

## Content Analysis: Supplier Selection Process using Multi-criteria approaches

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### Abstract

Supplier selection can be considered as the foundation of Supply Chain Management. In this competitive business environment, it is crucial to select the best supplier among all the alternatives. For this purpose, researchers developed number of selection criteria and methods. These selection criteria and methods helping to solve this supplier selection problem within different industries. In this process, supplier selection literature has been enriched by involving several multi-criteria decision-making systems. The aim of this paper is to demonstrate Content Analysis on existing literature on supplier selection process using multi-criteria decision-making system to understand the progress of this sector over the span of time till 2014.

### Introduction

In global competitive business, organisations pay special attention for selecting the most suitable supplier amongst all. This extremely competitive business environment is driving manufacturing firms to set up a long-term efficient partnership with outsourcing organisations. As we all know, these days manufacturing firms highly depend on outsourcing companies for different parts of their products. A simple product is seldom prepared in the same factory rather different parts of that product is outsourced from different places and fixed at last in a place before placing the product in the market. Firms operating in Readymade Garment, IT, Call centres, Packed Food etc. industries are especially on outsourcing. In this globalised market different companies are now focusing on the selection of global business associates either to supply the parts or to get raw materials in competitive price from them (Bashir, 2012).

Therefore, choosing the right suppliers involves much more than scanning a series of price list and choices of suppliers depend on a wide range of qualitative and quantitative factors. Supplier selection had always been an important part of supply chain management. Several approaches were proposed by researchers in different time periods based on a number of variables. Previously, several methods have been used for the supplier selection process however most of them were limited to domestic supplier selection only. For this reason, many significant variables which are very important in determining the global supplier have not been argued in a proper way. The objective of this paper is to conduct content analysis of existing literature on supplier selection process using multi-criteria decision-making system.

### Methodology

Heish and Shannon (2005) argued that in order to analyse the content of communication, content analysis can be used as a research technique. A particular text can be analysed in quantitative and qualitative approach to deduct a specific meaning by means of searching key words, statements etc. (Neuendorf, 2002). In content analysis, researchers establish a set of categories. The crucial requirement is that the categories are sufficiently precise (Silverman, 2001). As Wildermuth (2009) suggested content analysis is not only related to quantitative analysis of words but also it can be used to analyse words in qualitative manners. To analyse a text using content analysis, it is usually divided into various categories, words, or sentences and then it is examined in more detail by other approaches (Zeh, 2005).

There are two types of content analysis- conceptual and relational analysis (Bazerman and Prior 2004). Conceptual analysis determines the frequency of a particular word, phrase or sentence in the content as much as finding out the exact number of times a specific word or phrase appeared in the chosen text. On the other hand, relational analysis is about analysing the connections and relationships for a specific word or concept between selected texts. By means of relational analysis one can get various meanings of a specific word or concept that is

analysed.

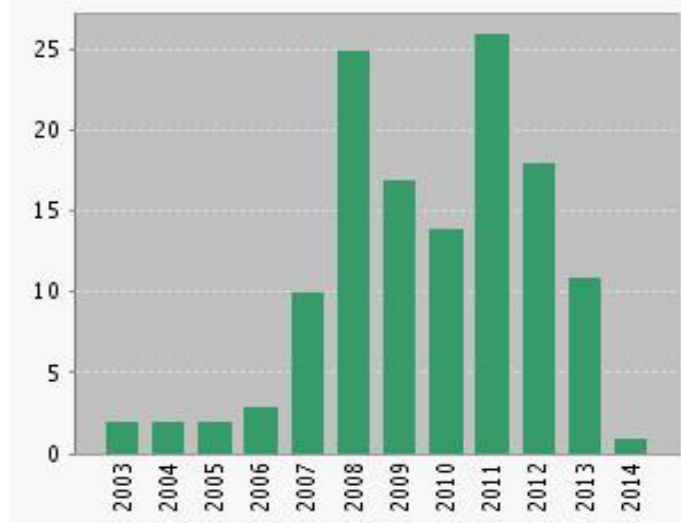
In this article, conceptual and relational analysis had been conducted given the validity and reliability of content analysis. First, a database had been quantitatively analysed to find out how many publications are there with a specific word- Supplier Selection- and how those were dispersed over various time periods. Second, twenty articles were selected from the key periods which had been analysed qualitatively. In this part the relationship between different contexts that were chosen from the key period had been examined. After seeing the implicit and explicit characteristics of the key words in the content analysis, 25-30% of the publications had been examined to eradicate the irrelevant publications to increase the consistency of the research.

In order to find relevant journal articles, one database which contains a high number of publications on Supply Chain Management was required. LexisNexis, ISI web of knowledge, IEEE and Compendex are the few database that could be used. For the purpose of this article, ISI web of knowledge had been used.

Finally, the key words had to be chosen by which one can get the database of supplier selection based on multiple criteria. In order to choose the articles, in the *basic search* section 'supplier selection\*' has been used (in the title) and in the sub section 'multi-criteria (within the topic)'. The reason behind choosing the title at the beginning of this analysis, is to focus on supplier selection articles only. The purpose of using '\*' after the word 'supplier selection' is to search for any word that starts with the chosen root word, for example vendor selection, outsourcing partner selection etc. In the chain of the search term 'AND' has been used so that it can also consider multi-criteria (within the topic) while selecting the articles.

#### **Content analysis on multi-criteria decision making approaches for supplier evaluation and selection**

After searching based on the criteria 131 articles are selected. The selected articles have been categorised according to their publication year, as shown in figure:1 below. It shows that article publication on supplier selection began to get attention since 2003. From then onwards, the number increased gradually till 2008 and the highest number of publications can be observed in 2011. After that it went down for the following two years.



**Figure: 01: (ISI Web of Knowledge)**

After analysing the key periods of publications in supplier selection process considering multi-criteria, it was important to look at the key fields that they are from. Though supplier selection techniques are mostly applicable for research related to engineering and computer science, these days it is also used to study Operation and Supply Chain Management. As Table-1 suggested that almost 65% research work has been conducted in operation management and supply chain domain. More than 21% of the researches were conducted in the domain of computer science. Rest of the other researches were in different fields such as engineering, business t etc. Moreover, if Table-2 is observed, it can be seen that the highest number of publications in Multi- Criteria Supplier Selection and Evaluation were published from Republic of China (26.71%) followed by Turkey, Taiwan and USA.

**Table1: (Source: ISI Web of Knowledge)**

Top 5 field categories of web of knowledge	Number of Publication	Percentage
Operation/ Supply Chain Management	85	64.88%
Computer Science	28	21.28%
Business/ Economics	2	1.52%
Engineering	2	1.52%
Library Science	1	0.76%

**Table2: (Source: ISI Web of Knowledge)**

Top 10 publication source by country	Number of Publication	Percentage
China	35	26.71%
Turkey	25	19.08%
Taiwan	18	13.68%
Iran	13	9.88%
USA	12	9.12%
India	3	2.90%
England	3	2.90%
France	3	2.90%
Malaysia	2	1.52%
Canada	2	1.52%

After observing the overall picture, now it is clear where the key points are, those need to be analysed is followed in the beginning of the publication period 2003 and 2004 then the highest number of publication period was 2011 has been analysed.

For the purpose of the qualitative analysis, 20 published journal articles were selected. 10 of them were from 2003-2004 period and other 10 were chosen from the 2011 period. During selecting these 20 articles, 45 articles were examined and 7 were deducted because of irrelevancy.

After analysing the papers from 2003-2004-time period, it can be observed that a simplified Data Envelopment Analysis (DEA) model was suggested by Liu et al. (2003) in order to measure the overall performances of suppliers in accordance to two out-put and three in-put criterion. The model was used to select a supplier who has higher supplier variety which in turn helped to reduce the number of suppliers used.

On the other hand DEA was used by Forker and Mendez (2003) in order to carry out a comparative analysis regarding the efficiencies of various suppliers. This comparative efficiency was determined by calculating the maximum ratio of a single input to multiple outputs. It is important to note that the outputs were measured based on the important factors of the quality management mentioned by other scholars. Notably, cross efficiency was measured in order to determine the “best peer” suppliers i.e resembling the study of Braglia and Petroni (2003).

DEA model was also used by Narasimhan et al. (2003) in order to assess different suppliers for a multinational organisation operating in the telecommunication sector. For conducting this study, the model analysed eleven factors, five of them were linked to the output related supplier performance and the rest six were linked to input related to the supplier capability. In addition, performance score was used to categorize suppliers in four different segments, which were low performers and inefficient, low performers and efficient, high performers and inefficient and finally high performers who are efficient.

For logistics distribution network design, Talluri and Baker (2004) utilized a three-phase approach. In Phase I DEA was applied in order to measure the effectiveness of potential stakeholders which included distributors, manufacturers and suppliers. The evaluating factors of suppliers consisted six different factors were two inputs and four outputs. The most efficient routing of material from selected suppliers to manufacturers to warehouses were determined by using the scores gathered in Phase I and by analysing optimal number of stakeholders to be utilized gathered in Phase II.

DEA was applied to assess performance of suppliers, for a study conducted by Talluri and Sarkis (2004). It is important to note that identical evaluating factors and dataset were used in order to show how the model worked in accordance to the previous study of Talluri and Baker (2004).

DEA was also used for identifying efficient supplier sources (Talluri & Narasimhan, 2003). The only difference of this study in comparison to the earlier work of Narasimhan et al. (2003) is that instead of using simple efficiency scores for the analysis, the research in 2003 utilized statistical methods and cross-efficiencies to categorize the supply base into various clusters.

On the other hand, the first set of researchers to consider performance variability measurements in assessing alternative suppliers were Talluri and Narasimhan (2003). Two linear programming model was developed in order to carry out a maximum minimum analysis for the performance of a supplier in relation to the foremost target measures which were set by the buyer. Furthermore this measurement of maximum and minimum efficiencies for each supplier also enabled a detailed interpretation of the supplier's performance.

The study conducted by Talluri (2003) used binary integer linear programming model was used to analyse various supplier bids on the basis of ideal goals for bid characteristics set by the buyer. Moreover the study enabled to determine an optimal set of bids by corresponding demand with capacity constraints; Effective negotiation strategies for unselected bids were suggested on the basis of the four variations of the model.

Moreover, non-linear mixed integer programming model was used by Ghodyspour and O'Brien (2003) in order to work out the multi-criteria sourcing problem. The optimal allocation of products to suppliers was identified by using the model which in turn resulted in minimizing the annual purchasing cost. This in turn highlights how the total annual purchasing cost could be minimized. It is important to note that three constraints were examined in the model.

Finally, Goal Performance Model was developed by Karpak et al. (2003) to critically assess and select the best suppliers. The three goals which were examined in the model consisted of cost, quality and delivery reliability. Optimum amount of products ordered were calculated by using the demand from the buyers and suppliers capacity constraint.

In order to evaluate casting suppliers, Akarte et al. (2003) formulized a web-based AHP system based on 18 criteria. For this methodology, casting specifications had to be provided by the registered suppliers. Furthermore, in order to carry out the assessment of suppliers, the buyers were assigned to rate the criteria in relation to the casting specifications and finally giving efficiency rating for each individual criterion by implementing a pairwise comparison.

After analysing the 10 articles from the period 2011-, it can be observed that, Chan (2011) used Analytic Hierarchy Process (AHP) with an interactive selection model to help decision makers to select the right suppliers. It is important to note that this methodology used a method called chain of interaction; this was deployed in order to find out the relative weight of the evaluating criteria, thus eliminating subjective human judgement. AHP was only used to find out the total score for different suppliers on the basis of relative importance ratings.

AHP was also used by Chan and Chan (2011) in order to assess and select the right suppliers. Their AHP hierarchy incorporated six evaluating criteria having 20 sub-factors. Here, the relative importance ratings were calculated in accordance to the customer requirements.

AHP was also used by Liu and Hai (2011), for assessing and selecting the most efficient suppliers. Like the Chan (2011) study, the scholars here did not use the pairwise comparison of AHP in order to find out the relative weightings among various criteria and the sub-factors. Liu and Hai (2011) incorporated Noguchi's voting and ranking method, this enabled all the managers to vote or participate in order to figure out the order of criteria rather than weights.

However, the AHP model devised by Chan et al. (2011) in order to find out the efficient suppliers, incorporated 14 different criteria to assess the potential suppliers. Expert choice was utilized in order to carry out a sensitivity analysis which assessed the reaction of alternatives, when the relative significance rating of each criterion was altered.

In order to assess supplier problem for a mass customization environment, Hou and Su (2011) formulized an AHP-based decision support system. Notably this study incorporated both internal and external factors, in order to be in line within the ever changing global environment.

For analysing the supplier selection for an auto parts manufacturing company, Ha and Krishnan (2011)

developed an integrated approach. The study suggested 12 evaluating criteria. For evaluation, firstly this approach utilized AHP in relation to five qualitative indicators. The scores that were calculated by AHP and the remaining seven criteria were given to DEA and artificial neural network (ANN) in order to further analyse efficiency of the suppliers. Both results were collated into a single efficiency index by applying an averaging method.

Kull and Talluri (2011) also used an integrated AHP–GP methodology in order to analyse and select efficient suppliers. This study was conducted by considering product life cycle and associated risk factors. AHP was utilized particularly to critically analyse suppliers in relation to risk criteria, and to suggest risk scores. Finally the GP model was used in order to assess the alternative suppliers on the basis of multiple hard constraints and risk goals.

In order to reduce a very significant number of potential suppliers to a more manageable unit, Mendoza et al. (2011) formulated an integrated AHP–GP methodology. The study ranked suppliers in accordance to the five evaluating criteria and the study also notified about the optimal order quantity.

Mendoza and Ventura (2011) suggested a two-stage methodology in order to identify efficient supplier and also to mitigate order quantity problems. Firstly, AHP was used to rank and reduce the number of suppliers to a manageable unit. This was assessed by analysing the five evaluating criteria. Secondly, the optimal order quantity was decided by using mixed integer non-linear programming methodology.

## Conclusion

There have been significant changes in supply chain management especially in supplier selection process over the period of time (2002 to 2011 and so on). After analysing the periods it can be observed that, the techniques, languages, assumptions changed dramatically. Lots of different techniques and approaches are coming and old techniques are criticised. It can be understood this field is a quickly changing field, and new developments are coming in every alternative researches. Although using this kind analysis system is very rare in the field of Supply Chain or Operation Management, this has been a new and interesting kind of experience of producing a report like this.

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