Supplier Selection by the Pair of AR-NF-IDEA Models

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ABSTRACT
Supplier selection is the process by which suppliers are reviewed, evaluated, and chosen to become part of a company’s supply chain. To select the best suppliers in the presence of cardinal data, ordinal data, nondiscretionary factors, and weight restrictions, this paper proposes a new model considering all of these assumptions. A numerical example demonstrates the application of the proposed method.

Keywords: Assurance Region, Company Supply Chain, Imprecise Data Envelopment Analysis, Nondiscretionary Factors, Supplier Selection

INTRODUCTION
Supplier selection is the process by which suppliers are reviewed, evaluated, and chosen to become part of the company’s supply chain. Shin et al. (2000) argue that several important factors have caused the current shift to single sourcing or a reduced supplier base. First, multiple sourcing prevents suppliers from achieving the economies of scale based on order volume and learning curve effect. Second, multiple supplier system can be more expensive than a reduced supplier base in terms of the labor and order processing costs to managing multiple source inventories. Third, multiple sourcing lowers the overall quality level because of the increased variation in incoming quality among suppliers. Fourth, a reduced supplier base helps eliminate mistrust between buyers and suppliers due to lack of communication. Fifth, worldwide competition forces firms to find the best suppliers in the world. Farzipoor Saen (2009c) proposes a method for ranking suppliers in the presence of nondiscretionary factors. Farzipoor Saen (in press) demonstrates the use of advanced Data Envelopment Analysis (DEA) modeling for measuring how well suppliers perform on multiple criteria relative to other suppliers competing in the same marketplace. The approach allows the buyer to evaluate effectively each supplier’s performance relative to the performance of the ‘best suppliers’ in the marketplace, through calculation of DEA efficiency measures.

One of the uses of DEA is supplier selection. In original DEA formulations the assessed Decision Making Units (DMUs) can freely choose the weights or values to be assigned to each input and output in a way that maximizes

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its efficiency, subject to this system of weights being feasible for all other DMUs. In supplier selection problems, Decision Makers (DMs) may have value judgments that can be formalized a priori, and therefore should be taken into account in supplier selection. For example, in the supplier selection problem in general, one input (material price) usually overwhelms all other inputs, and ignoring this aspect may lead to biased efficiency results. Suppliers might also supply some outputs that require considerably more resources than others and this marginal rate of substitution between outputs should somehow be taken into account when selecting a supplier.

Traditionally, supplier selection models are based on cardinal data with less emphasis on ordinal data. However, with the widespread use of manufacturing philosophies such as Just-In-Time (JIT), emphasis has shifted to the simultaneous consideration of cardinal and ordinal data in supplier selection decisions.

In any realistic situation, there may exist nondiscretionary criteria that are beyond the control of management. Banker and Morey (1986) illustrate the impact of exogenously determined inputs that are not controllable in an analysis of a network of fast food restaurants. In their study, each of the 60 restaurants in the fast food chain consumes six inputs to produce three outputs. The three outputs (all controllable) correspond to breakfast, lunch, and dinner sales. Only two of the six inputs, expenditures for supplies and expenditures for labor, are discretionary. The other four inputs (age of store, advertising level, urban/rural location, and presence/absence of drive-in capability) are beyond the control of the individual restaurant manager. Their analysis clearly demonstrates the value of accounting for the nondiscretionary character of these inputs explicitly in the DEA models they employ; the result is identification of a considerably enhanced opportunity for targeted savings in the controllable inputs and targeted increases in the outputs. In the case of supplier selection, distance and supply variety are generally considered nondiscretionary criteria.

In supplier selection context, the objective of this paper is to use a model that considers imprecise data, weight restrictions, and nondiscretionary factors.

This paper proceeds as follows. First, literature review is presented. Next, the method which selects the suppliers is introduced. Then, numerical example and concluding remarks are discussed respectively.

LITERATURE REVIEW

Some mathematical programming approaches have been used for supplier selection in the past. Zeng et al. (2006) considered a simplified partner selection problem which takes into account only the bid cost and the bid completion time of subprojects, and the due date the project. They modeled the problem as a nonlinear integer programming problem and proved that the decision problem of the partner selection problem is NP-complete. Then they analyzed some properties of the partner selection problem and constructed a branch and bound algorithm. Ghodsypour and O’Brien (2001) developed a mixed integer nonlinear programming model to solve the multiple sourcing problems, which takes into account the total cost of logistics, including net price, storage, and transportation and ordering costs. The model is burdensome because it must be run $2^n$ times for $n$ suppliers. Dahel (2003) presented a multiobjective mixed integer programming approach to simultaneously determine the number of vendors to employ and the order quantities to allocate to these vendors in a multiple-product, multiple-supplier competitive sourcing environment. Talluri and Baker (2002) presented a multi-phase mathematical programming approach for effective supply chain design. More specifically, they developed and applied a combination of multi-criteria efficiency models, based on game theory concepts, and linear and integer programming methods. Ip et al. (2004) described
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