

# Supplier Evaluation and Selection: A Review

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**Abstract** - Supplier selection is a process by which an organization identifies, evaluate and contract with suppliers. To get the quality material at a reasonable cost and at right time, proper supplier selection is must. Looking to its importance, various methods have been developed for this purpose. This paper takes a review of methods developed for supplier selection and also explains their merits, demerits and suitability for particular application.

**Keywords:** Analytical Hierarchy Process (AHP), Fuzzy AHP.

## INTRODUCTION

Supplier selection is defined 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. Basically there are two types of supplier selection problems . In single sourcing type, one supplier can satisfy all the buyer’s needs. In the multiple sourcing type, no supplier can satisfy all the buyer’s requirements. Hence the management wants to split order quantities among different suppliers [8]. Supplier Selection is important task of any purchasing department. The main objective of supplier selection process is to reduce purchase risk, maximize overall value to the purchaser, and develop closeness and long-term relationship’s between buyers and suppliers, which is effective in helping the company to achieve “Just-In-Time” (JIT) production[6]. A supply chain is a network of departments, which is involved in the manufacturing of a product from the procurement of raw materials to the distribution of the final products to the customer. Small cost reductions gained in the acquisition of materials can have a greater impact on profits than equal improvements in other cost-sales areas of the organization. Purchasing department ought to be purchasing the right quality of a product in the right quantity from the right source at the right time. The right source can provide the right quality of material on time at a reasonable price. Supplier evaluation and selection are very important to the success of a manufacturing firm because the cost and quality of goods and services sold are directly related to the cost and quality of goods and services purchased. Therefore, purchasing and supplier selection have an important role in the supply chain process. Traditionally, vendors are selected on their ability to meet the quality requirements, delivery schedule, and the price offered. The problem of finding and

evaluating the most suitable vendors usually emerges when the purchase is complex, high-dollar value, and perhaps critical. The supplier selection process is a multi-objective decision, encompassing many tangible and intangible factors in a hierarchical manner [16]. Supplier selection problem is affected by different tangible and intangible criteria such as quality, price, delivery, technical capability and many more. So selecting the right supplier by a decision maker with reduce purchasing cost improves competitive ability and increase customer satisfaction[3].

Supplier selection problem usually involves more than one criterion and these criteria often conflict with each other[9]. It is a multi-criteria decision-making problem which consists of both qualitative and quantitative metrics. There are several approaches to the supplier selection problem in the literature Some of which are Analytic Hierarchy Process, Fuzzy Analytic Hierarchy Process, Data Envelopment Analysis, Mixed Integer Programming, TOPSIS, Fuzzy TOPSIS, Analytic Network Process and Expert Systems.[1]. Some authors have identified several criteria for supplier selection, such as net price, quality, delivery, historical supplier performance, capacity, communication systems, service, geographic location, among others. These criteria are a key issue in the supplier assessment process since it measures the performance of the suppliers. Small cost reductions gained in the acquisition of materials can have a greater impact on profits than equal improvements in other cost-sales areas of the organization. The 23 criteria are ranked with respect to their importance observed in the beginning of the sixties. At that time, the most significant criteria were the “quality” of the product, the “on-time delivery”, “Performance history” of the supplier and the warranty policy used by the supplier[4].

## 1. Literature Review

Mustafa[2013] applied F-AHP Methodology in gear motor company and identified 5 different criteria for selecting supplier, including Quality, Origin, Cost, Delivery, After sales service. He proposed that there are some more techniques as; TOPSIS, ANP, etc. in this study Analytical Hierarchy Process technique is used empowered with fuzzy approach. Since the decision makers preferences depend on

both tangible and intangible criteria, these vague linguistic variables should be represented by Fuzzy Set Theory. Hence Fuzzy AHP model is utilized to solve the supplier selection problem of a manufacturing company.

Verma and Pateriya [2013] proposed that Selection of criteria's and number of criterion's may vary from industry to industry and even from person to person. selection of criteria was done on the basis of literature survey and a series of informal discussions with the industry personnel. All the necessary attempts were made for investigating criteria for supplier selection and originality of the work, yet extensive research may be done in this field. Sometimes, it becomes very difficult for a supplier to give numerical values to the criteria. A supplier selection criterion is a qualitative term and for the purpose of calculations it must be quantifiable. In order to quantify the criteria we assign the numerical values to the criteria.

Sinan Apak et.al[2012] applied AHP for luxury car selection and identified seven criteria's as quality, reliability, technology, brand image, flexibility, performance and price. They conclude that AHP process provide a useful guidelines as a structured and logical means of synthesizing judgments for evaluating appropriate decision tools, decision makers can compare different scenarios and possibilities with respect to appropriate criteria through the AHP. Thus decision makers can examine the strengths and weakness of each criterion. AHP methodology can be applied in strategic management issues for decision making in a multi-criteria context

Yaser N. Alsuwehri[2011] used AHP for supplier selection and their criteria's are cost, quality, delivery, management and organization, financial. Their main contribution of the work was the identification of the important criteria for the supplier selection process. Then a multi-criteria decision model for evaluating and selecting a supplier was developed. The model for supplier evaluation and selection was developed using the AHP method. The AHP model is assessing decision-makers to identify and evaluate the supplier selection. Finally, the developed model is tested on four supplier selection problems. The results show the models are able to assist decision-makers to examine the strengths and weaknesses of supplier selection by comparing them with appropriate criteria, sub-criteria.

Sanjay kumar[2009] applied AHP in small, medium and large scale Industries criteria's used were price, transportation cost quality certification, goodwill of vendor, reliability, experience, lead time, buffer stock of inventory. They suggests that while large scale industries are the best alternative solution for the vendor selection problem, Reliability of the vendor, product quality and the vendor experience are the top three parameters in the vendor selection problem.

Amy H.I. Lee[2009] applied a fuzzy analytic hierarchy process (AHP) model with the consideration of benefits, opportunities, costs and risks (BOCR) is constructed for supplier selection. They conclude that there are many supplier selection models available, most models usually only stress the criteria that are required by the buyers, but seldom the opportunities, costs and risks that need to be faced by the buyers if they select a specific supplier. fuzzy set theory is incorporated into the model to overcome the uncertainty and ambiguity in human decision-making process. By applying the model, decision makers can evaluate the expected performance of each supplier on various factors and can determine the overall ranking of the suppliers. The model also provides the importance of the factors that decision makers should consider in supplier selection. The model can also be modified as required by a firm in any other industry to help it select the best suppliers.

S. Mahmoodzadeh et.al[2007] applied fuzzy AHP and TOPSIS for project selection, they proposed a new methodology to provide a simple approach to assess alternative projects and help decision maker to select the best one. By using improved AHP with fuzzy set theory the qualitative judgment can be qualified to make comparison more accurate and reduce or eliminate assessment bias in pair-wise comparison process.

I. Fernández et.al proposed both weighting and fuzzy logic and they conclude that, the weighting method initially presented is characterized by great flexibility in the evaluation process , it does not permit the analysis of certain situations very likely to happen in real business. The adaptation of the initial model is made by using the fuzzy logic inference. As a consequence, the disadvantages have been mitigated, resulting in a robust, versatile and congruent model for the qualification of a supplier in the different phases within the purchase process.

Maggie C.Y. [2001] proposed that the hierarchical structure used in formulating the AHP model can enable all members of the evaluation team to visualize the problem systematically in terms of relevant criteria and sub criteria. The proposed model is applied to vendor selection problems. In both cases, the decisions reached by using the model agreed with those obtained by using the pre-existing vendor selection process. However, using the AHP model, the criteria for vendor selection are clearly identified and the problem is structured systematically. This enables decision-makers to examine the strengths and weaknesses of vendor systems by comparing them with respect to appropriate criteria and sub criteria. Moreover, the use of the proposed AHP model can significantly reduce the time and effort in decision making.

## 2.METHODS FOR SUPPLIER SELECTION

Various supplier selection methods developed by researcher are given in table 2.1

S/R	Researcher	Method	Quantitative/ Qualitative parameters	Advantages	Disadvantages
1	Timmerman [1986]	Categorical	-Quality -Delivery -Service -Price	-The evaluation process is clear and systematic -Inexpensive -Requires a minimum performance data	-Attributes are weighted equally -Subjective -Imprecise
2	Timmerman [1986]	Weighted Point	-Quality -Delivery -Service -Price	-Attributes are weighted by importance	-Subjective -Difficult to effectively consider qualitative criteria
3	Timmerman [1986]	Cost ratio	-Quality -Delivery -Service -Price	Subjectivity is reduced -Flexibility	-Complex
4	Ellram [1995]	Total Cost of Ownership	-Price -Quality costs -delivery performance -service costs -Transport costs -Ordering costs -Reception costs -Inspection costs	-Substantial cost savings -Allows various purchasing policies to be compared with one another	-Complex
5	Wei [1997]	Neural Network	-Performance -Quality -Geography -Price	-Saves a lot of time and money of system development	-Requires a software
6	Betul Ozkan [2011]	Analytical Hierarchy Process	-Communication capability - Employees number and quality -References -sector experience -capital -service adequacy	-simplicity -captures both qualitative and quantitative criteria	-Inconsistency on the method
7	Rajeev Jain [2013]	Fuzzy AHP	-Cost -quality -Delivery -Flexibility	F-AHP is extension of AHP, It allows a more accurate description of the decision making process.	It requires data based on experience, knowledge and judgment which are subjective for each decision makers.

Supplier selection methods are explained in brief below.

### 2.1 Categorical Method

This method relies heavily on the experience and ability of the individual buyer [20]. People in charge of purchasing, quality, production, and sales all express their

opinions about the supplier's performance on the basis criteria which are important to them. These departments assign either a preferred, unsatisfactory, or neutral rating for each of the selected attributes for every contending supplier. At periodic evaluation meetings, the buyer

discusses the rating with department members. The buyer then determines the supplier's overall scores.

The primary advantage of the categorical approach is that it helps structure the evaluation process in a clear and systematic way. This method is quite simple, it is not supported by objective criteria, and rarely leads to performance improvements. The main drawback of this method is that the identified attributes are weighted equally and the decisions made using this system tend to be fairly subjective.

### 2.2 Weighted Point Method

This method considers attributes that are weighted by the buyer. The weight for each attribute is then multiplied by the performance score that is assigned. Finally, these products are totaled to determine a final rating for each supplier [20]. All measurement factors are weighted for importance in each purchasing situation. Typically this system is designed to utilize quantitative measurements.

The advantages of the weighted point method include the ability for the organization to include numerous evaluation factors and assign them weights according to the organization's needs. The subjective factors on the evaluation are minimized. The major limitation of this approach is that it is difficult to effectively take qualitative evaluation criteria into consideration.

### 2.3 Cost-ratio method

The method relates all identifiable purchasing costs to the monetary value of the goods received from vendors [20]. The higher the ratio of costs to value, the lower the rating applied to the vendor. The choices of costs to be incorporated in the evaluation depend on the products involved. Quality costs can be determined and documented by the quality control department, with the help of other departments such as production and receiving. The usual costs associated with delivery include communications, settlements and emergency transport costs. Cost ratio method is flexible and in which subjectivity is reduced. This method is very complex.

### 2.4 Total cost of ownership method

This method attempts to quantify all of the costs related to the purchase of a given quantity of products or services from a given supplier [5]. Optimum use of all discounts available can lead to substantial savings. In addition to the price component, other cost factors also play an important role, including the costs associated with quality shortcomings, a supplier's delivery performance, transport costs, ordering costs, reception costs, and inspection costs. This method uses activity-based costing which is a management accounting technique that attempts to assign costs to cost generating activities within a business. This technique uses activity analysis, which defines the various activities performed by an organization. The total cost of ownership is substantial cost savings method and allows various purchasing policies to be compared with one another. This method is very complex.

### 2.5 Neural network method

This method has been developed to help selecting the best supplier. Comparing to conventional models for decision support system, neural networks save a lot of time and money of system development. The supplier-selecting system includes two functions: one is the function measuring and evaluating performance of purchasing (quality, quantity, timing, price and costs) and storing the evaluation in a database to provide data sources to neural network [22]. The other is the function using neural network to select suppliers. Most of the neural-network paradigms commonly used have three layers: input layer, output layer, and hidden layer. It should be decided which Artificial Neural Network (ANN) model should be used, and the number of nodes in the input layer, hidden layer and output layer. Back-propagation network (BPN) is the most popular neural network model and has the highest success rate. This method saves a lot of time and money of system development and the disadvantage is that it required software.

### 2.6 Analytic Hierarchy Process (AHP) method

This method has been developed by T. Saaty (1977). It allows users to assess the relative weight of multiple criteria or multiple options again given criteria in an intuitive manner. In case quantitative ratings are not available, policy makers or assessors can still recognize whether one criterion is more important than another. Therefore, pair-wise comparisons are appealing to users. Saaty established a consistent way of converting such pair-wise comparisons into a set of numbers representing the relative priority of each of the criteria [13]. It is based on the well-defined mathematical structure of consistent matrices and their associated eigenvector's ability to generate true or approximate weights [11]. The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair wise mode. To do so, the AHP uses a fundamental scale of absolute numbers that has been proven in practice and validated by physical and decision problem experiments. The fundamental scale has been shown to be a scale that captures individual preferences with respect to quantitative and qualitative attributes just as well or better than other scales [20]. It converts individual preferences into ratio scale weights that can be combined into a linear additive weight for each alternative. The resultant can be used to compare and rank the alternatives and, hence, assist the decision maker in making a choice [18]. The advantage is that it's simplicity and captures both qualitative and quantitative criteria but there is inconsistency in method.

### 2.7 Fuzzy AHP method

This method is extension of AHP. The Fuzzy AHP approach allows more accurate description of the decision making process. Objective is converted into triangular Fuzzy number. This triangular fuzzy numbers are used to build the comparison matrices of AHP based on pair wise comparison technique. In classical AHP, directly



the numerical values of linguistic variables are used for evaluation of criteria. If the environment where the decision making process takes place is fuzzy, then fuzzy numbers are used for evaluation. Nowadays, especially in complex economic conditions, many of the decisions are made in such an environment. Thus, fuzzy version of AHP or similar method should be used in spite of its complexity during the calculation [1]. In the fuzzy AHP, triangular fuzzy numbers are utilized to improve the scaling scheme in the judgment matrices, and interval arithmetic is used to solve the fuzzy eigenvector[15]. The advantages of FAHP is that it allows a more accurate description of the decision making process and disadvantage is that it require data based on experience, knowledge and judgment which are subjective for each decision maker.

### CONCLUSION

It has been observed that 23 criteria's have been proposed by researcher for supplier selection. Literature review shows that several methods have been developed for ranking the suppliers .Among to proposed methods, AHP is the best method for small and medium scale industry. It is simple for implementation and capture both qualitative and quantitative criteria. Among the 23 criteria's, four criteria (i.e. cost, quality, delivery and capacity) have been proposed by most of the researchers.

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