# A Review Paper on "Multicriteria Decision Making Approaches and Criterion" Used in Supplier Selection and Evaluation

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## Abstract

The objective of this paper is review of all developed appropriate methods and tools that deal with decision making problems in supplier selection. Supplier selection has become an important part of supply chain management and hence selecting and evaluating suppliers is complicated task due to the fact that various criterion must be considered in the decision making process. An extensive range of decision making methods have been suggested to handle the supplier selection problem by a large number of authors in this area. Review of international journal articles published between 2000 and 2013 have been surveyed for this purpose. The articles are observed and studied to summarize the existing methods and the repeatedly used most popular method is identified and presented in this paper. Finally, suggestions for future researches are proposed for the decision makers.

## 1. Introduction

Selecting and evaluating suppliers is complicated task due to the fact that various criterion must be considered in the decision making process. Supplier selection is one of the strategic elements in managing purchases, as the ability of a company to satisfy its clients, as well as its own continuity, depends to a large extent on its suppliers. The researchers in supplier selection field have been applied multi-criteria decision making methods, such as Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Artificial Neural Network(ANN), Data Envelopment Analysis(DEA), fuzzy set theory, mathematical programming. The process involves different types of criteria with these approaches.

There are at least six journal articles reviewing the literature regarding supplier evaluation and selection models (Weber et al. 1991; Holt 1998; Degraeve et al. 2000; de Boer et al. 2001; Ho et al. 2010; Amindoust et al. 2012). This paper presents a comprehensive review of literature to identify the existing supplier selection methods and determine the most popular ones.

## 2.Approaches of Supplier Selection

Most common reviewed methods that are used in decision making are briefly discussed below:

### 2.1 Analytic Hierarchy Process (AHP):

A AHP method was first introduced by Saaty. In AHP, the problem is constructed as a hierarchy breaking down the decision top to bottom. The goal is at the top level, criteria and sub-criteria are in middle levels, and the alternatives are at the bottom layer of the hierarchy.

### 2.2 Analytic Network Process (ANP) :

The ANP methodology is a general form of the AHP, both were introduced by Saaty . Although AHP is easy to use and apply, its unidirectional relationship characteristic cannot handle the complexity of many problems. ANP, however, deals with the problem as a network of complex relationships between alternatives and criteria where all the elements can be connected.

### 2.3 Technique for order preference by similarity to ideal solutions (TOPSIS):

The basic concept of this method is that the selected alternative is the one that has the best value for all criteria, i.e. has the shortest distance from the negative ideal solution.

### 2.4 Multi-attribute utility theory (MAUT):

This is one of the most popular MSDM methods. The theory takes into consideration the decision maker's preferences in the form of the utility function which is defined over a set of attributes, where

the utility of each attribute or criterion doesn't have to be linear.

### 2.5 Simple Additive Weighting (SAW):

It is probably the most used MCDA method. It is intuitive and easy. Simple Additive Weighting (SAW) which is also known as weighted linear combination or scoring methods is a simple and most often used multi attribute decision technique. The method is based on the weighted average. An evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance directly assigned by decision maker followed by summing of the products for all criteria. The advantage of this method is that it is a proportional linear transformation of the raw data which means that the relative order of magnitude ofthe standardized scores remains equal.

### 2.6 Artificial Neutral Network :

The human brain provides proof of the existence of massive neural networks that can succeed at those cognitive, perceptual, and control tasks in which humans are successful. The brain is capable of computationally demanding perceptual acts (e.g. recognition off aces, speech) and control activities (e.g. body movements and body functions). The advantage of the brain is its effective use of massive parallelism, the highly parallel computing structure and the imprecise information-processing capability. Hence the student stress is dealing with the biological factor ANN is the best method to validate problems associated with it. Artificial neutral networks (ANN) have been developed as generalizations of mathematical models of biological nervous systems.

### 2.7 Data Envelopment Analysis:

Data envelopment analysis (DEA) is a mathematical programming method to provide a relative efficiency evaluation for a group of decision making units (DMU) with multiple numbers of inputs and outputs. It is proposed by Charnes, Cooper and Rhoders in 1978 . To allow for applications to a wide variety of activities, it uses the term DMU to refer to any entity that it to be evaluated in terms of its abilities to covert inputs into outputs. It assumes that there are n DMUs to be evaluated.

## 3. Individual and Integrated Approaches Reviewed From The Papers During Year 2000-2013

| APPROACH | YEAR | AUTHOR |
|---|---|---|
| Data Envelopment Analysis(DEA). | 1997<br>2000<br>2000<br>2001<br>2001<br>2001<br>2002<br>2002<br>2004<br>2006<br>2006<br>2006<br>2006<br>2006<br>2007<br>2007 | 1.Baker and Talluri<br>2. Braglia and Petroni<br>3. Liu et al<br>4.Forker and Mendez<br>5.Narasimhan et al<br>6. Narasimhan et al.<br>7. Talluri and Baker<br>8. Talluri and Sarkis<br>9. Talluri and Narasimhan<br>10. Garfamy<br>11. Ross et al.<br>12. Saen<br>13.Seydel<br>14.Talluri et al.<br>15. Saen<br>16.Wu et al. |
| Linear Programming (LP). | 2003<br>2005<br>2008 | 1. Talluri and Narasimhan<br>2. Talluri and Narasimha<br>3 .Ng |
| Integer Linear Programming | 2002<br>2005 | 1. Talluri<br>2. Hong et al. |
| Integer Non-Linear Programming | 2001 | Ghodsypour O'Brien |
| Goal Programming | 2001 | Karpak et al |
| Multi-objective programming | 2006<br>2007 | 1.Narasimhan et al.<br>2. Wadhwa and Ravindran |
| Analytic Hierarchy Process(AHP) | 2001<br>2002<br>2004<br>2005<br>2007<br>2007 | 1. Akarte et al<br>2. Muralidharan et al.<br>3. Chan and Chan<br>4. Liu and Hai<br>5. Chan et al.<br>6. Hou and Su |

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|---|---|---|
| Analytic Network Process (ANP) | 2002<br><br>2006<br>2007 | 1.Sarkis and Talluri<br>2.Bayazit<br>3.Gencer and Gürpinar |
| Fuzzy Set Theory | 2006<br>2006<br>2007 | 1. Chen et al.<br>2. Sarkar and<br>3.Mohapatra Florez-Lopez |
| Simple Multi-Attribute Rating Technique (SMART) | 2003 | 1.Barla<br>2.Huang and Keska (2007) |
| Genetic Algorithm (GA) | 2005 | Ding et al. |
| Integrated AHP And Bi-Negotiation | 2007 | Chen and Huang |
| Integrated AHP And DEA | 2007<br>2007<br>2007 | 1.Ramanathan<br>2.Saen<br>3.Sevkli et al |
| Integrated AHP, DEA And Artificial Neural Network | 2008 | Ha and Krishnan |
| Integrated AHP And GP | 2003<br><br>2004,2005<br>2006<br>2008 | 1.Çebi and Bayraktar<br>2.Wang et al<br>3.Perçin<br>4.Kull and Talluri<br>5. Mendoza et al. |
| Integrated AHP And Mixed Integer Non-Linear Programming | 2008 | .Mendoza and Ventura |
| Integrated AHP And Multi-Objective Programming | 2007 | .Xia and Wu |
| Integrated Fuzzy And AHP | 2003<br><br><br>2007 | 1. Kahraman et al.<br>2.Chan and Kumar |
| Integrated Fuzzy, AHP And Cluster Analysis | 2008 | Bottani and Rizzi |
| Integrated Fuzzy And GA | 2004 | Jain et al. |
| Integrated Fuzzy And Multi-Objective | 2006 | Bevilacqua et al. |
| Integrated Fuzzy And Quality Function Deployment | 2006 | Bevilacqua et al. |
| Integrated Fuzzy And SMART | 2002<br>2008 | 1. Kwong et al<br>2. Cho u and Chang |
| Integrated ANN And CBR | 2003, 2004 | Choy et al. |
| Integrated ANN And GA | 2006 | Lau et al. |
| Integrated ANP And Multi-Objective Programming | 2008 | Demirtas and Üstün |
| Integrated ANP And GP | 2009 | Demirtas and Üstün |
| Integrated DEA And Multi-Objective Programming | 2000<br>2008 | 1. Weber et al.<br>2. Talluri et al. |
| Integrated DEA And SMART | 2005 | Seydel |
| Integrated GA And Multi-Objective Programming | 2007 | Liao and Rittscher |
| Fuzzy logic | 2009 | Gulcin Buyukozkan et al. |
| Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). | 2009 | Fatih Emre Boran et al. |
| Analytic Hierarchy Process (AHP) | 2011 | Katica Simunovic et al. |
| Fuzzy Analytic Hierarchy Process | 2011 | Adnan Aktepe et al. |
| Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). | 2011 | Mohammad Saeed Zaeri et al. |
| Fuzzy Analytic Network Process (ANP) | 2011 | He-Yau Kang et al. |
| Data Envelopment | 2011 | Mohsen Jafari Songhori et al. |

| | | |
|---|---|---|
| Analysis (DEA) | | |
| An integrated approach of Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). | 2012 | Bahar Sennaroglu et al. |
| Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). | 2012 | Ajit Pal Singh et al. |
| An integrated approach of Analytic Network Process (ANP) and Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). | 2012 | Ali A. Yahya Tabar et al. |
| Analytic Hierarchy Process (AHP) | 2012 | David Asamoah et al. |
| An integrated approach of Analytic Network Process (ANP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). | 2012 | K. Shahroudi et al. |
| Measuring Attractiveness By a Categorical-Based Evaluation Technique (MACBETH) | 2012 | Prasad Karandea et al. |
| Individual Analytic Hierarchy Process (AHP) | 2013 | Emrah Onder et al. |
| Individual Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) | | |
| An integrated approach of Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) | | |
| Individual Grey relational analysis (GRA) | 2013 | Pandian Pitchipoo et al. |
| Individual Analytic Hierarchy Process (AHP) | | |
| An integrated approach of Grey relational analysis (GRA) and Analytic Hierarchy Process (AHP) | | |
| Fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) | 2013 | Ozer Uygun et al. |
| Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) | | |
| Analytic Network Process (ANP) | | |
| Fuzzy Analytic Hierarchy Process | 2013 | Mustafa Batuhan et al. |
| Technique for Order of Preference by Similarity to | 2013 | Ashish H. et al. |

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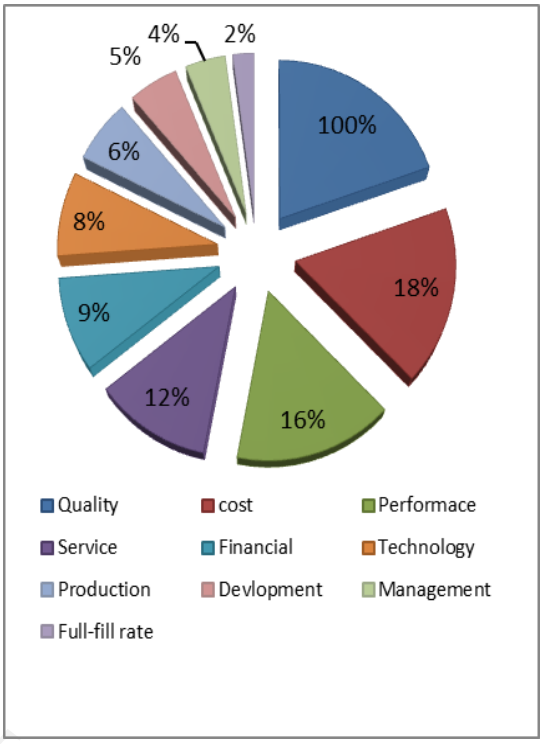
|---|---|---|
| Ideal Solution (TOPSIS). | | |
| An integrated approach of Fuzzy Analytic Network Process (ANP) and Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). | 2013 | Massoud Kassaee et al. |
| Green Supplier selection Fuzzy Analytic Network Process (ANP) | 2013 | Malihe Dehghani et al. |




## 5. Most Popular Criterion Observed In These Review Papers

The most popular criterion used for evaluating the performance of suppliers is quality, price/cost, performance, service, management, technology, production and development, finance, flexibility, reputation, relationship, risk, and safety and environment.

## 6. Future Work

Since in the proposed methodology all the inputs are ordinary or single-value numbers. The review it has been found that individual approaches were used more than the integral approaches in earlier days and Environmental criterion not precisely focused in many articles. Further study can be based on the integrated approaches along with the green supplier selection. Some criteria may be impractical to evaluate, information may be difficult to obtain, complex to analyze, or there may not be sufficient time to perform such evaluations. When the performance of alternative suppliers can only be approximated. The proposed model can be implemented to reduce the number of criteria to most important ones in some other problems, to which MCDM approaches can be applied. Among the numerous methods that have been proposed for assessing the supplier, loss functions such as Taguchi loss function without any range are considered one of the most effective techniques for identifying quality parts. Quality loss functions are more reliable and precise functions in order to assess the quality. Also integrating Taguchi loss function with other methods can be applied.

## 7. Conclusion

This paper review the multi criteria decision making approaches for supplier evaluation and selection on literature from 2000 to 2013 and it has been found that many individual and integrated approaches were proposed for supplier selection. The supplier selection process is a technique for evaluating suitable companies to meet a particular need, and in order to narrow the field for such a selection, some evaluative criteria are needed. Even with the large number of available MCDA methods, none of them is considered the best for all kinds of decision-making situations. Different methods often produce different results even when applied to the same problem using same data. There is no better or worse method but only a technique that fits better in a certain situation. The most prevalent individual approach used earlier is DEA and now a days the TOPSIS method is used whereas the most popular integrated approach is AHP–Mathematical Programming. The most popular criterion used for evaluating the performance of suppliers is quality, price/cost, performance, service, management, technology, production and development, finance, flexibility, reputation, relationship, risk, and safety and environment. Recently also the Environmental criteria are widely used in supplier selection systems called green supplier selection method along with integrated approaches.



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