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# A two-phased semantic optimization modeling approach on supplier selection in eProcurement

Jin Ho Choi [a], Yong Sik Chang [b,*]

[a] Graduate School of Management, Korea Advanced Institute of Science and Technology, 207-43, Cheongryang, Seoul 130-012, South Korea
[b] Department of e-Business, Hanshin University, 411 Yangsan-dong, Osan, Kyungki 447-791, South Korea

**Abstract**

The eProcurement planning is crucial to reduce purchase cost while selecting the right suppliers and it contributes to improve corporate competitiveness. This eProcurement planning research describes a framework for the integration of a knowledge-based system capable of identifying a goal model from a Primitive Model. The Primitive Model is screened by the screening factors reflecting the purchase strategy. As a result, by using the framework for supplier selection and allocation (SSA), a purchaser is able to reduce the costs and time required to select the right suppliers and to alleviate anxiety for 'out-of-favor' suppliers. This approach is based on two-phased semantic optimization model modification that semantically builds a goal model through model identification and candidate supplier screening based on model identification rules and supplier screening rules. This approach contributes significantly to construction of an optimization model from the perspective of model management and it provides a useful environment for efficient eProcurement from the perspective of a purchaser.


*Keywords:* eProcurement planning; Knowledge-based system; Supplier selection and allocation; Optimization model; Model management

## 1. Introduction

The proliferation of B2B e-Commerce in recent years has resulted in an explosion of eProcurement on the Internet. Procurement from various suppliers is a capital-intensive decision that often accounts for a large portion of the total operating costs (Bonser & Wu, 2001). Hence, it is very important to reduce purchase cost while selecting the right suppliers and it contributes to improve corporate competitiveness.

Research works related to supplier selection can be classified into two broad categories: a qualitative approach and a quantitative one. A majority of the research deals with qualitative supplier evaluation schemes. Given the economic importance and inherent complexity of the supplier selection process, only a few articles have addressed decision-making by quantitative methodologies. None of the supplier selection models, however, explicitly reflect the purchase policy or the supplier-related knowledge dynamically nor do most of them reflect the possibilities of purchasing several parts from a single supplier for price discount or bundling effect.

Purchase strategies depend on the situation of an organization. In order to support the strategies, diverse models are necessary. Recently, model warehouse (Bolloju, Khalifa & Turban, 2002) is one of the methods to solve these problems. However, it is not easy for purchaser to meet with diverse purchase strategies by using only several ready-made models, and it is very inefficient to prepare all combinations of models in advance from model management point of view. Moreover, candidate suppliers vary depending on purchase conditions. It is a little complex to build a goal model to select right suppliers among all of the potential suppliers. Hence, a simpler approach is needed to solve this problem.

In this research, we propose a two-phased semantic optimization modeling approach that formulates a goal model through model identification and candidate supplier screening for strategic supplier selection and allocation (SSA). In the procurement process, supply conditions of suppliers and purchase strategies of purchaser are considered together. Basically, a purchaser wants to minimize the purchase cost with supply conditions such as price discount and bundling while making purchase strategies. A purchase strategy affects a goal model. We build a goal model from SSA base models through the process of model modification that reflects purchase strategies.

* Corresponding author. Tel.: +82 31 370 6421; fax: +82 31 370 6605.
*E-mail addresses:* jhchoi@kgsm.kaist.ac.kr (J.H. Choi), yschang@hs.ac.kr (Y.S. Chang).

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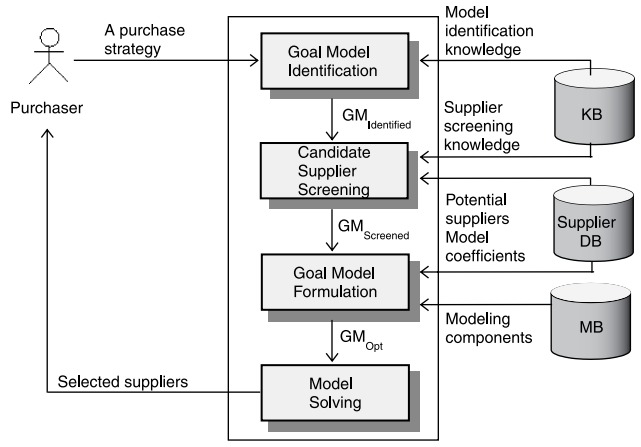


Fig. 1. The modeling architecture for supplier selection and allocation.

Fig. 1 depicts the modeling architecture for SSA. The SSA procedure is broken down into goal model identification, candidate supplier screening, goal model formulation, and model solving. The details of each component are as follows.

- *Goal Model Identification*. A new specific goal model based on the SSA base model is identified by modeling factors, which compose a purchase strategy by purchase manager. Chang and Lee (2004) proposed three approaches to derive a goal model from a base model: the Primitive Model approach, the Full Model approach, and the Most Similar Model approach. The Primitive Model has only mandatory constraints and the Full Model has all possible requested constraints. The Most Similar Model is a model case that is the most similar one to a modeling request. Those models can be modified into a goal model by adding or deleting model components. Intuitively the Primitive Model Approach is effective when the goal model is similar to the Primitive Model (Chang & Lee, 2004). Thus, in this research, we use the Primitive Model Approach, because it starts from a simple model. The identified goal model is composed of an SSA Primitive Model and additional model constraints. The identified goal model can be represented as:

$$GM_{Identified} = (\text{SSA Primitive Model};\ \text{Added Constraints}).$$

We described Model Identification Knowledge, which identifies a goal model from the Primitive Model, in Section 4.1.

- *Candidate Supplier Screening*. Candidate suppliers are screened by the supplier screening factors, which compose a purchase strategy. The preliminary screened candidate suppliers must satisfy the purchaser's requirements for evaluation criteria such as quality, delivery, and price boundary. After screening, the goal model is described as:

$$GM_{Screened} = (GM_{Identified};\ \text{Candidate Suppliers}).$$

We described Candidate Supplier Screening Knowledge, which sifts candidate suppliers from potential suppliers, in Section 4.2.

- *Goal Model Formulation and Model Solving*. The Modeling components corresponding to a base model and added constraints in $GM_{Screened}$ formulate an optimization model $GM_{Opt}$ using model coefficients of candidate suppliers and it can be solved by an IP solver such as iLOG, LINGO, or LINDO, etc.

To describe the above approach, we organized this article as follows. In Section 2, we reviewed previous studies related to SSA. In Section 3, we introduced an SSA Primitive Model with price discount and bundling effect. In Section 4, we described two-phased model formulation in details. Finally, we conclude our study.

## 2. Related work

Purchasers in an organization buy many different types of items and services. The procedures used in completing a total transaction normally vary among the different types of purchases. Procurement is defined, in a narrow sense, as the act of buying goods and services for a firm or, from a broader perspective, as the activity of obtaining goods and services for the firm (Cavinato, 1984). Weele (1994) divided procurement process into five stages: identification of suppliers, supplier selection, recognition of needs, ordering, and evaluation of supplier. In these stages, selection of the right supplier is the key to obtain: the desired level of quality, timeliness, and price; the necessary level of technical support; and the desired level of service (Dobler & Burt, 1996).

The proposed quantitative methodologies for SSA can, from the optimization models' point of view, be grouped into the following three categories: linear programming models, mixed integer programming models, and goal programming models. Table 1 shows the comparison results of each optimization model for SSA.

A few of the above models take into account the quantity discount effect (Chaudhry, Forst & Zadiak, 1993; Rosenthal, Zydiak & Chaudhry, 1995). Two common types of quantity discounts are the all-units (cumulative) price breaks and non-cumulative price breaks. A different but prevalent quantity discount scheme is bundling, where the price of an item depends on the buying quantities of other items (Rosenthal et al., 1995). This occurs when more than two related items are sold together as a bundle, which provides an economic advantage to the buyer and seller.

However, a few studies have analyzed the bundling effect in the context of SSA. Quantity discount and bundling effect are realistic factors that effectively bring the power of the optimization models to solve practical procurement problems. In procurement planning all of these factors should be applied differently according to the purchasing environments and purchasing strategy. Also, most of the above models are static by nature, in that all model components such as objective functions and constraints are made in advance. These models, therefore, cannot reflect the purchase policy or the supplier-related knowledge dynamically. So, we propose an approach to