INTERNATIONAL JOURNAL
FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Supplier Evaluation and Selection - A Review

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Abstract: Supplier evaluation and selection process is an important activity in supply chain. However, for many organizations the process is a big challenge because it is a multi- criteria decision problem leading to tradeoffs. As such several criteria and methods have been devised for the process. Researchers have proposed criteria that should be considered when selecting and evaluating suppliers and the importance of each criterion in the process. Also various methods have been suggested to easy the supplier evaluation and selection process. However, the challenge has been on which criteria and method are most suitable given the supplier evaluation and selection process varies from one organization to another. Hence the focus of this review is to shed light on the most important supplier evaluation and selection criteria and method to use.
Keywords: supplier evaluation, supplier selection methods, supplier selection criteria

I.   INTRODUCTION

According to Chhabile.S & Dalu R. (2014) Supplier evaluation and selection is a process by which an organization identifies, evaluates and contracts a supplier to provide it with the right quality products and/or services at the right price, at the right quantities and at the right time. Shiati M, (2012) describes it as an ongoing process of searching and evaluating to find a supplier of essential goods and services required in an organization for normal operations. The process is an important activity in the supply chain management because improper evaluation and selection of potential supplier can reduce the organization supply chain performance (Pitchipoo P et al., 2016). The biggest challenge with the process for many organizations is that, it involves many conflicting criterion which cost of both qualitative and quantitative metrics. Tahriri, F., et al (2008) explained that being a multi criteria decision problem, trade-offs among multiple criteria is a common practice. This is because each supplier will portray different traits based on the criteria's used. For instant, an aspiring supplier may be willing to supply an item at the lowest cost but is unable to deliver the item in good time when compared to other suppliers and it is challenging to find a supplier who excels in all dimensions of performance Guler, M., (2008). A second reason is explained by Shiraouyehzad, H. et al., (2011) who states that internal policies within an organization can act as a barrier. Organizations set minimum and/or maximum quantities of a product and similarly, the suppliers may also impose their own constraints. Because of the complexity and importance of supplier evaluation and selection process, there are several approaches to the supplier evaluation and selection problem in literature.

A.   Supplier Evaluation And Selection Criteria

The number of stages defined in the supplier evaluation and selection process differ from one author to another. Boer L., et al. (2001) categorised the process into four stages as problem determination, criteria formulation, pre-qualification of potential suppliers and finally the choice. Sonmez, M., (2006) defined five stages by adding supplier need determination stage before problem determination. Monczka et al (2011) defined seven stages; Recognize need for supplier selection, identify key sourcing requirements, determining sourcing strategies, Identify potential supply source, Limit suppliers in selection pool, Determine method for evaluation and selection process and select supplier.

Despite variation in the number of stages involved in the supplier evaluation and selection process, what stands out is that there is need for a set of criteria that will be used to evaluate the suppliers. Many scholars have argued on what criteria should be considered when selecting and evaluating suppliers and the importance of each criterion in the process.

In the sixties Dickson, G.W., (1966) study revealed and ranked 23 important criteria for supplier evaluation and selection process. The study was based on 273 respondents who were required to assess the importance of each criterion on a five point scale. Based on the respondent reply, quality was the most important followed by delivery then performance history.

 Weber et al. (1991) carried out a literature review and classified 74 articles that appeared since 1966 with regard to particular criteria used in supplier evaluation and selection. He identified the major supplier evaluation and selection criteria used include; price, delivery, quality, and production capacity and location. Based on the 23 criteria identified by Dickson in 1966, Zhang, Lei, Cao and Ng (2003) collected 49 articles between 1991 and 2003. The study concluded that net price, quality, and delivery were the most important supplier selection criteria replacing Dickson (1966) number one ranked quality criteria.

Lambert and Pohlen (2001) indicated that traditionally many companies use logistics focused metrics such as lead time, fill rate, or on-time performance to evaluate their current and potential suppliers

Monczka et al. (1998) suggested eleven categories: supplier management capability; overall personnel capabilities; cost structure; total quality performance systems and philosophy; process and technological capability, including the supplier's design capability; environmental regulation compliance; financial capability and stability; production scheduling and control systems, including supplier delivery performance; information systems capability; supplier purchasing strategies, policies, and techniques; and longer-term relationship potential Juhantila and Virolainen (2002) recognized that the process of managing business relationships during all respective stages is a critical success factor. From this study, good supplier attributes which clearly stood out are: high quality, delivery accuracy, responsiveness and service, low competitive cost and competitive price.

In a survey, Kannan and Tan (2002) identified quality level, on-time delivery; response time and service level the most important factors. Chengter and Ming-Hung (2008). Proposed 13 criteria for supplier evaluation and 30 for supplier selection. Out of 13 criteria for supplier evaluation the most important criteria included: On time delivery, Quick responses time, Quality performance, Quality precision and Service performance. Of the five most important supplier selection criteria include: Commitment to quality, timely delivery, prices, reputation of supplier and supplier process capability

Omar, S.K., & Simon, H.K. (2010) in a study on supplier evaluation and selection criteria conducted on Malaysian Manufacturing firms found that cost followed by quality ranked higher than any other determinants. Delivery ranks third based on their analysis**.**

B.   Supplier Evaluation And Selection Methods

Supplier evaluation and selection methods are used to help an organization choose the best supplier. There are many approaches that have been proposed to analyse and solve the problem of supplier evaluation and selection. Boer L., et al. (2001) presented a review on decision methods that can be used in the different stages of supplier evaluation and selection process. He clearly demonstrated that there are many suitable operation research methods such as Statistical, Artificial Intelligent, mathematical and linear weighted methods that have already been used in supplier evaluation and selection problem. The choice of the method is extremely important to the overall process because it has significant influence on the final results. In choosing a method it is important to take note of the stage being applied to. Many evaluation and selection methods used today are based on traditional methods. According to Kar, A.K., (2009) cost ratio method, categorical method, weighted-point evaluation, mathematical programming models and statistical approaches are traditional methodologies for supplier evaluation and selection. Bruno, G., et al (2011) categorised the approaches into single and combined methods; single methods use a single methodology while combined methods merge two or more methods. The single methods are derived from Mathematics, Statistics and Artificial Intelligence fields. The combined methods use more than one method in the same framework, they include Mathematics combined methods, Artificial intelligence combined methods and hybrid combined methods.

C.   Linear Weighting Methods

This method rates supplier based on some criteria and a final single score is obtained. Weights are allocated to the criteria and the biggest weight indicates the highest score. Rates on the criteria are multiplied by their weights and summed up in order to obtain a single figure against each supplier. One major characteristic of this method is the compensatory nature. In a compensatory environment a high score on a criterion can balance a low score on another criterion; this may not reveal the true characteristics of the supplier. Boer L., et al. (2001) indicated that the linear weighting model can be used for supplier evaluation and selection with a variety of changes in the way it is used. Categorical method, weighted point method and Analytical Hierarchy Process (AHP) are examples of linear weighting models. The categorical method relies on the experience and ability of the buyer, which helps structure the evaluation process in a clear and systematic way, however it major drawback is giving equal weights which make the results subjective Chhabile.S & Dalu R. (2014). The weighted point method tries to reduce the subjectivity in Categorical method by assigning weights for each attribute based on the level of importance. This allows the organization to define numerous evaluation factors and assign weights as per the organization needs. However the limitation of these approach is the difficulty to effectively take qualitative evaluation criteria into consideration Chhabile.S & Dalu R. (2014). Analytical Hierarchy Process (AHP) method which was developed by Saaty T in 1977. AHP permits some little irregularity in judgment on the grounds that human is not generally consistence. The proportion scales are obtained from the principal eigenvectors and the consistency file is obtained from the major eigenvalue Fashoto et al., (2016). Advantages of AHP include: Presenting the purchaser with a decent picture of the supplier's execution by utilizing the hierarchy of the criteria and assessing the suppliers (Omkarprasad and Kumar, 2006) stability and flexibility because an existing model can be changed.

D. Mathematical Programming Methods

As the number of supplier alternatives increase and more selection criteria are taken into consideration, the supplier evaluation and selection and evaluation problem requires more extensive evaluation methodologies such as Mathematical Programming models. According to Kar, A.K. (2009) current organizations especially in e-procurement scenario allow many suppliers to be selected to supply the same product, mathematical programming methods can be appropriate since they take into consideration many alternatives. Mathematical Programming methods are objective and allow the problem to be formulated in form of a mathematical objective function which is varied so that it either leads to minimisation or maximisation. The objectives must be stated as constraint. When the problem contains a single objective function that needs to be minimized or maximized, linear programming can be used. If the problem contains multiple objectives, goal programming (GP) or Data Envelopment Analysis (DEA) method can be used.

E. Statistical Methods

This methods deal with the stochastic uncertainty related to supplier choice Boer L., et al. (2001). They analyze a set of items by determining the relationship among the items. Although stochastic uncertainty is present in most type of purchasing situations, very few models have been developed to handle this uncertainty. For instance an organization may want to know the number of items in the store, when to order and the quantity to be ordered. This can only be possible with a prediction model. From literature only few researchers have exploited the use of statistical models. The methods that have been proposed under Statistical method are Cluster Analysis (CA) and Principal Component Analysis (PCA).

Artificial intelligent based methods are based on computer aided systems that can be trained by an expert or based on past data Boer L., et al. (2001).. Non experts who face similar but new decision situations can consult the system. Even though such models are new and very few examples exist, it is paramount to acknowledge the importance of this method whose idea is based on current trends. With the rise of supply chain management and customer relationship management this method is appropriate in addressing such issues. Examples of methods based on Artificial Intelligence technology that have been applied to supplier choice include Artificial Neural Networks (ANN) and Case Based Reasoning (CBR).

Lam, K.C., et al (2010) developed an Artificial Neural Network model to assist public clients identify suitable contractors for tendering. 112 real prequalification cases were collected from civil engineering projects in Hong Kong and 88 hypothetical prequalification cases were generated. The case studies showed that the ANN model is suitable for mapping complicated non-linear relationship between contractor's attributes and their corresponding pre-qualification or disqualification decisions.

II. DISCUSSION

The foregoing literature on supplier evaluation and selection criteria reveals that even though researchers are focusing on identifying and analyzing supplier evaluation selection criteria, Dickson and Weber identified criteria are most widely used for supplier selection Patil A.N (2014). Review on criteria's identified by researcher from 1966-2012 signifies that quality is the most important criteria followed by delivery, price, reputation of organization, technical capability, after sales service, financial position and management.

As the number of suppliers have increased and the way of conducting business has changed, criteria have evolved and inception of new criteria such as technology, payment terms, conceptual manufacturing, manufacturing challenge, driving force, lead time, personnel capability, solution oriented, global factor, environmental risk coined for purpose of selecting not only the deserving supplier rather the most exceptional one. Even though there are a lot of changes in the way suppliers are evaluated and selected over time, some of the criteria such as cost, quality and delivery performance are still important.

Literature on supplier evaluation and selection methods reveals that Linear weighting methods are simple to implement and take into consideration group decision making since the decision makers are involved in assigning weights thus making it easy to explain the results to the potential suppliers. However, linear weighting models suffer from Compensatory problem. Sonmez, (2006) defines two supplier rating approaches as compensatory and non-compensatory. Compensatory is a problem that allows a good score on one criterion to uplift a bad score on another criterion. This can hide weakness. It could be assumed that the option is the best however in essence lower scores have been lifted by good scores. Instead of using scores obtained from decision makers this method can be improved by using Monte Carlos simulation technique which will give the probability distribution. This will get rid of the uncertainty associated with decision makers' perception; however this will trade off the importance assigned to the criteria to models such as weighted point and AHP. Also there is a high probability in selecting an inappropriate supplier which could adversely affect the organization.

AHP considers one way hierarchical relationship among factors which makes it simple to implement. Also its hierarchical structure ensures a decision problem is broken down into smaller manageable sections which provide a deep insight of the problem and systematic prioritizing of criteria. Decomposition is done in such a way that two factors can be compared at a time. However, the problem with such an approach is that when the numbers of pairs to be compared increase, the pair wise comparison task may become long and time consuming. This approach does not also consider relationships among factors, or those within them. For example when selecting a supplier, a decision maker may categorize factors into cost, quality and delivery time. A supplier is rated on each of these factors separately and aggregated to arrive at an overall score, which implies that AHP does not consider interaction among the various factors. Secondly, AHP suffers "rank reversal". Saaty (1996) defines rank reversal as a modification in the order of already ranked traits when a new trait is introduced or an old one removed from the set. Already evaluated. This implies that addition or deletion of an alternative will alter the order of existing alternatives which will lead to a repeat of the entire ranking process. Thirdly, as much as AHP is a simple and robust method Bruno et al. (2011) owing to the factor that it is of additive type, the problem is that addition of scores leads to compensation. Which implies that if a criteria gets a low score it can be compensated by a high score in another criteria. Compensation of scores on criteria can mask weakness. Fourthly, The AHP model is based on a discrete 9-point scale which is used to compare any two criteria during pair wise comparison. Sometimes this poses a challenge to the decision makers who may have difficulties to distinguish among alternatives. For instance trying to figure out if an alternative is 5 or 6 times more important than another, Fifthly, AHP method has a perceptive application to decision makers since it supports group decision making by calculating the geometric mean of individual pair wise comparisons, however human perception is subjective in nature and can lead to distorted results. Lastly, no attempt has been made to prove the mathematical foundation of AHP which makes it unreliable for critical decision making.

Mathematical programming methods provide a better way to solve a problem than linear weighted methods since they are objective and allow the decision problem to be formulated in form of a mathematical objective function, which can be varied so that it either leads to minimisation or maximisation. Pehlivan (2007) argued that since the decision maker has to first state the objective function, this makes Mathematical Programming models more objective than the linear weighting methods. However just like linear weighting methods Mathematical Programming models Boer (2001) only consider quantitative criteria and Pehlivan (2007) they are too complex for practical use. Secondly mathematical models produce result that can be explained using mathematical formulas however Mirabi, et al (n.d.) stipulates that they do not produce optimal solutions for large scale problems and the solutions are static and lack ability to learn from the environment which makes it difficult to deal with situations that are uncertain. Also the deterministic nature in them makes them sensitive to measurement errors. Thirdly, even though mathematical programming is geared towards modelling the constraints in the problem which makes it much easier than other approaches to work with a large number of constrains, it is limited to quantitative criteria and that most models are too complex for practical use by operation managers. Fourthly the beauty of such models is that there is no need to estimate the relative weights for the supplier selection criteria. One can incorporate the minimum requirements for each criterion as the objective. However efficient solutions cannot be identified with a single solution rather one should make a scenario analysis to obtain the efficient boundary. For instance DEA and Goal Programming are mathematical programming models that can handle many inputs and many output which can be modelled as constraints, however their deterministic nature results to scores that are sensitive to measurement and an under estimation or over estimation reduce the efficiency.

Artificial based methods address current situation in the world since they can devise solutions that can learn from the environment. One of the strengths of the methods is that they don't need a formula to coin the decision making process. In this respect, Artificial Intelligence technologies can cope better with complexity and uncertainty than traditional methods because they are designed to be more like human judges. Users of Artificial Intelligence systems only need to provide information on features of current situation. However, Artificial Intelligence technologies make tradeoffs based on what they have learnt from the expert or cases in the past. Lastly, AI based methods produce objective results since Boer et al (2001) they rely on what they have learnt or from previous experiences. This derails the problem of subjectivity which many methods have yielded to. However, this results in decisions that the buyer may not be able to explain. Therefore this model will fit well in situations where external justification is not important. However, the problem of not being able to explain the results of an AI based model can be solved by using statistical methods which can be able to prove solutions to the supplier selection problem since they are based on probability which is an intrinsic factor among statistical methods. Despite the problem of supplier evaluation and selection being full of stochastic situation, little research has been reported on using statistical methods. For instance PCA is fairly simple to implement and has been available in off the shelf computer packages for many years, however many researchers have not intensively used it.

III. CONCLUSION

In terms of criteria to use for supplier evaluation and selection process, researchers have proposed a different combination of criteria, however it can be concluded that most researchers agreed that Cost, quality and delivery are the most important criteria. In terms of the methods used for supplier evaluation and selection process, Researchers agree the AHP is a good method for small and medium scale industry. Wide use of AHP is attributed to simplicity of implementation and ability to capture both qualitative and quantitative criteria.

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