Supplier Selection and Order Allocation Models in Supply Chain Management: A Review

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Abstract: Supplier selection decisions are an important component of production and logistics management for many firms. Such decisions entail the selection of individual suppliers to employ and the determination of order quantities to be placed with the selected suppliers. This paper reviews supplier selection and order allocation models based on an extensive search in the literature (170 paper during 2000-2010) and tries to show their contribution to supply chain management. After discussing different methods and their applications, the most prevalently used approaches and criteria are presented. In the second step, different attributes of these papers are defined and finally issues for future research are recommended.

Key words: Outsourcing - Supplier selection - Purchase - Supply chain management

INTRODUCTION

In today’s competitive environment, companies are trying to attain the goals of low cost, high quality, flexibility and more customer satisfaction. So they should know that for a company to remain competitive it is crucial to work with its supply chain partners. Traditionally supply chain management is the integration of key business processes from end user to original supplier, provides products, service and information that add value for customers. Therefore it is very important for all companies to have long relationship with few reliable suppliers. Also in manufacturing industries, the cost of raw materials and components comprise the major portion of product’s final cost, sometimes it can equal up to 70% product cost. In this situation purchasing department can play a key role in cost reduction. The success of a company is highly depended on selection of proper suppliers and it is critical task to achieving the different objectives of the supply chain. Over the years the significance of supplier selection has been long recognized and emphasized. Lewis [1] suggested that of all the responsibilities that related to purchasing, none was more important than the selection of a proper source. As long as supplier relationship management (SRM) concept is concerned, Companies are trying to build long-term and profitable relationships with suppliers. The objective of this paper is to present a review of 170 articles published during 2000 to 2010, particularly on vendor selection criteria and methods. The sources used for this research are refereed journals and publications. Articles in languages other than English were not included.

As follows in this paper, all the articles will be compared in several categories. First they will be discussed about their proposed models and approaches and then their different solution methods and their different features and attributes will be showed. Finally in conclusion section the future direction of supplier selection problem will be discussed.

Supplier Selection Methods: Among 170 articles used in this survey, there are at least 7 papers reviewing the literature of supplier selection models [2-8]. The main purpose of this study is to extend and update them. It is very crucial to know which methods are most used by firms because it can have a very important influence on the selection results. So we should find out the models used for many years and well known.

Multi Attribute Decision Making (MADM) Techniques: A vendor selection problem usually involves more than one criterion and these criteria often conflict with each other. So MADM techniques such as Analytic hierarchy process (AHP), Analytic network process (ANP), TOPSIS and Multi attribute utility technique (MAUT) are implemented to solve the problem. The AHP method was introduced by Satty [9]. There has been wide discussion
about the empirical effectiveness of this technique. 37 out of 170 articles applied AHP to select best suppliers. Due to its wide applicability and case of use, the AHP has been studied extensively for the last 20 years. It is observed that the focus has been confined to the applications of the integrated AHPs rather than the stand-alone AHP [10]. Ghodseypour and O’Brien [11] applied the method of integrating AHP and linear programming for the first time to make a tradeoff between tangible and intangible factors with different priorities. After that Tam and Tammala [12] formulated an AHP-based model and applied it to a telecommunication system. In 2001, Akarte et al. [13] has proposed a systematic methodology to evaluate suppliers using AHP, which has been based on 18 subjective and objective criteria. Also Chan [14] used AHP approach considering the goals of cost, quality, technology, performance and design. Kahraman et al. [15] used AHP method in a fuzzy environment and Chan and Chan [16] showed that the vendor selection problem must be solved in a structural manner and provide a framework for the organization to select suppliers using AHP. Yang and Che [17] applied an integrated model of AHP and GRA to a real case to examine its flexibility in selecting a best supplier. Liu et al. [18] used AHP method but instead of pair-wise comparison applied the voting method. Hou [19] applied AHP and the business theories to provide a web-based supplier selection system. Also chan et al. [20] presented a case study on solving the supplier selection problem in the airline industry through a decision support system that employs the analytical hierarchy process. Ramantahan [21] integrated AHP and the total cost of ownership approach to consider mix of both qualitative and quantitative factors in supplier selection process. Chan [22] presented a model to select the best global supplier using triangular fuzzy numbers to construct fuzzy pair-wise comparison. The AHP hierarchy consists of five evaluating criteria and 19 sub-criteria. Micheli et al. [23] used AHP approach to create a systematic framework to examine the strength and weakness of a vendor’s capability using fuzzy values. Percin [24] tried to provide a tool to select the best vendor using AHP and finally made a comparison between this method and Rembrandt technique. Also chen et al. [25]; seydel [26]; oliveira [27] used AHP for supplier selection problem. Lee et al. [28] applied a fuzzy AHP approach considering 9 factors and 23 sub-factors to help evaluate performance of the selected green suppliers. Lee et al. [29] also presented a fuzzy AHP method with the consideration of BOCR for vendor selection.

Analytic network process (ANP) is the extended version of AHP and somehow more sophisticated. It was proposed by Sarkis and Talluri [30] which considered strategic, operational, tangible and intangible measures in the evaluation process. Bayzit [31] used ANP approach to handle interdependencies between factors. Also Gencer [32] presented an ANP method and implemented that in an electronic firm, finally showed that using this approach will gain flexibility to the decision process.

Another favorable technique for solving MADM problems is the TOPSIS (technique for the order performance by similarity to ideal solution). The concept of TOPSIS is rational and understandable and the computation is uncomplicated. Shyur [33] present an effective model using both ANP and modified TOPSIS, to accommodate the criteria with interdependencies and Chen et al. [34] implemented an extension version of TOPSIS in a fuzzy environment. According to the concept of the TOPSIS, a closeness coefficient was defined to determine the ranking order of all suppliers and linguistic values were used to assess the ratings and weights of the factors. In continue, Boran [35] has proposed a multi criteria group decision making approach using fuzzy TOPSIS, to deal with uncertainty. Outranking methods are useful decision tool to solve multi-criteria problems. The first paper on outranking was published in the late 1960s (Roy 1968). Since then a lot of attention has been paid to outranking models. De Boer et al. [36] applied the ELECTRE 1 method to supplier selection process and Dulmin [37] used PROMETHE 1, 2. The approach would be able to deal with several conflicting performance criteria. Also Araz and Ozkarahan [38] developed a new multi-criteria sorting method based on PROMETHE for supplier evaluation problem. MAUT (multi attribute utility theory) is another important MADM approaches which has ability to deal with both deterministic and stochastic decision environments.

This method requires a large value of data and has less computational difficulty than other multi-objective models. Barla [39] tried to find the best suppliers using multi-attribute selection model in five basic steps. Sanaye et al. [40] presented an effective model using both MAUT and LP for solving the supplier selection problem. Figure 1 shows the classification of MADM techniques articles.
Figure 2 is the distribution of MADM articles between 1999 up to 2010. As it is shown the AHP is the most common approach used during these years and after 2006 applying ANP method has grown because of its ability to handle interdependencies between factors. The combination of TOPSIS and other methods is also going to use more. Other approaches are not so common. Totally there has been so attention to MADM techniques in recent years because supplier selection is multi-criteria in nature.

**Mathematical Programming:** 54% of all reviewing papers have implemented mathematical programming approaches. Templmeier [41] developed new model formulation and a heuristic solution method for the dynamic order sizing and supplier selection problem under quantity discount condition. Feng *et al.* [42] applied a stochastic linear model to concurrent selection of supplier and Talluri and Narasimhan [43] have proposed a max-min approach to maximize and minimize the performance of a vendor against the best target measures, set by the buyer. Talluri and Narasimhan [44] also used mathematical programming for supply base optimization problem, they considered different attributes and have tested the methodology on an actual dataset of suppliers from a large, multinational, telecommunication company. Torres *et al.* [45] suggested a dynamic model to establish good linkage between vendor selection and buyer's company's policy and Wang lung Ng [46] proposed a weighted linear programming for supplier selection problem. He also presented a new technique which enables the weighted linear program to be solved without optimization. Che *et al.* [47] used linear programming to select most suitable suppliers of parts with the highest quality and minimum time and costs.
Kumar et al. [48] presented a rational approach to decision-making process for vendor selection problem. They used the multi-objective model contained three fuzzy goals and some crisp constraints. They also applied the goal programming approach for solving the problem. Narasimhan et al. [49] proposed a mathematical programming model which contained 5 different goals and allocated the optimum order quantities of multi-products to selected suppliers. Kumar et al. [50] and Amid et al. [51] used fuzzy multi-objective linear programming models to solve the vendor selection problem. Also Amid et al. [52] proposed another fuzzy multi-objective model simultaneously consider the impression of formulation and determine the order quantities to each suppliers based price breaks. Liao et al. [53] presented a multi-objective programming, integrating supplier selection, procurement lot sizing and carrier selection decisions, over multiple planning periods, while demand quantities are inconstant. They finally used GA to handle the model. Wadhwa and Ravindran [54] modeled the vendor selection problem as a multi-objective optimization problem. They considered price, lead time and quality as three conflicting criteria that have to be minimized simultaneously. Ebrahim et al. [55] introduced a multi-objective linear integer programming model in which qualitative and quantitative factors are considered. Since the problem was NP-hard, they proposed a scatter search algorithm (SSA) by which this problem can be solved. The numbers of mathematical models are increasing these years. Many researchers like: Demirtas [56]; Demirtas [57]; Kawtumachai [58]; Saen [59]; Ustun [60]; Wu [61]; Degraeve [62]; Ustun [63]; Sawik [64] have used mathematical programming to formulate the supplier selection problem. Also Talluri and Baker [65], proposed a three-phase mathematical programming approach for designing an effective supply chain network and tried to evaluate the performance of suppliers, manufacturers and distributors. Basnet et al. [66], presented a multi-period inventory lot-sizing model and Liu-yi et al. [67] applied a coordination strategy called ATC (analytical target cascading) to solve the distributed planning problem and also used an integer programming to find the best arrival period of components from the best suppliers. Sucky [68] proposed a two stage process for evaluating and selecting strategic vendors. Glickman et al. [69] developed a MILP model for vendor selection when multiple products are transported via truckload and less than truckload shipment to a number of distributed centers. Rezaei et al. [70] proposed a model in which, the buyer needs to decide what products to order, in what quantities, with which suppliers and in which periods. Wang [71] applied a fuzzy optimization model to a production system, where the parts of products are manifold and any part is available with several suppliers. Finally the solution model has been put into a case of TFT-LCD.

Ghodseypour and O’brien [72], Burke et al. [73], Kheljani et al. [74], applied a nonlinear programming model to solve the multiple sourcing problem.

Karpak et al. [75] used goal programming to identify the best suppliers and how to allocate orders among them, Thereby analyzing trade-offs among multiple goals such as cost, quality and delivery simultaneously.

Data envelopment analysis (DEA) proposed by Charnes et al. (1978), measures the relative performance of suppliers where the presence of multiple inputs and outputs make comparison difficult. DEA is particularly suitable for analyzing the efficiency of units with both qualitative and quantitative criteria and it has the ability to identify role models for under-performing units. An additional advantage of DEA models is the ability to evaluate the productivity of units’ given inputs (such as resources) and outputs (such as the product) and determine how well the unit generates the output based on the input.

Baker et al. [76], Weber et al. [77], Weber et al. [78], Braglia and petroni [79], Wu et al. [80], Narasimhan et al. [81], Mendez [82]; Talluri and Sarkis [83]; Talluri et al. [84]; Zhu [85]; Ross et al. [86]; Liu et al. [87]; Sarkar [88]; Huang [89] and Seydel [90]. Saen [91] used DEA approach to present an innovative method for selecting suppliers. Forker and Garfamy [92] demonstrates the application of data envelopment analysis (DEA) approach in evaluating the overall performances of suppliers on multiple criteria based on TCO concept. TCO is a technique which looks beyond the price of a purchase to include many other purchase-related costs. It focuses on the true costs associated with the entire purchasing cycle, thus it considers all costs related to the acquisition, usage, maintenance and follow-up of purchased goods or service as well as purchasing price. Garfamy considers the cost items like: technology, quality and manufacturing and after sale services. Degraev et al. [93] proposed to use the concept of total cost of ownership as a basis for comparing vendor selection models. Talluri et al. [94] consider variability in vendor attributes. Wu et al. [95]
presented a modified data envelopment analysis (DEA) method for supplier selection which can operate under conditions of imprecise information and Saen [96] proposed an innovative method, which is based on imprecise data envelopment analysis (IDEA). Ha and Krishnan [97] outlined a hybrid method, which incorporates multiple techniques like AHP, DEA and neural network into an evaluation process, in order to select competitive suppliers in a supply chain. They finally devised a combined supplier score for rating suppliers. Celebi and Bayraktar [98] applied the integration method of DEA and neural network for evaluation of suppliers under incomplete information of evaluation criteria. Also Desheng Wu [99] presented a hybrid model using data envelopment analysis (DEA), decision trees (DT) and neural networks (NNs) to assess supplier performance. Figure 3 shows the classification of MP articles.

Figure 4 shows that lots of attention has paid to mathematical programming models in recent years. The usage of DEA method has decreased since 2006, but before that many researchers have applied that method. After the year 2006, mixed integer linear programming and multi-objective programming models are used so prevalently and they are going to use more in the future.
**Artificial Intelligence Methods:** The artificial intelligence (AI) methods can cope better with complexity and uncertainty than ‘traditional methods’, because they are designed to be more like human judgment functioning. In AI systems, users only have to provide the information on performance of a supplier on the criteria. The AI methods subsequently make the actual trade off of the users, based on what they have ‘learned’ from the experts or cases in the past. Talluri [100] applied a game theory model considering multiple performance criteria and Choy et al. [101] proposed an intelligent system using case base reasoning (CBR) technique to integrate customer relationship management (CRM) and supplier relationship management (SRM) to facilitate supply chain management in the areas of supplier selection. Choy et al. [102] also proposed a generic supplier management tool which comprises three parts. First, supplier management network, second, using pair-wise comparison for all suppliers attributes in a tree structure format and third is an intelligent decision-making process working with the CBR technology. Choy et al. [103] proposed an analytical model using CBR which looked like the paper they proposed in 2002. Choy et al. [104] proposed an intelligent system using hybrid CBR and ANN technique to select potential suppliers. Also choy et al. [105-109] used CBR method during the years 2002 up to 2005 and presented different approaches for supplier selection problem. Humphreys et al. [110,111] integrated both case base reasoning and decision support components including multi-attribute analysis (MAA) to present a framework to measure the supplier's environmental performance. Hong et al. [112] applied a clustering method to find best suppliers in three steps: preparation, prequalification and final selection, so they could maximize revenue while satisfying the customer needs. Lopez [113] have combined the both numerical and linguistic information using the 2-tuple fuzzy linguistic model which is basically similar to artificial neural networks. Torres [114] utilizes the decision tree approach to determine the optimal number of suppliers in the presence of supplier failure risks. Scheile [115] used a two layer neural network model and Bottani and Rizzi [116] have presented hybrid method using cluster analysis and AHP.

Association rule is a widely used data mining technique that searches through an entire data set for rules revealing the nature and frequency of relationships on associations between data entities. [117]; Haery et al. [118] applied this method for ranking the best suppliers. Keskinn et al. [119] proposed an ART network for selecting the best suppliers which composes of two layers: An input layer and an output layer.

They considered no hidden layers. The algorithm has the clustering ability and is very effective to deal with the supplier evaluation problem. Artificial Neural Networks (ANNs) are Machine Learning models that try to establish mathematical formulas about the structure of the brain, characterized by the learning through the experience and the mining of knowledge from multiple events.

Luo et al. [120], Albino [121], Wu et al. [122], Lee and Yang [123] and soroush et al. [124] presented a model using neural network approach.

As the figure 6 shows, Artificial intelligence methods are used after 2004. Although CBR method was applied in 2002-2005, but it has decreased after that and the methods like neural network and decision tree is going to be used more. Figure 5 shows classification of artificial intelligence articles.

![Artificial intelligence method](image)

**Fig. 5: Classification of artificial intelligence articles.**
The methods of solving Mathematical programming

- Exact methods
  - OR software
  - B&B
  - Dynamic programming

- Search algorithms and heuristics
  - Scatter search algorithm
  - Heuristic algorithm

- Metaheuristic algorithms
  - Genetic algorithm

Table 1: The methods of solving mathematical models

<table>
<thead>
<tr>
<th>Mathematical programming solvers</th>
<th>OR software</th>
<th>B&amp;B</th>
<th>Dynamic programming</th>
<th>Scatter search algorithm</th>
<th>Heuristic algorithm</th>
<th>Genetic algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exact methods</td>
<td>Many papers such as: Kheljani et al (2009); Guneri et al (2009) &amp;…</td>
<td>Basnet et al (2005); Li et al (2009);</td>
<td></td>
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</tr>
<tr>
<td>Search algorithms and heuristics</td>
<td>Ebrahimi et al (2009); Tempelmeier (2001); Cao &amp; Wang (2007); Ng (2008); Burke et al (2008);</td>
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The Methods of Solving Mathematical Programming Models: Table 1 classifies the mathematical programming models base on their solving method and figure 7 shows the methods of solving mathematical models.

Statistical Models: Some of the researchers have used statistical models for supplier selection problem. Katsikeas et al. [125] tried to measure the impact of supplier performance on distributor performance. They studied the sample of 273 distributors using different statistical tests for the presence of significant differences between high-performance and low-performance distributors. Valluri and Croson [126] presented a statistical approach to study the model proposed by Croson and Jacobides for supplier selection. Cao and Wang [127] proposed a two-stage vendor selection framework in outsourcing and finally developed a solution procedure to find the exact optimal solution. Ernst et al. [128] tried to select best suppliers considering the distribution of vendor's delivery lead time and they showed that the distribution of demand per unit time must also be considered if an optimal decision is to be made.
Fuzzy set theory

Individually

Combine with other methods

Fuzzy + MADM techniques:
Kahraman et al. (2003) [14];
Chen et al. (2006) [19];
Chan & Huang (2007) [141];
Chen & Huang (2008) [143];
Boran et al. (2009) [144];
Lee (2009) [145];
Lee et al. (2009) [25];
Wang et al. (2009) [146];
onü et al. (2009) [147];
Fuzzy + mathematical programming:
Kumar et al. (2004) [45];
Kumar et al. (2006) [47];
A. Amid (2007) [49];
Wang & Che (2007) [148];
Wang (2008) [59];
Wu et al. (2010) [149];
Fuzzy + MP + AI:
F. Faez et al. (2006) [150];
Fuzzy + AI:
R. Florez-Lopez (2007) [93];
Bottani & Rizzi (2008) [96];
Keskin et al. (2009) [99];
Fuzzy + MADM + MP:
Razmi et al. (2009) [151];
Lin (2009) [152];
Wang & Yang (2009) [153];
Guner et al. (2009) [154];
c.k. Kwong et al. (2001);
Jain et al. (2004) [135];
M. Bevilacqua et al. (2006) [136];
Sanaye et al. (2009) [137];
Shen & Yu (2009) [138];
amen et al. (2013);
shu [140]

Fig. 8: Classification of fuzzy articles

Fig. 9: Distribution of fuzzy articles.

pearn et al. [129] considered supplier selection problem which deals with comparing two one-sided processes and selecting the one that has a significantly higher capability value. Li et al. [130] considered a vendor selection problem in which the buyer firm faces stochastic price and demand and Aswashti et al. [131] tried to find a low-cost assortment of suppliers which is capable of satisfying the random demand.

Fuzzy Set Theory: Vendor selection often takes place in a fuzzy environment. For example, demand changes occur from one period to another with a probability distribution that is difficult to estimate because of the lack of historic data. Therefore, demand must be characterized as a fuzzy variable. Zadeh [132] first proposed fuzzy set theory which provided a framework for handling problems in fuzzy environments. 35 out of 170 papers have applied that in their researches. For instance, Kwong et al. [133] applied fuzzy expert systems approach to provide a more human approach to solve supplier assessment problem and Degraeve [134] characterized quality, budget and demand as fuzzy variables in a fuzzy vendor selection and order allocation problem.

Figure 8 shows the classification of fuzzy articles. Figure 9 shows that, there is a sudden Growth in the applying fuzzy set theory from the first six years (2000-2005) to the recent four years, (2006-2009), (4 vs. 31). It shows that the number may keep increasing in the coming years.
**Hybrid Methods:** Near about 40% of the papers used hybrid methods. For example, Sevkeli et al. [155] applied a hybrid method of DEA and AHP, developed by Ramanathan [20] to a well-known Turkish company operating in the appliance industry and the results show that DEAHP method provides a better decision than the AHP.

It seems that hybrid methods will be used more in future. Cebi and Bayraktar [156], Hammami et al. [157], Wang et al. [158,159], Verma [160], Wang and Che [161], Liao and Rittscher [162], Kull and Talluri [163], Talluri et al. [164], Yu and Tsai [165], Ozgen et al. [166], Chen [167], Xia and Wu (2009)[168], Kokangul and susuz [169] used hybrid methods.

As figure 10 shows, individual approaches were used more often before 2006, but after that the more attention has paid to hybrid methods and it is estimated that the number will keep increasing in the coming years.

**Supplier Selection Attributes**

**Order Allocation Problem:** Selecting right suppliers significantly reduces the material purchasing cost and improves corporate competitiveness, which is why many experts believe that the supplier selection is the most important activity of a purchasing department. In many papers buyers order quantities from different vendors in a multiple sourcing network. Supplier's capacity constraints make the buyers to order quantities from multiple suppliers and the total demand is split among them. So they should decide what to buy (buy or make), from who and how many (order allocation) and when (single period or multi-period).figure 11, Table 2 and 3 shows the models which considered order allocation problem.

**Quantity Discount:** Suppliers sometimes offer discounts. The motivation for using discount schemes stems from the fact that it tends to encourage buyers to procure larger quantities and to obtain operating advantages (such as economies of scale or reducing the cost of transportation) for the buyer. From a coordination perspective, it has been shown that both the buyer and the supplier can realize higher overall profits if discounting schemes are used to set transfer prices. Various kinds of discount schemes which are usually offered by suppliers were discussed in relevant studies. So, the supplier selection problem in presence of discount schemes becomes more complicated. Usually, two types of discounts, all-units discount and incremental discount
Supplier selection models

- With discount
  - All units discount
  - Incremental discount
  - Business volume discount

- Without discount

**Fig. 12:** The segmentation of models considering quantity discounts.

The combination of vendor selection problem with other models

- Inventory problem
- Production planning problem
- Distribution planning
- Production design

**Fig. 13:** Classification of articles according to their attributes.

are used for cost reduction. Although the process of supplier selection and evaluation has been studied extensively, the problem of supplier selection under multi-supplier quantity discount has received little attention. Figure 12 and Table 4 shows the models which considered discounts.
Table 4: The segmentation of articles considering quantity discounts.

<table>
<thead>
<tr>
<th>Quantity discount</th>
<th>Articles</th>
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<tbody>
<tr>
<td>All unit discount</td>
<td>Tempelmeier (2001); Amid et al (2007); wadhwa &amp; ravindran (2007); Burke et al 2008; Ebrahim et al (2009); Wang &amp; Yang (2009); Sawik (2009);</td>
</tr>
<tr>
<td>Incremental discount</td>
<td>Tempelmeier(2001); Burke et al 2008; Ebrahim et al (2009);</td>
</tr>
<tr>
<td>Business volume discount</td>
<td>Xia&amp;Wu(2007);</td>
</tr>
</tbody>
</table>

Table 5: The combination of vendor selection problem with other models.

<table>
<thead>
<tr>
<th>The combination</th>
<th>Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory problem</td>
<td>Kheljani et al (2009); Ustun et al (2008); Rezaei et al (2008); Eric Sucky (2007); Basneta et al (2005);</td>
</tr>
<tr>
<td>Production planning problem</td>
<td>Wang&amp;Che (2007);</td>
</tr>
<tr>
<td>Distribution planning</td>
<td>Liu-yi et al(2006);</td>
</tr>
<tr>
<td>Production design</td>
<td>Hou&amp;Su (2006);</td>
</tr>
</tbody>
</table>

The Combination of Vendor Selection Problem with Other Models: A few of the article considered different purposes. They tried to choose the best suppliers and other objectives simultaneously.

Figure 13 and Table 5 shows that, which articles solve the inventory problem, distribution planning problem and… besides vendor selection problem in their models.

CONCLUSION

The state of choosing most appropriate supplier as a strategic factor in supply chain has been receiving much attention in recent years. The numbers of published articles are increasing and it shows the importance of supplier selection.

The nature of this type of decisions is usually complicated and without definite structure and many quantitative and qualitative measures should be considered. But the most common used criteria are:

1. The quality
2. Lead time or delivery time
3. Price

According to their different solving method, the reviewed paper are classified in several categories. The main categories are:

- Among all papers presented in these years 54% of them used mathematical models to solve the supplier selection problem. Figure 15 shows which models are applied in different years.

- As it shows in figure 15, after 2007 mathematical models are used more than qualitative ones, because they have exact solution, less estimate error and decision makers can use them easily.

- Since 2008, researchers applied hybrid methods more than individual ones because they can integrate the benefits of two or more models to solve the problem.

- In recent years most of the papers tried to determine the optimum order quantity that should buy from selected suppliers and shows that it is crucial to know how much to buy to achieve minimum cost.

- Some papers in 2008 and 2009 tried to consider inventory problem and integrates it with supplier selection and some of them integrates supplier selection with production planning problem. So it is supposed to see more integrated papers in the future.

The importance of supplier selection problem in a supply chain made researchers to focus on this subject and the numbers of articles have increased during these years, but in all papers, they tried to find the best suppliers in first tier of the supply chain and it seems necessary to consider the second tiers suppliers and design a supply network to manage the purchasing task.

REFERENCES


