Supplier evaluation and selection using Taguchi loss functions

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Abstract The purchasing function directly affects the competitive ability of a firm. Purchasing managers need to periodically evaluate supplier performance in order to retain those suppliers who meet their requirement. Four attributes are frequently used as performance criteria. These attributes are quality, on-time delivery, price and service. An evaluation and selection system of suppliers using Taguchi loss functions is proposed in this paper based on these four attributes. These four attributes are transferred to the quality loss and combined to one decision variable for decision making. It is useful to make supplier evaluation and selection for promoting the competitive ability of a firm. An example of application to supplier evaluation and selection is also presented.

Keywords Price, Service · Quality, Delivery · Supplier Evaluation · Taguchi loss functions

1 Introduction

Quality is a critical concern for most manufacturers. The need for high quality suppliers has always been an important issue for many manufacturing organizations [1] but it is not enough to consider only that the suppliers can provide good quality parts. When manufacturers reduce their materials inventory, they increase their reliance on receiving the “right parts at the right time in the right condition” from their suppliers [2]. Especially, a just-in-time purchasing or delivery system refers to the relationship between suppliers and manufacturers.

Usually the purchasing price is also a highlighted consideration to the purchasing organization but the purchase price is only a fraction of the cost associated with material receipt. When a supplier fails to meet delivery, quality and price requirements, additional costs are required by the purchasing organization to correct these deficiencies. So, purchasing’s focus must shift from primarily a unit-price-oriented to a cost-based-performance evaluation of suppliers. Monczka and Trecha (1988) provided a cost-based supplier performance evaluation system to evaluate key supplier performance.

Improving service quality is also considered an essential strategy for success and survival in today’s competitive situation. In order to meet the actual needs of customers, it is important to quantify service quality. Li (2003) proposed two modified quality loss functions to measure service quality.

The purchasing department may try to find the optimal supplier - not necessarily the supplier offering the best technical service, the lowest price or the shortest delivery. The purchasing function directly affects the ability of a firm to compete through its impact on quality, cost, technology and supplier responsiveness. So firms have been encouraged to develop longer-term trust-based relationships with fewer suppliers [5]. At this time, supplier selection is one of the most important phases of the purchasing process. Once an acceptable supplier is identified, the buyer has an opportunity to establish a long-term relationship with the supplier, which may provide a strategic advantage [5].

Within many sectors of manufacturing, the evaluation of suppliers has become a more common activity. Manufacturers have been looking at the supplier organization’s systems for costing, delivery, quality, management and technology, called process-based evaluations, or looking at the supplier’s quality and delivery performance, called performance-based evaluations [6]. Despite the emphasis on supplier evaluation, there has been little empirical investigation of the supplier evaluation process in terms of the suppliers’ reaction to it [2].

In this paper, we develop a simple method for supplier evaluation and selection based on quality, on-time delivery, price and service. The model quantifies these four attributes in terms of Taguchi quality loss and then combines them into one global decision variable for decision making. A numerical example is also presented to illustrate the model and to show its utility.
2 Supplier evaluation model review

A lot of literature has accumulated on the subject of vendor evaluation and selection models. Most of these models finalize the supplier selection decision-making process based on a set of supplier performance criteria [7]. They are summarized in the following:

2.1 Categorical models

In the categorical model [8], suppliers are evaluated on criteria such as cost, quality, speed of delivery, etc. Against each criteria, suppliers were classified to good, fair, bad and were assigned a (+), (0) or (−) to each level, respectively. A supplier will be the best one if it gets more (+) than another. The limitation with this approach is that all the attributes are weighted equally. Apparently, this approach is intuitive, subject, simplistic in nature and is easy to use.

Alternatively, the method can be useful if weights are assigned to each attribute and the (+), (0) and (−) are replaced by (+1), (0) and (−1), respectively. Based on the total score, suppliers then can be ranked and the supplier with the highest score will be selected [7].

2.2 Cost-ratio method

The cost ratio method evaluates the cost of each attribute as a percentage of the total purchase for the supplier. Summing these percentages and adding to the price percentage, we can get the total price of the purchasing parts. However, this approach has difficulties in developing cost accounting systems for this purpose [9].

2.3 Cost-based models

This model recognizes that material price is only a fraction of the cost of the purchased material [3]. According to Monczka and Trecha (1988), a cost-based supplier performance evaluation system reflects the actual total cost of doing business with suppliers. They developed two indexes for their cost-based model, namely supplier performance index (SPI), and service factor rating (SFR). Before calculating these two indexes, the evaluated key items and performance parameters should be identified. This model has several advantages [7]. First, it allows for qualitative and quantitative evaluation criteria. Second, the evaluation on qualitative criteria is done by those who have direct contact with suppliers. Third, the two indexes are complementary to each other and, if integrated properly, would make this model superior to other available models. However, with this and other models, the process of evaluation is still subjective.

2.4 Weighted point method

In general, weighted point models are formulated as follows [10]:

\[ A_j = \sum_{i=1}^{n} a_i b_{ij} \]  

(1)

where:

- \( A_j \) = Summated score to represent the total performance anticipated from vendor \( j \).
- \( a_i \) = Importance weight attached to evaluative criterion \( i \).
- \( b_{ij} \) = Performance rating on evaluative criterion \( i \) for vendor \( j \).
- \( n \) = Number of evaluative criteria.

To use the weighted point method, the criteria of vendor evaluation must be identified and assigned the weight point in the beginning [8]. Then, the related purchasing people will rate the suppliers’ performance under intuitive judgment. Thompson (1991) pointed out that the mathematics underlying weighted point models is simple; they can be adapted to any type of purchase decision. However, weighted point models also have some disadvantages. One major disadvantage is the limitations associated with scaling techniques.

2.5 Vendor profile analysis

Vendor profile analysis is a modified weighted point model [10]. Using Thompson’s notations, the vendor profile analysis model can be written as follows:

\[ A_{jk} = \sum_{i=1}^{n} a_i b_{ijk} \]  

(2)

where:

- \( A_{jk} \) = Summated score for vendor \( j \) on iteration \( k \) of the simulation.
- \( a_i \) = Importance weight attached to evaluative criterion \( i \).
- \( b_{ijk} \) = Performance rating on evaluative criterion \( i \) for vendor \( j \) during iteration \( k \) from simulation.
- \( n \) = Number of evaluative criteria.

This model uses the Monte Carlo simulation technique for modelling the uncertainty associated with predicting vendor performance against the evaluative criteria instead of rating from human intuitive judgment. The simulation algorithm randomly samples values \( (b_{ijk}) \) from within each estimated performance range, and then combines these values with importance weights, in accordance with linear compensatory rules, to produce a distribution of summated scores. Each computer generated \( A_{jk} \) amounts to a single iteration of the simulation process. This process is repeated up to several thousand times for each supplier. The use of Monte Carlo simulation simplifies decision makers’ input to the evaluation model and provides output that contains considerably more information upon which to base purchase decisions than do standard weighted point decision models.