order allocation problems are the primary subjects that must be considered in the beginning of a supply chain design. Many papers have been published to develop models in this field. Most of these models have considered and optimized only a buyer's objectives without respect to suppliers' utilities. In these models, suppliers offer their conditions such as production constraint, sale prices and discounts, and the buyer selects the right suppliers in the light of his optimal situation and allocates orders to them. Here, the buyer's bargaining power impels suppliers to accept and follow his decisions. This paper develops a supplier selection and order allocation model to minimize the average total cost incurred in the whole supply chain. Furthermore in this paper, a model is generated to coordinate decisions between buyers and suppliers in a supplier selection process.

The remaining part of this paper is organized as follows. In Section 2, previous studies are reviewed. In Section 3, a single-objective supplier selection model and its solving algorithm are presented. In Section 4, a numerical example is illustrated. Finally, in Section 5, results and future research directions are presented.

2. Literature review

Supplier selection models can be broken down into single-source and multiple-source models. In single-source models, one supplier is able to respond to a buyer's demand. Therefore, in these models the buyer with regard to some criteria chooses one supplier from among many suppliers. In multiple-source models the allocation problem has been considered as well as the selection problem (Sharafali and Henry, 2000). Generally, in single-source models ranking techniques have been applied, but in multiple-sourcing models mathematical programming models have been implemented. Some of these mathematical programming models are reviewed.

In a pioneering paper, Dickson (1966) identified 23 criteria that have been considered by purchasing managers in various vendor selection problems. Two years later, Wind et al. (1968) concluded that most vendor selection decisions involved multiple criteria. Weber et al. (1991) reviewed 74 papers surrounding supplier selection and identified several techniques or models that have appeared in studies over the previous 25 years. They found that the large majority were linear weighting models, mathematical models such as economic order quantity (EOQ) and a few probabilistic models. They also stated that only 10 articles applied mathematical programming to vendor selection and indicated that in spite of the complexity and economic importance of vendor selection, little attention has been paid in the literature to the application of mathematical programming methods. Ghodsypour and O'Brien (1998) in their article identified seven papers, as well as Weber et al. (1991). Weber and Current (1993) introduced multi-objective programming (MOP) as a technique for selecting vendors with their order quantities in procurement.

Gaballa (1974) developed a mixed-integer programming model to minimize total purchasing costs, while considering quantity discounts and supplier capacity constraints. Moore and Fearon (1973) stated that price, quality and delivery are important criteria for supplier selection and they explained that linear programming can be applied to this decision making. Anthony and Buffa (1977) used a single-objective linear programming model to minimize total purchasing and storage costs with purchasing budget, vendor capacities and buyer's demand constraints in scheduling vendor deliveries. Buffa and Jackson (1983) presented a multi-criteria linear goal programming model for supplier selection. Bender et al. (1985), to help purchase managers at IBM, applied a mixed-integer single-objective programming to minimize the sum of purchasing, transportation and inventory costs by regarding multiple items, multiple time periods, vendors' quality, delivery and capacity. Narasimhan and Stoynof (1986) used a single-objective, mixed-integer programming model to minimize the sum of costs associated with shipping and the penalty costs for inefficient utilization of supplier capacities. Turner (1988) presented a single-objective linear programming model to minimize the total contract cost by considering the vendor capacity, maximum and minimum order quantities, demand and regional allocated bounds as constraints in the presence of bulk value discounts. Pan (1989) used a single-objective linear programming model to choose the best suppliers, in which three criteria are considered—price, quality and service. The total purchase cost is taken into account as an objective function,