



A Methodology to Prioritize The Constructs in Supplier Selection – an Application in an Engineering Industry

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ABSTRACT

Dynamic business environment demand the most appropriate selection of suppliers who are highly competitive both in quality and cost. The criteria used for evaluating the suppliers enhance a firm's sourcing strategy. The supplier selection is a multi criterion decision making problem which involves both qualitative and quantitative criteria. The purpose of this paper is to develop a methodology using Structural Equation Modelling (SEM) to prioritize the constructs used in supplier selection. Based on the factor scores obtained from SEM, the relative weightages of the factors are evaluated. The factors are then ranked and the strategies are formulated accordingly. These strategies aid the managers in the process of evaluating the suppliers. An application of the proposed model in a heavy engineering industry is also made.

KEYWORDS : Supply Chain Management, Supplier selection, SEM.

1. Introduction

Today's globalized economy has made almost all the industries to face a highly competitive environment. Right supplier selection is becoming a highly difficult task in this competitive environment. Supplier selection and evaluation is the process of finding the appropriate suppliers who are able to provide the buyer with the right quality products and/or services at the right price, in the right quantities and at the right time (A. Hadi Vencheh, 2011).

The main purpose of this article is to find out the importance of each factor using their relative weightages, derived from their factor scores. Based on their importance, the factors are ranked and strategies are formulated accordingly.

The remaining section of the article is organized as follows. Literature review is presented in the second part. The third part deals with the main objectives with which the study has been carried out. SEM is presented as the fourth part. The proposed methodology forms the fifth part. Application of the proposed model in an industry is given the sixth part and Managerial Implications forms seventh part and the conclusion is given as the final part.

2. Literature Review

Supplier selection is defined in (Sonmez, 2006) as the "process of finding the suppliers being able to provide the buyer with the right quality products and/or services at the right price, at the right quantities and at the right time".

Since the initial study by Dickson (1966) many researchers have identified different sets of supplier selection criteria. Based on the literature review we have identified six constructs and twenty three indicators for those constructs. They are:

Quality:

Quality related attributes taken for our study includes continuous improvement, quality systems used by customers, conformance to specification, reliability and process capability. Continuous improvement is to check whether the supplier follows a continuous improvement program. Quality systems used by customers is whether they are certified with quality system certificate. Conformance to specification is the capability to produce products that conform to specification. Reliability is the ability to produce precise products both qualitatively and quantitatively. Process capability is the supplier's ability to produce quality products.

Firm Performance:

The indicators used to evaluate firm performance in our study includes, performance history, competitive position, financial position and environmental performance. Performance history evaluates the firm's performance in the past with respect to the quality of the product, market share, annual turnover, profit, investment in R&D, etc. Competitive position of the firm is either in terms of the percentage of market share or in terms of transaction compared to their competitors. Financial position can be analyzed using the financial statements of the firm over a period of time. Environmental performance is the level of supplier's dedication towards environmental policies.

Technology:

The technology indicators used in our study includes, technical capacity, design and development ability and future technology. Technical capacity is the level of the supplier expertise to manufacture products without defects and with precise specifications. Design & Development ability is the capability of developing new designs, speed of development and ability to respond to design changes. Future technology is their advancement and investment in Research and development activities and their speed of adapting to new technology.

Flexibility:

Flexibility indicators used in our study includes flexibility of operation, service flexibility and volume flexibility. Volume flexibility is the ability of the supplier to change the output rate based on demand. According to Jafar Razaei et al (2014) flexibility refers to the agility level, promptness and degree to which a supplier can adjust with product volume and product mix.

Cost:

The indicators used to evaluate cost in our study includes, net price, operating cost, logistics cost and pay time / payment terms. Net price is the unit price of the product. Operating cost includes assembly and manufacturing, labor, long-term operations, and equipment cost. According to Felix T.S.Chan et al (2008) logistic cost includes distribution channel cost, transport expenses, inventory cost, handling and packaging cost, damages in the way and insurance costs.

Service:

In our study the indicators like on-time delivery, technical assistance and support, warranties and claims / after sales service and information sharing are used to evaluate the service level of the suppliers. On time delivery is the ability of the supplier to meet predefined delivery times. Technical assistance and support is the degree to which

the suppliers accept to offer technical support if needed during the production of the product. After sales service is the response time to any service after the sales assured by the supplier. The long term relationship between the supplier and the manufacturer depends heavily on the ease with which they communicate and negotiate with each other.

3. Objectives of the study:

This study has been conducted with the following objectives:

- * To identify the factors influencing supplier selection.
- * To develop a causal model for supplier selection
- * To find out the relative importance of the factors affecting supplier selection
- * To formulate strategies based on the present study.

4. Structural Equation Modelling (SEM):

According to Sewall Wright (1921), SEM is a statistical technique for testing and estimating causal relations. SEM consists of a Measurement model and a Structural model. Measurement model shows the relationship between the indicators and the factors. Structural model of SEM denotes the relationship between the factors and the final goal. According to Punniyamorthy et al (2012) the measurement model is summarized as:

$$Y = A_y \eta + \epsilon$$

The structural model is summarized as:

$$\eta = \Gamma \xi + \zeta$$

5. Methodology:

Through the literature review the constructs and their indicators were derived upon. The survey instrument has been developed based on those constructs and indicators (Table 1). Thus the final questionnaire consist of 23 indicators that comes under 6 factors namely quality, financial performance, technology, flexibility, cost and service.

A causal model was developed based on SEM. The factor scores for the indicators arrived at the measurement model (fig 1) are given as an input to the structural model (fig 2). From the structural model the factor scores for the factors are arrived at. Based on the mean of these factor scores, the factors are ranked and the strategies are formulated accordingly.

6. Application:

To demonstrate the proposed model, an example of a company producing Boilers have been considered. Using random sampling we have taken a sample of 105 executives, who are involved in the process of the decision making of selecting the suppliers. From the literature review, we have arrived at six factors along with their indicators. All these factors along with their indicators are summarized in table 1.

The relative weightage of all the factors are thus arrived from the output of the structural model. The relative weightage thus obtained and the corresponding ranking of the factors are presented in Table 2.

7. Managerial Implications:

From the analysis of the relative weightages it is clear that service factor is ranked the most important among all the factors followed by technology, quality, financial performance, flexibility and cost. To survive the heavy competition on-time delivery of goods and services forms a very crucial part. High development and constant updation of technology leads to the increase in the level of importance given to technical assistance and support. The maintenance cost can be kept at the minimum by having an extended warranties and claims. Proper information sharing is the key for a successful partnering relationship between the supplier and the manufacturer.

Next important factor is technology. The frequency of technology getting updated is shortening day by day i.e the life span of a particular technology is so short.

Quality is the next important factor. From the analysis we infer that quality of a product speaks than it's cost. Customers have started preferring high quality products than low cost products. Quality systems

like ISO certifications have become mandatory for the firms to prevail in the market. Conformance to the specification is an important indicator of the quality factor.

Financial performance, the fourth important factor has the ability to positively contribute for the long term relationship. Even though the supplier meets the quality standards, an unstable financial position may strain the relationship.

Flexibility factor involves the flexibility in operations, service and volume. Operational flexibility is important due to the constantly changing technology. Changing demand patterns has to be met with the aid of volume flexibility. Final importance is for the cost factor. Current market conditions forces the organization to achieve competitive advantage in terms of service, technology and quality and not by means of cost.

8. Conclusion:

Supplier selection forms a crucial and most important stage in supply chain because of its impact in achieving service, quality, cost and delivery objectives. In this paper we have proposed a methodology for effective supplier selection based on SEM. The inferences imply that service factor has to be given more weightage followed by technology, quality, financial performance, flexibility and cost. The proposed methodology aids organizations to decide on the weightages for the factors and thus in the process of supplier selection.

Table 1: Factors and Indicators:

S.No	Factors	Indicators
1	Quality	1. Continuous Improvement
		2. Quality Systems used by supplier
		3. Conformance to specification
		4. Reliability
		5. Process Capability
2	Firm Performance	1. Performance History
		2. Competitive Position
		3. Financial Position
		4. Environmental Performance
3	Technology	1. Technical Capacity
		2. Design & Development ability
		3. Future Technology
4	Flexibility	1. Flexibility of Operation
		2. Service Flexibility
		3. (Delivery Frequency, Supply Variety...)
		4. Volume Flexibility
5	Cost	1. Net Price
		2. Operating Cost
		3. Logistics Cost
		4. Pay time / Payment Terms
6	Service	1. On - Time Delivery
		2. Technical assistance & support
		3. Warranties & Claims / After Sales Service
		4. Information Sharing

Table 2: Factors and their relative weightage:

S.No	Factors	Relative Weightage	Rank
1	Quality	0.7829	3
2	Financial Performance	0.7508	4
3	Technology	0.79	2
4	Flexibility	0.7506	5
5	Cost	0.7163	6
6	Service	0.8043	1

Table 3:
Fit Index:

Fit Index	Range	Obtained Values	Fit
Root Mean Square Error Approximation (RMSEA)	0.08 – 0.1	0.1	Mediocre Fit
Goodness of Fit Index (GFI)	0.0 – 1.0	0.67	Good Fit
Adjusted Goodness of Fit Index (AGFI)	0.0 – 1.0	0.58	Good Fit
Normal Fit Index (NFI)	0.0 – 1.0	0.7	Good Fit
Root Mean Square Residual (RMR)	0.0 – 1.0	0.06	Mediocre Fit

Fig 2:
Structural Model:

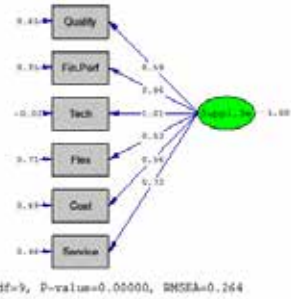
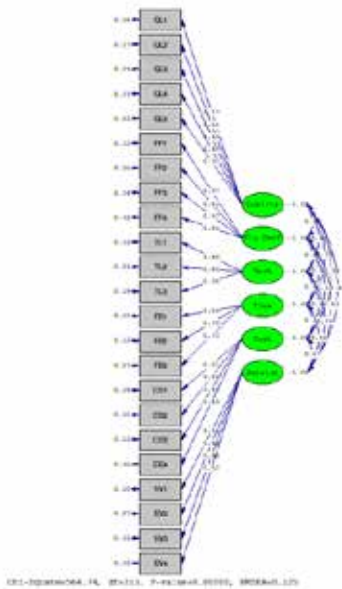


Fig 1:
Measurement Model:



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