
Supplier Selection: Key Literature Review

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ABSTRACT

Supplier selection attained the state of paramount importance for companies in the current scenario because of increasing global competition. It helps in reducing the costs, improve the quality and deliver the products on time, thereby enabling the organizations to survive the rising competition in the current scenario of global competing environment. Improper selection of suppliers will have an adverse impact on the overall performance of the company. The number of available alternatives in the current market is on a rise, and hence it becomes difficult to select a supplier from among a large lot. However the understanding of supplier selection criteria and the use of advanced tools are still under the spotlight. This paper will discuss the key literature about supplier selection and our findings of pilot interviews in the industries in India.

KEYWORDS *Supplier Selection, Vendor Selection, Evaluation Criteria, literature review*

1. INTRODUCTION

The key to success in the market is to meet the customer's demands in shortest time and least cost and therefore, emphasis is on the reduction of total costs and the delivery time. Analysis reveals that the cost of the raw materials and the component parts themselves carry around 70% of the total cost of the product (Weber *et al.* 1991). The total cost will reduce considerably by reducing these costs. These costs depend on the supplier. Hence, supplier selection becomes a very important activity in the course of the flow of supply chain. Supply chain starts with selecting the right supplier for the raw materials. The stage in the buying process when the intending buyer or the retailer chooses the preferred supplier or suppliers from those qualified as suitable is known as *supplier selection*. It is a strategic decision. Qualifying the suppliers 'suitable' depends on the suppliers being able to provide the retailer with the right quantity of the right product/service at the right time in the right place (Mandal and Deshmukh 1994; Sarkis and Talluri 2002). Much of the success in a supply chain depends on the supplier. The supplier may be a raw material supplier to the manufacturer or a component supplier or a service supplier, i.e., contractor. The supplier must adhere to all the required criteria to satisfy the buyer and thereby, the end customer. Thus, supplier selection process becomes a multiple criteria decision making problem involving various criteria which may be quantitative as well as qualitative.

In the initial days of supplier selection, only three criteria were considered to be important—price, quality and time. Service was also considered an important factor in the selection. But, research was done on the vendor selection process and many other criteria evolved. Dickson (1966) summarized 23 criteria which are vital in the process of supplier selection. Researchers from then on gave many other criteria involved in the process of supplier selection. The parameters involved in the supplier selection may be the cost, lead time, delivery time, quality, reliability, aesthetics etc. These well-defined criteria have been adopted in the later technologies and methodologies since then. But, the selection criteria are ultimately defined depending on the level of supplier-buyer relationship and integration, the organization's position in the market or the competitive situation, the organization's corporate strategies and strategic management decisions (Weber *et al.* 1991).

Supplier selection process is of utmost importance in the success of supply chain management. The activities involved in the vendor/supplier selection process are triggered with the realization of the need for a supplier. Determining the decision criteria and formulation of the problem follows. A shortlist of suppliers from a large list is prepared (pre-qualification) and from this shortlist, the final list of suppliers is selected

depending on the adherence to the preferred criteria. Supplier evaluation is the next step by monitoring the selected suppliers by continuous assessment. Any supplier selection process can be of two types. One method is the one in which there are no restrictions on the supplier which means one supplier can satisfy all the requirements of the price, demand, delivery, quality etc. This method is called single sourcing. The other method is the one in which there are some constraints in the capacity of the supplier. Then the buyer has to go to more than one supplier to fulfill all his requirements. This method is called multi sourcing. In any single sourcing method, the management has to take only one decision of which supplier is the best whereas in a multi sourcing way of supplier selection, the management has to take two decisions on who are the best suppliers and how much should be acquired from each of the suppliers. The order allocation decision is critical in the supplier selection process. But, order allocation decision is more sophisticated in a multiple supplier selection process than in a single supplier selection problem because the activities of order allocation in a multiple supplier selection process are dependent on each other. The just-in-time (JIT) concept has affected the supplier selection significantly. The introduction of JIT environment has emphasized on the reduction of the number of suppliers and the criteria by which the process of supplier selection is achieved.

From all these factors, it is evident that the supplier selection is the paramount important step in supply chain management. A vendor/ supplier can either make the company or break the company by reaching upto the customers' demands or failing miserably in process. This has motivated people to research deeply on supplier evaluation and selection process involving multi criteria decision making.

2. REVIEW OF LITERATURE

Supplier selection is a very important component in Supply Chain Management. In the present global scenario, it becomes necessary to cut the production and variable costs to sustain and survive in the high competition. In the past, there has been a lot of research on supplier selection process as well as supply chain management. There is a lot of literature available about the process of supplier selection as well as evaluation. Extensive research is done on the available literature and is reviewed. Researchers and practitioners describe supplier selection as a number of phenomena which determine suitable suppliers in the supply chain. Managing supply chain partnerships for competitive advantage is receiving considerable interest among both academic researchers and industrialists, according to Christopher and Juttner (2000). According to Atluntas B.M, Bayraktar D and Cebi .F (2006), supplier selection and evaluation are very critical to any organization. In the past four decades, the activity of supplier selection has undergone an enormous change due to high technology advancement. It is impossible to produce low cost, high quality products without proper suppliers in today's competitive scenario (Weber *et al.*, 1991). There is no definite method for supplier selection in the earlier literature. But the retailer is provided with some criteria to evaluate the supplier and select him. The decision making is done on the basis of how well the supplier can cater to his needs and the requirements of his customers. Dickson (1966) gave 23 criteria which can be used for the process of supplier selection or evaluation. But, the criteria for selection depend on the requirements of the firm. A detailed review of supplier selection is given in Aissaoui *et al.* (2007). Supplier selection is classified into 3 categories in the past literature (Wu Bei *et. al* 2006 and Srinivas Talluri 2002).

- 1) **Conceptual approach**, giving importance to supplier selection and its strategies;
- 2) **Empirical study**, where the relationship between various attributes in supplier selection and the effect of one over the other and on the selection process is studied deeply; and
- 3) **Analytical models**, where a model to solve the supplier selection problem and multi-criteria decision making problem is presented.

2.1 Conceptual Approach

Supplier selection process is of paramount importance in any supply chain. A supply chain is said to be successful or efficient if the right quantity and desired quality of the final product is delivered at the right place in the right time (Mandal, A. and Deshmukh, S. G. (1994) & Sarkis, J. and Talluri, S. (2002)). Supply

Chain Management is the link between each and every element in the manufacturing and supply processes, starting from the raw material to the end consumer (New and Payne (1995) & Scott and Westbrook (1991)). Selecting the right vendors reduces the purchase costs and improves the corporate competitiveness significantly (Ghodsypur and O'Brien (2001)). Supplier selection is one of the order quantities and order timing decisions (Slack *et al.* 2004). Organizations have realized that they cannot attain success without satisfactory vendors (Handfield and Nichols, 1999). An extensive literature review was carried out regarding the concepts of "supplier selection" or "vendor selection" and different criteria are associated with it. Gary W. Dickson (1966) gave 23 criteria used for supplier selection based on a survey in industries. Nydick and Hill (1992) concentrated on four important criteria in the supplier selection: quality, price, delivery and service. Some authors have studied multiple objective sourcing selection (C.A. Weber and J.R. Current (1993), Karpak *et al.* (2001), Nydick and Hill (1992), Ghodsypur and O'Brien (1998), Boer *et al.* (2001)). S.S. Chaudhary *et al.* (1993) studied about vendor selection with price breaks. Li and Rao's research (2002) conceptualizes, develops and validates six dimensions of SCM practice which are strategic supplier partnership, customer relationship, information sharing, information quality, internal lean practices and postponement.

Supplier selection is a process which contains many steps, the first starting with the realization of the need for a supplier; determination and formulation of the decision criteria; initial screening and drawing up a shortlist of potential suppliers (pre-qualification); final supplier selection and finally, continuous evaluation and assessment of the final suppliers (Mahmut Sonez(1977) & de Boer, L. and van der Wegen, L. L. M. (2003)). A vital function in supply chain management is the purchasing function. Within the purchasing function, one of the prime responsibilities is the evaluation and selection of suppliers (Robert J. Vokurka, Joobin Choobineh and Lakshmi Vadi (1996)). In today's highly competitive, global operating environment, it is impossible to produce low cost, high quality products successfully without satisfactory suppliers (Weber.C., Current.J, and Benton.W (1991)). In the present globally competitive, rapidly changing environment, it is necessary for the firms to formulate strategic plans that are consistent with their investment in and use of manufacturing technology to be successful (Michael Tracey, Mark A. Vonderembse and Jeen-Su Lim (1999)). Supplier selection procedures are divided into pre-selection, selection and the post-selection procedures (Reggie Davidrajuh (2003)). The selection procedure is further divided into the following stages: bidder selection, partner selection, and performance evaluation. CHEN Xu and LI Xiang-yang (2007) gave multiple phase suppliers sorting model based on the supplier development orientation using multiphase selection methods and unconventional criteria combination. The model classified selection into three phase: preselection, evaluation and development. Thomas Y. Choi and Janet L. Hartley (1996) explored supplier selection practices across the supply chain and found out that the companies have increased the level of outsourcing in their strategies and are relying more heavily on their supply chain as a source of their competitive advantage. Thus, supplier selection has become a key critical strategic consideration. In supply chain literature, the supplier selection problem is treated as an optimization problem that requires formulating a single objective function (Satish Nukala and Surendra M. Gupta (2007)). However, not all supplier selection criteria can be quantified, because of which, only a few quantitative criteria are included in the problem formulation. Park and Krishnan (2001) examined the supplier selection practices among 78 small business executives and adopted 15 criteria from Ellram (1990).

Information technology can improve the efficiency with which a user makes a decision, and can improve the effectiveness of that decision (Saaty, 1987). Decision Support Systems (DSS), used to support complex decision making and problem solving, was first defined by Gorry and Morton (1971). Gorry and Morton (1971) combined Anthony's (1965) categorization of management activities into strategic planning, management control and operational control and Simon's (1960) description of decisions as existing on a continuum from programmed to non-programmed, using the terms structured, unstructured and semi-structured, rather than programmed and non-programmed. Radical thinking is required by managers of organizations interacting with diverse environments (Mitroff and Linstone (1993)). Courtney (2001) suggested the need for a decision-making approach to accommodate the importance of the customer weightage in evaluating the supply chain entities and emphasized that DSS researchers should consider a much more comprehensive view of organizational decision-making and handling much softer information.

The overall performance of the organization has been studied and many conclusions have been arrived. The manufacturing department's overall performance in different organizations was compared and the crucial role played by manufacturing in supporting the achievement of the overall business strategy of a company was pointed out (Andrea Rangone (1996)). Stephen J. Tvorik and Michael H. McGivern (1997) found out the determinants of organizational performance and an integrative model is defined by an organization's internal variables represented as economic rates of return for both economic and organizational factors. These variables are used to examine performance variance and their economic contribution to firm profitability. The factors responsible for success in supplier development are extensively studied by Daniel R. Krause and Lisa M. Ellram (1997). They said that one of the purchasing function's basic objectives is to maintain a network of capable suppliers. To flourish in their respective markets, buying firms must ensure that their suppliers' performance, capabilities and responsiveness equals, or surpasses that experienced by the buyer's competitors. The moderating effect of buyer – supplier relationships on quality practices and performance was discussed in detail by Brian Fryes and Chris Voss (2002). Paul H. Schurr (2007) investigated into critical interaction episodes that fundamentally strengthen or fatally weaken relationship development. Paul Humphreys, K.L. Mak and Ronan McIvor (1998) studied the benefits of dimensional analysis approach over the traditional assessment methods and how it can be used to measure not only suppliers' performance, but also the contribution to the purchasing relationship from the buyer organization. Lyn Purdy and Frank Safayeni (2000) developed a framework for supplier evaluation based on whether the supplier evaluation focuses on information from product-based or process-based domains and whether the information acquisition mode used is direct or indirect. In doing so, various advantages and limitations related to each approach are identified. Werner Jammerneegg and Gerald Reiner (2007) discussed the opportunities and challenges for improving the performance of supply chain processes by coordinated application of inventory management and capacity management. Carol Prahinski, W.C. Benton (2004) determined how suppliers perceive the buying firm's supplier evaluation communication process and its impact on suppliers' performance. Erik Berggren and Rob Bernshteyn (2007) noted that organizational transparency drives company performance. An intelligent supplier relationship management system is developed by integrating a company's customer relationship management system, supplier rating system and product coding system by the case based reasoning technique to select preferred suppliers during the new product development process (King L Choy, Wing Bun Lee, Victor Lo(2004)). An expert system approach of supplier selection and evaluation and the importance of supplier evaluation and selection in the buying process was given by I.H. Yigin, H. Taskin, I. H. Cedimoglu and B. Topal (2007) & B. Murat Altuntas, Demet Bayraktar, Ferhan(2006). Kathryn Cormican and Michael Cunningham (2007) evaluated supplier performance from a large multinational organization and found out that reducing the number and improving the quality of suppliers resulted in increased quality, reduced lead time and a reduction in the number of errors and defects. Handfield et al. (2002) focused on environmental issues in supplier evaluation.

Dávid Rómer (2002) studied about different partnership strategies in the purchasing function and compared the different customer-supplier relationships from the point of view of purchasing and deals with virtual companies in particular. It also traces the architecture of the virtual organizations and analyses their advantages and disadvantages. Liu Xiaobing and Lv Qiang (2007) did research on supplier selection tactic model for strategic purchasing. Mary Ann Curran (2001) developed a tool for environmentally preferable purchasing. Outsourcing is a management approach by which an organization delegates some noncore functions to specialized and efficient service providers (F. Franceschini, M. Galetto, A. Pignatelli and M. Varetto (2003)). In the era of "global market" and "e-economy", outsourcing is one of the main pillars of the new way to conceive the relationships among companies. Andreas P. Kakouris, George Polychronopoulos and Spyros Biniaris (2006) proposed a framework for purchasing and outsourcing decisions together with a process model for evaluating and assessing possible suppliers. They focused in particular on the "planning" and "qualifying" phases of the process which, respectively, set the criteria and prepared a shortlist, before the final selection.

The total quality management in a supply chain and its impact on the performance was deeply discussed in detail by L. B. Forker, D. Mendez and J. C. Hershauer (1997). R. Jagadeesh (1999) gave a

perspective and analysis of total quality management in India. Denis Leonard, Rodney McAdam (2002) studied about the strategic impact and implementation of total quality management. S.Thomas Foster Jr (2008) worked towards an understanding of supply chain quality management (SCQM) and Lamia Berrah and Vincent Clivillé (2008) prepared a quantitative performance measurement model in a buyer-supplier relationship context. Werner Jammerneegg and Gerald Reiner (2007) studied and discussed the opportunities and challenges for improving the performance of supply chain processes by coordinated application of inventory management and capacity management. Jean-François Henri (2004) tried to bridge the gap between the organizational effectiveness (OE) models developed in the field of organizational theory and the performance measurement models presented within the management accounting literature. Rohit Verma and Madeleine E. Pullman (1998) examined the difference between managers' rating of the perceived importance of different supplier attributes and their actual choice of suppliers in an experimental setting. Sonny Nwanjkw, Ben Obidigo(2002) studied the scope for expert systems in supplier quality management. Injazz J. Chen and Antony Paulraj (2004) proposed a networked supply chain. This novel perspective has created the challenge of designing and managing a network of interdependent relationships developed and fostered through strategic collaboration. Nitin Seth, S.G. Deshmukh, Prem Vrat (2006) extensively defined. the key gaps in both the directions (forward and reverse) that are likely to affect the service quality at different levels. These gaps may exist between a 3PL service provider and the manufacturer, the marketing function and the 3PL service provider, etc. G. Kannan and A. Noorul Haq (2007) analyzed the interactions of criteria and sub-criteria for the selection of supplier in the built-in-order supply chain environment.

2.2 Empirical Study

Empirical study classification of the supplier selection process deals with the relationships of various entities or attributes with each other involved in the process of supplier selection of supply chain. There exists a fair amount of literature regarding the empirical study of supplier selection process. It may deal with the buyer – supplier relationship or the relation between efficiency of the supply chain and the sourcing strategy.

Chapman S.N *et. al* (1990) and Carol Lee Stamm and Damodar Y.Golhar (1993) discussed about just-in-time (JIT) concept in general and identified the attributes related to JIT purchasing. Thereby, the benefits and problems with JIT purchasing are determined. Chapman S.N *et. al* (1990) further provides insight about the change in the relative importance of JIT purchasing depends on whether customer inventory or supplier inventory is used as the dependent variable. Sunder Kekre, B.P.S. Murthi and Kannan Srinivasan (1995) developed a model by integrating concepts from manufacturing, marketing and business strategy to find out and better understand the links between operating decisions of the firm, supplier availability and product quality. They found out that operating decisions of the firm along with some other factors help in reducing the supplier base and thereby increase the quality levels. Amelia S. Carr and John N. Pearson (1999) studied the relation between strategic purchasing, supplier evaluation systems, buyer–supplier relationships and firm's financial performance and prepared five hypothesized relationships and found out that strategic purchasing is more important to the success of the firm. Keith Goffin, Marek Szwejczewski and Colin New (1996) studied about supplier base management and established that the key reason for supplier base reduction is to free time to effectively manage the remaining suppliers. George Tagaras and Hau L. Lee (1996) found out that looking only at the quality cost of the supplier does not suffice for vendor evaluation process. The relationship between vendor's quality cost, input quality and imperfections of the manufacturing process is explored and the resulting quality cost model is analyzed.

Efficient SCM practices can lead to enhanced competitive advantage and improved organizational performance. Huge literature on supplier relationships has developed, often termed as interim buyer-seller relationships in business markets (Anderson and Narus, 1990). A major factor in supplier management involves the type of relationship the firm develops and maintains with its suppliers. The relationship between supplier and the buyer is studied extensively in relation marketing by Morgan and Hunt (1994). Ellram (1990) studied about supplier selection by considering case studies of various firms involved in the buyer – supplier relationships. The importance of relation building and the uncertainties in cooperation between buyer and supplier is highlighted by Kent Eriksson, Deo Sharma and Lars Silver (1998). Thorelli (1986) portrayed

relationships as ranging from markets to hierarchies. Manufacturing companies place a strong emphasis on the role of supply chain management-the management of supplies, suppliers, inventory and distribution, according to Keith Goffin, Marek Szwejczewski and Colin New (1997). It was further established that a key reason for supplier base reduction is to free time to more effectively manage the remaining suppliers. The quality cost analysis of the supplier selection process is done by George Tagaras and Hau L. Lee (1996). It was inferred that looking at only one dimension of the quality cost is not sufficient and therefore, the relationship between supplier's quality cost, input quality and imperfections of the manufacturing process are studied. Monczka R.M *et. al* (1981), Morgan and Hunt (1994), Daniel Corsten and Jan Felde (2004), Wu Bei, Shanshan Wang and Jun Hu (2006), Amelia S. Carr and John N. Pearson (1999) & A. De Toni and G. Nassimbeni (1999) give an extensive research about the buyer and supplier relationships and its effect on the organization. They give different buying strategies and the influence of cooperative relation between the buyer and supplier on the supply chain. The relationship between different criteria involved in the supplier selection process is deeply studied in Mark A Vonderembse and Michael Tracey (1999), Chapman S.N *et. al* (1990), Michael Tracey *et. al* (2001), Tullous R. *et. al* (1991) & ZHANG Fu-jiang (2006). The supplier selection criteria are very vital in the success of the supply chain and hence, of the organization and their relationships are critical in the selection of the supplier. The organization's performance, the inter-related relationships and the other factors affecting the performance of the organization are exclusively analyzed by Amelia S. Carr and John N. Pearson (1999), Amelia S. Carr and Hale Kaynak(2007), Chang Won Lee, Ik-Whan G. Kwon and Dennis Severance (2007), Chin-Yen Lin and Tsung-Hsien Kuo (2007), Ho Yin Wong and Bill Merrilees (2007) & Vicente Roca-Puig, Inmaculada Beltra'n-Martín, Ana B. Escrig-Tena and J. Carlos Bou-Llugar (2007). Sanjay L. Ahire and Paul Dreyfus (1999) give the impact of design management and process management on quality. The effect of supplier selection on the firm's performance is given in ZHANG Fu-jiang (2006).

2.3 Analytical Models

Many models and methods have been developed to solve the problem of supplier selection in the past literature. Each method takes various different criteria into consideration while selecting the suppliers. The objective of the supply chain is to maximize the difference between what the final product is worth to the customer and the effort the supply chain expends in fulfilling the customer needs. For this, the initial step is the selection of proper supplier, suitable to the requirements of the situation. There is a huge literature about the supplier selection procedures available. Matrix method, Analytical Hierarchy Process (AHP), Data Envelopment Analysis (DEA), Structural Equation Modeling (SEM), Analytic Network Process (ANP) are a few methods to name.

The literature of retailing provides the retailer with sets of criteria in vendor selection. A combination of the criteria from the literature of the reading with the rating scheme of industrial purchasing yields a sophisticated, systematic decision matrix approach (John S. Berens (1972)) to supplier evaluation and selection which under certain conditions can eliminate much bias and incomplete evaluation of vendors.

Charles A. Weber (1996), Marcello Braglia and Alberto Petroni(2000), Jian Liu, Fong Yuen, Vinod Lal (2000), Srinivas Talluri, Ram Narasimhan(2005) & Reza Farzipoor Saen and Majid Zohrehbandian (2008) studied deeply and discussed about Data envelopment analysis (DEA) process of vendor selection. Vendor selection is multi-objective in nature. Little has been done to develop techniques for measuring vendors' performance on multiple criteria. Charles A. Weber (1996) used data envelopment analysis (DEA) as a tool for measuring the performance of vendors on multiple criteria. Supplier selection is sometimes very complicated, owing to a variety of uncontrollable and unpredictable factors which affect the decision. Marcello Braglia and Alberto Petroni(2000) describe a multiple attribute utility theory based on the use of data envelopment analysis (DEA), aimed at helping purchasing managers to formulate viable sourcing strategies in the changing market place. Jian Liu, Fong Yuen, Vinod Lal (2000) used DEA to compare suppliers for supplier selection and performance improvement.

Analytical Hierarchy Process (AHP) is deeply discussed by many authors. Analytic Hierarchy Process method was developed by Saaty (1990) to assist in multi-criteria decision problems. The new method

overcomes the difficulties associated with the categorical and simple linear weighted average criteria ranking methods. It provides a more systematic way of deriving the weights to be used and for scoring the performance of vendors (S. Yahya and B. Kingsman (1999)). Dyer and Forman (1992) claim that the AHP will be an effective methodology for group decision making. The usage of pairwise comparison in AHP was applied by Narasimhan (1983) and Nydick and Hill (1992). Eon-Kyung Lee, Sungdo Ha and Sheung-Kown Kim (2000) proposed an effective supplier development methodology for enhancing supply chain performance using AHP. C. Murlidharan, N. Anatharaman and S.G. Deshmukh (2001) used AHP for vendor/supplier rating in purchasing scenario. Web based casting supplier evaluation using analytical hierarchy process was discussed by M. M. Akarte, N. V. Surendra, B. Ravi, N. Rangaraj (2001).

Mehmet Sevkli, S.C. Lenny Koh, Selim Zaim, Mehmet Demirbag and Ekrem Tatoglu(2008) proposed a new method, a hybrid method of supplier selection, Analytical hierarchy process weighted fuzzy linear programming model (AHP-FLP) and applied it to a real industry case. The weights of the various criteria, taken as local weights from a given judgment matrix, are calculated using analytical hierarchy process (AHP) that are also considered as the weights of the fuzzy linear programming model. Integration of two processes is also done to get better results. Shin-Chan Ting and Danny I. Cho (2008) proposed an integrated approach for supplier selection and purchasing decisions. It was an integration of Analytic Hierarchy Process (AHP) and MOLP (multi objective linear programming). Through the analytical hierarchy process (AHP), in consideration of both quantitative and qualitative criteria, a set of candidate suppliers is identified. A multi-objective linear programming (MOLP) model, with multiple objectives and a set of system constraints, is then formulated and solved to allocate the optimum order quantities to the candidate suppliers. Jiaguo Liu and Chong Wu (2005) proposed another integrated method, a combination of AHP (Analytical Hierarchy Process) with DEA (Data Envelopment Analysis) to determine the integrated weight for the evaluation criteria of supplier so as to make up for the inconsistent judgments which the AHP is liable to decision-maker and also to solve the problem that the DEA cannot suitably reflect the preference of decision makers. Supplier selection using combined analytical hierarchy process and grey relational analysis was proposed by Ching-Chow Yang and Bai-Sheng Chen (2006).

Vesna Zabkar (2000) studied the application of Structural Equation Modeling in relationship quality context by considering some methodological issues. Phillip K. Hellier, Gus M. Geursen, Rodney A. Carr, John A. Rickard (2003) discussed about the customer repurchase intention by using SEM. This is done by adding the customer views of equity, value and customer's preference of brand to an analysis of integrated repurchase intention. Nikolaos Tsigilis, Athanasios Koustelios and Aspasia Togia (2004) proposed a model to determine the multivariate relationship between employee tiredness and job satisfaction using Structural Equation Modeling. C. Prahinski and W.C. Benton (2004) have developed a SEM model with the data taken from 139 first-tier automotive suppliers and concluded that the supplier's view of the buying organization's communication does not affect the performance of the supplier directly. Supplier selection was considered as one of the criteria in proposing a SEM model to study the success of buyer-supplier relationships by Vijay R. Kannan and Keah Choon Tan (2006). C. Lin et al. (2005) also used supplier selection along with supplier participation as the factors in an SEM model to show the correlation between the quality management practices and organizational performance. However, no model has used Structural Equation Modeling (SEM) for supplier selection to arrive at score value.

Charles A. Weber, John Current and Anand Desai (2000) presented an approach for evaluating the number of vendors to employ in a procurement situation using multi objective programming (MOP) and data envelopment analysis (DEA). Rainer Lasch and Christian G. Janker (2005) studied about the multivariate analysis of vendor selection. Konstantinos Kirytopoulos, Vrassidas Leopoulos and Dimitra Voulgaridou(2008) & Cevriye Gencer, Didem Gurpinar (2007) discussed deeply about Analytic Network Process (ANP). A risk efficiency-based supplier selection (REBaSS) approach is developed for critical supplies that allow a decision maker to consider the procurement-related "risk" and "investment" for mitigation/exploitation interventions (Guido J.L. Micheli (2008)). Chee-Cheng Chen, Tsu-Ming Yeh and

Ching-Chow Yang (2004) proposed customer-focused rating system of supplier quality performance. Hua-Li Sun, Jian-Ying Xie, Yao-Feng Xue (2005) developed a model for supplier selection process based on Supplier Vector Machine (SVM). The Rough set theory was studied by B. Chang, H. F. Hung and C. C. Lo (2007). Yuantao Song, Qiang Zhang, Xiaoguang Zhou (2006) developed a supplier Selection model based on distance measure between intuitionistic fuzzy sets. V.N. Karthik (2001) proposed a Performance Value Analysis (PVA) algorithm in which an integrated multi-criteria supplier selection process is proposed, and the use of performance value analysis in the actual selection process is also demonstrated.

In addition to these, there were many fuzzy approaches for the supplier selection problem. Zimmermann (1978) introduced the fuzzy programming approach for handling the multi-objective problems. Bellman and Zadeh (1970) suggested fuzzy programming model for decisions in fuzzy environment. C.K.Kwong, W.H.Ip, J.W.K. Chan (2002) combined scoring method and fuzzy expert systems for supplier assessment. Fuzzy expert system is an alternative approach from which the heuristics and knowledge of supplier assessment can be captured and the impreciseness and uncertainties due to the human subjectivity, that are common in the process of the supplier assessment, can be handled. There were many papers discussing fuzzy analytical hierarchy process (A. Noorul Haq, G. Kannan (2005), Bohui Pang (2006), Manoj Kumar, Prem Vrat, Ravi Shankar(2006) & Cengiz Kahraman, Ufuk Cebeci and Ziya Ulukan (2003)). Fuzzy logic, a subset of artificial intelligence, together with analytical hierarchy process (AHP) is used to model this process and rank potential suppliers. It reflects the information of both personal and impersonal, according to Bohui Pang (2006). Ding-zhong Feng, Lei-lei Chen and Mei-xian Jiang (2005) discussed on fuzzy decision theory. Rajkumar Ohdar and Pradip Kumar Ray (2004) & Vipul Jain, M.K. Tiwari and F.T.S. Chan (2004) proposed an evolutionary fuzzy-based approach for the evaluation of suppliers and performance measurement in a supply chain. A fuzzy programming approach for vendor selection problem in a supply chain was given by Manoj Kumar, Prem Vrat and Ravi Shankar (2006). Based on fuzzy logic approaches, Morlacchi (1997) developed a model that combines the use of fuzzy set theory (FST) with AHP and implements it to evaluate small suppliers in the engineering and machine sectors. An integrated fuzzy-goal-programming-based framework for selecting suppliers in strategic alliance formation was developed by Oluwafemi Famuyiwa, Leslie Monplaisir and Bimal Nepal (2009). The method utilizes a model based on fuzzy logic/goal programming to analyze the vague, imprecise, and usually subjective information regarding the compatibility of potential suppliers that is available during the early formation of a strategic partnership.

Ramakrishnan Ramanathan(2007) proposed a methodology to integrate DEA with the total cost of ownership (TCO) and the analytical hierarchy process (AHP) approaches for selecting appropriate suppliers for a firm. K.S. Chen and K.L.Chen (2006) gave a method of supplier selection by testing the process incapability index. YANG Yuzhong and WU Liyun (2007) proposed Grey entropy method. The subjectivity which lies in ascertaining factors' weights in lower hierarchy was avoided in this model. So the evaluation result is more objective than other evaluation methods. Santosh K. Mahapatra, Ram Narasimhan and Srinivas Talluri (2006) gave a multiproduct, multicriteria model for supplier selection with product life-cycle considerations. Helen Chan Co (2000) proposed High priority supplier (HPS) selection process. HPS process is the key to Advanced Product Quality Planning (APQP) implementation in new car model programs for North American automakers. Khurram S. Bhutta and Faizul Huq (2002) studied about total cost of ownership approach. It is a methodology or philosophy, which look beyond just the price of a purchase to better understand and manage the costs in selecting and maintaining relationships with suppliers. T. Shu, S. Chen, B. L. MacCarthy, L. Muyldermans, K. K. Lai and S. Y. Wang (2007) established a new hierarchical economic information filter model of supplier selection by analyzing the development process of the supplier selection methods as well as the historic criterion system and on the basis of the results of multiple turns of investigating and interviewing the management staff in different manufacturing enterprises. In the recent literature, supplier selection problem for a single manufacturing unit under stochastic demand was addressed by A.Awasthi, S.S.Chauhan, S.K.Goyal and Jean-MarieProth (2009). Supplier selection with quantity discount has been proposed by using integrated AHP and mathematical programming (Ali Kokangul and Zeynep Susuz (2009)). Another integrated method to find key suppliers in SCM was given by Rong-Ho Lin, Chun-Ling Chuang, James J.H. Liou and Guo-Dong Wu (2009).

In the categorical method (Zenz (1981)), buyer rates each vendor as being preferred, unsatisfactory, or neutral on all the attributes considered in the evaluation process. The limitation with this approach is that all the attributes are weighted equally. Timmerman (1986) proposed the so-called cost-ratio method. The cost ratio method evaluates the cost of each factor as a percentage of total purchases for the vendor. However, this approach has difficulties in developing cost accounting systems for this purpose. In a research paper published by Zeger Degraeve, Eva Labro and Filip Roodhooft (2000) the authors propose to use the concept of Total Cost of Ownership as a basis for comparing vendor selection models. The TCO quantifies all costs associated with the purchasing process throughout the entire value chain of the firm. Talluri and Narasimhan (2003) suggested max-min approach to vendor selection.

The term cluster analysis (Holt, 1998) encompasses a number of different algorithms and methods for grouping objects of similar kind into respective categories. It is a partitioning technique. In K-means algorithm (Hartigan, 1975 and Hartigan and Wong, 1976), the data given is divided into K-clusters (Mitchell 1977). According to past literature, the benefits consumers derive from various product and service attributes are powerful discriminatory variables for market segmentation. Traditionally marketing scholars have restricted benefit-based market segmentation scheme to conjoint analytic models (Lau et al. 2000; Samadhi and Hoang, 1998; Ghobadian et al. 1993). A cluster analytic model has several methodological advantages like not depending on unreliable individual-level estimates of benefits based on any subjective a priori segmentation scheme, as often seen in conjoint analytic models founded on (Carroll and Green, 1995) two-stage procedures; allowing ample degrees of freedom provided the sample size is adequate unlike conjoint models which often suffer from insufficient degrees of freedom (Wedel and Kamakura 1999; Umesh and Mishra 1990); and not have identification problems often witnessed in alternative models that over-parameterize degenerate solution. Cluster analysis classifies unknown groups whereas discriminant analysis classifies known groups (Anderberg, 1973; Jain and Dubes, 1988). Clustering techniques have been applied to a wide variety of research problems (Hartigan (1975)).

Hierarchical techniques perform successive fusions or divisions of the data. There are two broad classifications in hierarchical techniques, agglomerative and divisive methods. Agglomerative methods proceed by forming a series of fusions of the n objects into groups. Divisive methods partition the set of n objects into finer and finer subdivisions. The output from both agglomerative and divisive methods is typically summarized by the use of a dendrogram, which is a two-dimensional treelike diagram illustrating the fusions or partitions that have been affected at each successive level (Johnson, 1967, Karypis et al. 1999).

Ghodsypour and O'Brien (2001) have stated that only a few mathematical programming models have been published which analyze vendor selection problems involving multiple sourcing with multiple criteria and with vendor's capacity constraints (Triantaphyllou et al. 1998). Gaballa (1974) applied mathematical programming to supplier selection in a real case by using mixed integer programming to minimize the total discounted price of allocated items to the suppliers. Erol and Ferrel (2003) proposed a methodology that assists DMs to use qualitative and quantitative data in a multiobjective mathematical programming model.

Few other methods available are TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) (Chen and Hwang, 1992; Tzeng *et al.*, 1994), PROMOTHEE (Preference Ranking Organization METHod for Enrichment Evaluations) (Brans *et al.* 1994), ELECTRE (ELimination and (Et) Choice Translating Reality) (Benayoun, *et al.* 1966 & Roy and Bertier, 1972) and fuzzy outranking methods. A detailed review and explanation of the above methods is available in Triantaphyllou (2000) and Opricovic and Tzeng (2006). Another method called VIKOR (Vlsekriterijumska Optimizacija I Kompromisno Resenje in Serbian) was less explored to solve MCDM problems and particularly for the application of supply chain (Opricovic and Tzeng (2006) and Tong et al. (2007)). VIKOR method can be used to solve multiple criteria decision making problems with conflicting criteria.

3. CONCLUSION

In conclusion, the literature review of supplier selection analyzed the supplier selection in three stages namely conceptual approach, empirical model and analytical study .The following issues are identified from the literature surveyed.

-) Though the importance of supplier selection and its strategies have been studied in conceptual models by earlier researchers, the relationship between various attributes in supplier selection and the effect of one over the other has not been carried out so far systematically.
-) Earlier researchers have viewed supplier selection as separate Conceptual, Empirical or Analytical models.
-) Provides an opportunity to develop a generic model to nullify the vagueness of human thoughts in the decision making.

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