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## Analysis of methods for supplier selection

### Abstract

This work seeks to determine the criteria and methods used in the problem of selecting suppliers, thus contributing to the support of entities wishing to start a selection of suppliers more effectively. To achieve these objectives, an analysis was performed of articles that make the literature review of the methods and criteria from the year 1985 to the year 2012. With the data obtained from these reviews, it was possible to verify which are the three main methods used over the years, namely data envelopment analysis (DEA), Analytical hierarchy process (AHP) and Fuzzy set theory and the main criteria used in the selection of suppliers.

In this work, we present an overview of the decision making and the methods used in multi-criteria decision making. It's tackled the problem of supplier selection, the process of selection and the reviews of literary methods and criteria used in recent years. Finally is presented the contribution to the selection of suppliers of the study conducted during the development of this dissertation, being presented and explained the main methods of selection of suppliers as well as the criteria used.

### Keywords

Multi-criteria decision making, Supplier selection, selection criteria, selection methods, DEA, AHP, Fuzzy set theory

## 1. Introduction

In today's highly competitive environment, an efficient supplier selection process is extremely important for the success of any organization (Tahriri, Farzad, et al., 2008).

The supplier selection area is one of the most important in the purchasing division. Nowadays consumers are looking for products with high quality, on time delivery and excellent after sale service. Hereby, the organizations are under high pressure to reduce the costs of products and material keeping a high level of quality and a good after sale service. Achieving these, starts by the supplier selection. Therefore, an efficient supplier selection process have to be implemented for a success management of the supply chain (Sonmez, M., 2006).

Nowadays, how to determine suitable suppliers in the supply chain has become a strategic consideration (Chen, Chen-Tung., et al., 2006). Thus, to select a vendor is required to set criteria. That these criteria should meet the concerns and philosophies of each company. Thus, with a varied number of criteria becomes more complex decision making. To resolve this problem have emerged over the years various methods of supplier selection, being more complex than others and each with its advantages and disadvantages. Given this large number of methods, it becomes necessary for an organization to know what the most effective methods for dealing with this problem.

Our objectives for this work are the search criteria and methods used in the selection of suppliers, as well as research vendor management

software that uses some of the methods of multi-criteria decision making to solve this problem. This study will be an asset for organizations that want to start selecting suppliers using these methodologies.

## 2. Supplier Selection Process

The main objective of supplier selection process is to reduce the risk of purchase, maximize overall value to the purchaser and develop close relationships and long term buyers and suppliers, which helps the company achieve a "just-in-philosophy time "(JIT). Therefore, it is requested to the suppliers a set of skills to be part of a competitive procurement system. To this end, companies that focus on performance of the supply chain, perform various actions and strategies in particular, the assessment processes have assumed a crucial importance. This is an obligatory point of departure and critical to the achievement of a customer-supplier collaborative system (Genovese, A., et al., 2013).

Supplier selection must take into account several factors to choose among potential suppliers. Cunha (2008) analyzes the importance of supplier selection and emphasizes that part of this importance comes from the fact that the same could compromise the organization's resources, directly influencing the production, planning, treasury and quality of the final product.

Several authors consider different numbers of stages for selecting suppliers. After a short review, three types of process for the selection of suppliers found. In Figure 1 the scheme considered the most complete and best represents the process of supplier selection is presented.

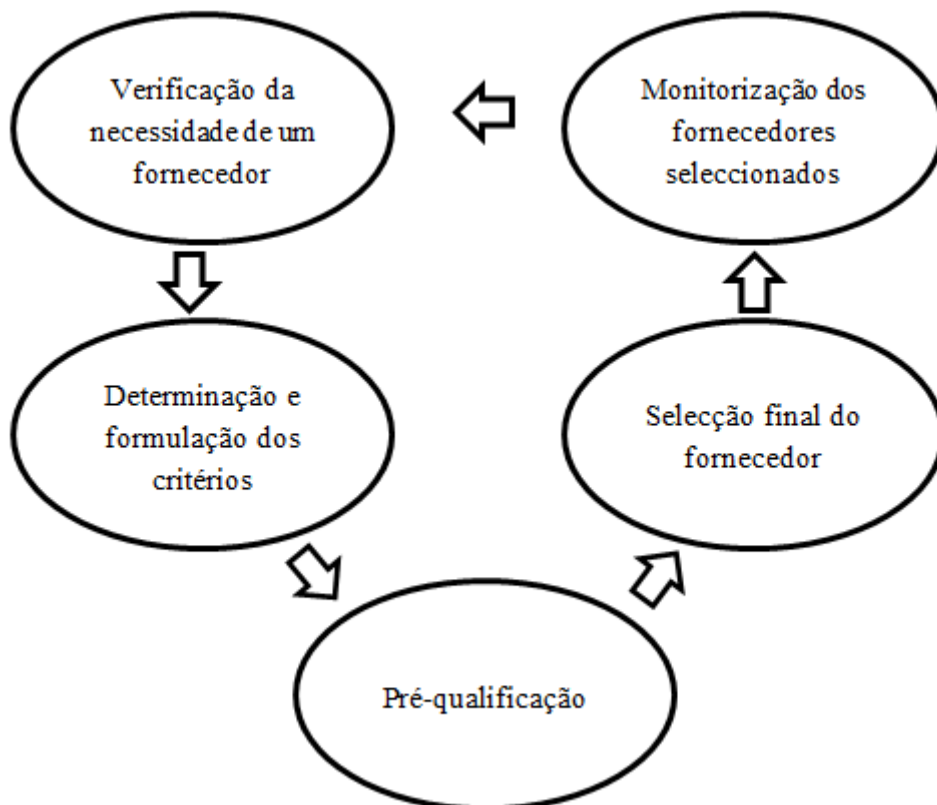


Figure 1 Supplier selection process scheme Sonmez (2006)

This work only focuses on the study of the final selection phase.

### 3. Decision Technics in Supplier Selection

Various authors use different classifications of technical decision-making. In this paper, will be followed the classification of Chai et al. (2013) who rated the techniques of decision making in three categories, namely: Technical multi-criteria decision making (MCDM) techniques, mathematical programming techniques (MP) and artificial intelligence (AI).

#### 3.1. MCDM

MCDM focus on problems with a discrete decision space. In these problems the set of decision alternatives is predetermined (Triantaphyllou, E., 2000).

Multi-attribute utility methods (AHP, ANP)

Outranking methods (ELECTRE, PROMETHEE)

Compromise methods (TOPSIS, VIKOR)

Other methods (SMART, DEMATEL)

#### 3.2 MP

Allows the person who makes decisions to formulate his problem in terms of an objective function and it's constrains.

Data envelopment analysis (DEA)

Linear programming (LP)

Non-linear programming (NLP)

Multi-objective programming (MOP)

Goal programming (GP)

Stochastic programming (SP)

#### 3.3. AI

Refers to cognitive processes and especially to reasoning. Before making decision, people also reason, it is therefore natural to explore links between AI and decision making.

Genetic algorithm (GA)

Neural network (NN)

Grey system theory (GST)

Rough set theory (RST)

Case based reasoning (CBR)

Bayesian networks (BN)

Particle swarm optimization (PSO)

Ant colony algorithm (ACA)

Dempster-Shafer theory (DST)

Association rule (AR)

Support vector machine (SVM)

Decision tree (DT)

#### 4. Final Selection Phase

The analysis of the main criteria and methods of supplier selection was performed through the revision of articles that make literature review.

##### 4.1. Results of the review of Criteria

The authors reviewed to find the most used criteria were the ones present in the table 1.

Table 1 Authors reviewed for the criteria

Authors	Year
Jain et al.	2007
Ho et al.	2010
Ware et al.	2012
Genovese et al.	2012
Ávila et al.	2012

After the analysis of the papers, it was built the table 2 where the criteria was classified as common (C), partial common (P) and not common (N).

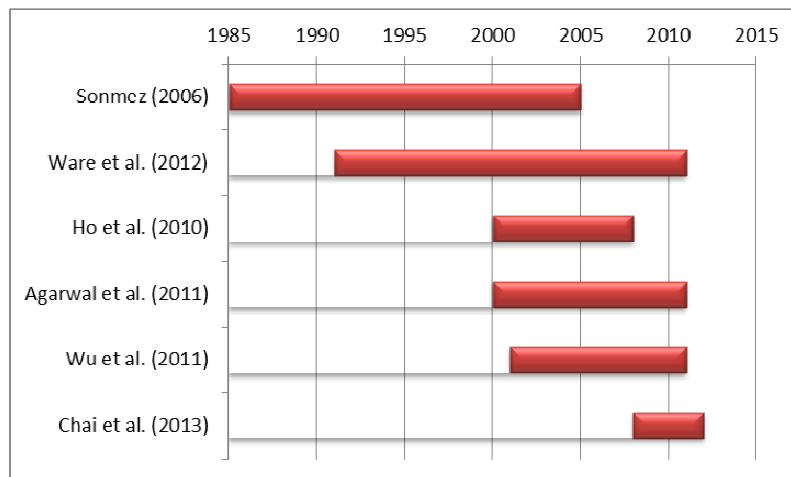
Table 2 Main criteria for supplier selection

Criteria	Classification	Criteria	Classification
Quality	C	After sale service	N
Price	C	Location	N
Service	P	Product appearance	N
Delivery	P	Number of trades	N
Production capacity	P	Brand	N
Historic	P	Attitude	N
Risk	P	JIT capacity	N
Technology	P	Labor relations	N
Environment	P	Reciprocal agreements	N
Reputation	P	Communication service	N
Sinergy	P	Maintainability	N
Finances	P	Response to requirements	N
Relationship	P	Ease of use	N
Management/Organization	P	Operational control	N
Availability	N	Technical capacity	N
Cycle time	N	Electronic commerce capacity	N
Research and development	N	Packaging capacity	N
Flexibility	N	Technical support	N
training support	N	Financial situation	N
Warranty and complaints	N		

As showed on table 2 the main criteria utilized on the supplier selection are the quality and price. This review also showed that there is no consensus regarding the separation of criteria and sub-criteria. Therefore the analysis made was made regarding only the criteria. As some author consider for example the after sale service as criteria and others consider it as a sub criteria, it was consider criteria for the analysis.

##### 4.2. Results of the Review of Methods

With the intention to find the most used multi-attribute models in the supplier selection, we carried out a research using scientific articles available on the B-on. On the graphic 1 it's possible to verify the distribution of the reviews over the years.



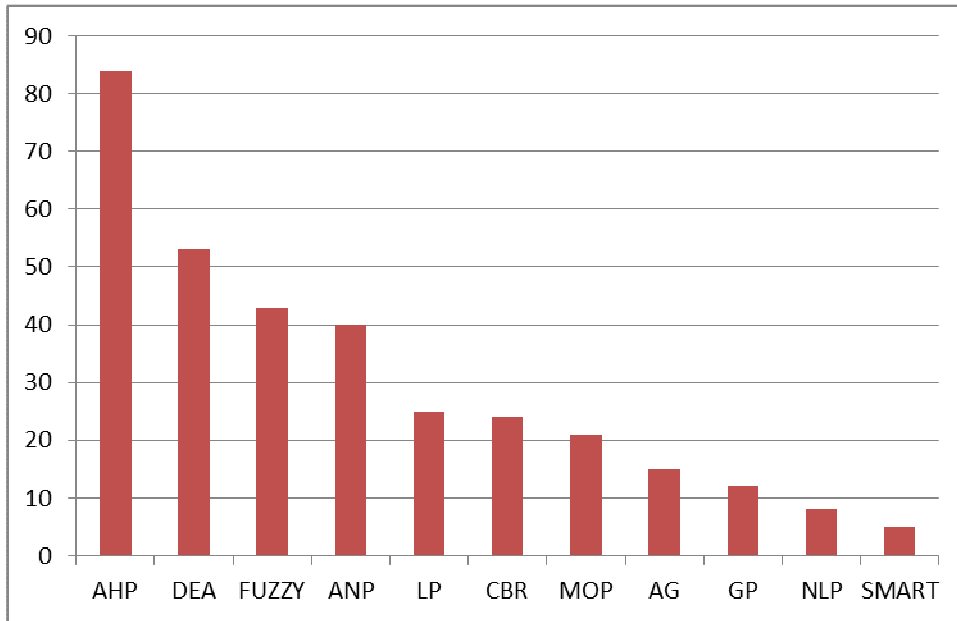
Graphic 1 distribution of the literature review

The review of the articles brought up many different methods. So to find the most used we pick the methods most referred and built the table 3.

Table 3 Most referred methods

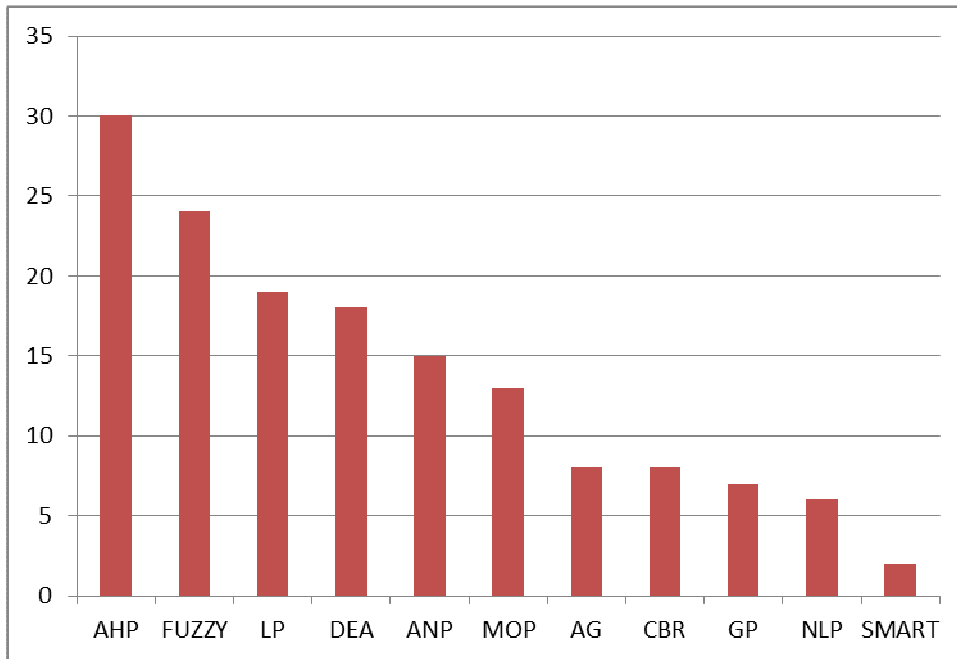
Category	Methods	Abbreviation	Nº articles
AI	Neural network	NN	2
	Genetic algorithms	GA	4
	Case based reasoning	CBR	4
	Bayesians networks	BN	2
MP	Non-linear programming	NLP	3
	Multi-objective programming	MOP	3
	Linear programming	LP	3
	Integer programming	IP	2
	Goal programming	GP	3
	Data envelopment analysis	DEA	5
MCDM	Analytical hierarchical process	AHP	6
	Fuzzy set theory		4
	Analytical network process	ANP	5
	Simple multi-attribute classification technique	SMART	3

For our study we only select from the table 3 the methods that are present in more than half of the articles. With this data we construct the graphic 2 with cumulative sum of the methods selected from table 3.



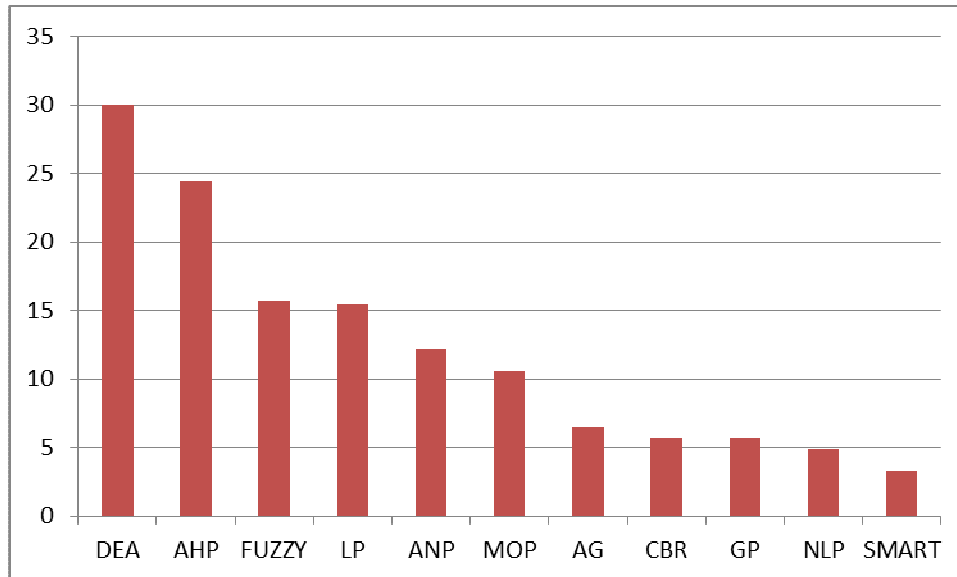
Graphic 2 Cumulative sum of the methods selected

Since some of the articles used in the review, utilize sources already used by previous reviews, there is a risk of having recurrence of sources. So to reduce the error, we analyzed all the revisions and is used to build the graph 3 the number of references of the article that has the largest number of references of a particular method.



Graphic 3 Maximum number of references per article

Still, as the number of articles found for each method can be influenced by the number of articles that each researcher used in the preparation of his article, we draw the graph 4, where the maximum value found for the graph 3 was divided by the number of sources used in the respective article.



Graphic 4 Percentage of fonts

### 4.3. Results of the Review of Software

The search for software for supplier selection revealed that the availability of this is limited, in other words, is only available on request. There is free software currently available that allows only the management of information from the suppliers. In our research, we found software available online that can use the methods for decision making, but is not specifically designed for the supplier selection problem.

### 5. Conclusions

The criteria most frequently mentioned in the literature have been identified, the price and quality. Although there is no consensus regarding which are the criteria and which are the sub-criteria. Perhaps, a criterion that gives emphasis to maintaining lasting relationships with suppliers should be used more often, since maintaining long term relationships with suppliers is an objective of supplier selection.

The methods most often analyzed in the literature are the DEA, AHP and Fuzzy set theory. However, the methods used in practice may not be the same. Throughout the literature review we found that there is no consensus on the categories in which the methods are divided.

There is no dedicated software for supplier selection, perhaps for not having a set of predefined criteria for selecting suppliers.

AS future developments we propose the analyses of the application of methods in companies, we also think that it's important the analyses of the other phases of supplier selection and we consider that should be made a collection of data to define the percentage of criteria allowing the development of a supplier selection software.

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