A Short Review of Multi Criteria Decision Making Approaches for Supplier Selection Problem

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INTRODUCTION

In the context of supply chain management, the supplier selection decision plays a key role. In today's globally competitive environment, firms give great attention for selecting right suppliers because it helps to reduce the purchasing costs and to improve the quality of final products and services.

Supplier Selection Problem (SSP) is a Multi Criteria Decision Making (MCDM) problem which includes both qualitative and quantitative factors like unit cost, delivery on-time, service quality etc. Multiple criteria of SSP may conflict with each other, so the selection process becomes complicated. SSP contains two major problems: (i) which supplier(s) should be chosen? and (ii) how much should be purchased from each selected supplier? In the last several years, SSP has gained great importance and is studied by both academic researchers and practitioners in business environment.

Generally, MCDM is handled under two main headings: Multi Attribute Decision Making (MADM) and Multi Objective Decision Making (MODM). Based on this, we classify the existing approaches for SSP in mainly four categories: MADM approaches, MODM approaches, Artificial Intelligence (AI) approaches and other approaches. Here, other approaches category contains for the most part the integrated MCDM techniques for SSP. In this study, we aim to provide fundamental information about SSP and its prevalent solution methods. The sources used for our study consist of scientific refereed journals and are selected with respect to their citation rate and the ability of presenting the contained technique well. Also the publications in languages other than English and non-refereed professional ones are not included.

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BACKGROUND

Supply chain management can be defined as the process of effective and efficient management of all events related to the flow and transformation of goods and services in a supply chain network. A typical supply chain network consists of several suppliers, manufacturing sites, distribution centers, retailers and customer zones, etc. The three major flows that occur in a supply chain are physical, information, and money (Lee, (2000)). Physical flow generally starts with the process of providing raw materials from several suppliers and finishes when the end customer is reached with a finished product. Information flow involves transmitting orders, manifest, invoice. Money flows covers all money transactions among all entities of a supply chain.

Basically, a supply chain aims to optimize its including decisions such as inventory levels, transportation, make or buy decision, facility location, supplier selection or as a whole whatever an organization does to plan, source, make and deliver its products. One of the significant decisions of supply chain management is the supplier selection process which can be defined as the core of purchasing function. Inherently, a supplier selection decision requires the ability to take multiple criteria and measures in order to arrive at a clear and straightforward prioritization or final selection (Ho, Xu, and Dey (2010)).

Based on De Boer, Labro and Morlacchi (2001), Wu and Barnes (2011) characterize the supplier selection process as comprising of four main stages, namely "formulation of criteria," "qualification," "final selection" and "application feedback" and present a detailed literature review. The *formulation of criteria* stage

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aims to determine what criteria to use in subsequent decision-making. For many years, the traditional approach to supplier selection has been to select suppliers solely on the basis of price. However, as companies have learned that the sole emphasis on price as a single criterion for supplier selection is not efficient, they have turned into a more comprehensive multi-criteria approach. Recently, these criteria have become increasingly complex as environmental, social, political, and customer satisfaction concerns have been added to the traditional criteria of quality, delivery, cost, and service, reliability, customer responsiveness, performance history (Mendoza, (2007)). Especially within the last decade, due to the governmental legislation and increased awareness among people of protecting environment, organizations cannot ignore environmental issues if they want to maintain their competitive advantage in this globalization trend (Kannan et al., (2013)). Thus green supply chain management becomes prominent and accordingly new green criteria such as pollution production, resource consumption, environmental management system and environmental certification and also some new constraints concerning the green issues should be taken into consideration. The *qualification* stage involves reducing the set of all possible suppliers to a smaller set of acceptable suppliers considering all the criteria. Sarkar and Mohapatra (2006) develop a systematic framework for carrying out the supplier reduction process assuming two important dimensions of suppliers - performance and capability. Commonly used decision techniques for this stage can be given as data envelopment analysis, cluster analysis, categorical methods and artificial intelligence. The *final selection* stage that involves the selecting process of the best supplier or suppliers under the specified criteria attracts great attention in the literature. The phases that precede and follow this stage have received far less attention. Although the final selection is often the most visible phase in the process, its quality largely depends on the quality of the other phases. Thus it is obvious that the phases besides the final selection also require attention (Wu and Barnes (2011)). With the aim of applying principles of continuous improvement and organizational learning, the *application feedback* stage is added to supplier selection process by Luo et al. (2009) and Wu and Barnes (2009). Besides these stages, it is also required to consider the purchasing case: first time buys, modified rebuys, or straight rebuys in a supplier selection process (De Boer et al., (2001)).

In the literature, there are mainly two kinds of SSP: single and multiple sourcing. In the first type, a supplier can fully provide the needs of an organization, whereas in the second type, a supplier is not enough to satisfy the needs by itself and the requirements can be satisfied partially by the suppliers (Kilic, (2013)). In addition to this categorization, when different types of products are provided in a SSP, then the problem is defined as multi-item. Early works in the literature are on to single-item/single sourcing SSP, the number of studies on to multi-item/multiple sourcing SSP is growing in recent years.

In this article, we only focus on the final selection stage of the process and classify the existing approaches for this stage. In the literature, most of the review papers about SSP categorized the solution methods relevant to this stage as individual and integrated. Instead of this, we detail the individual part according to the novel classification of MCDM area and consequently classify the existing approaches in mainly four categories: MADM approaches (*Analytical hierarchy process, Analytical Network Process, TOPSIS, ELECTRE, PROMETHEE, VIKOR*), MODM approaches (*Data Envelopment Analysis, Mathematical Programming*), Artifical Intelligence approaches and other approaches. Here, other approaches category contains for the most part the integrated approaches for SSP. The primary objective of our review is to provide fundamental information about SSP, its literature and also significant papers about its prevalent solution methods. As our second objective, we reemphasize a number of gaps in the literature.

APPROACHES

Multi-Attribute Decision Making Approaches

Analytical Hierarchical Process (AHP)

AHP which has the ability to combine both qualitative and quantitative factors in the decision-making process is a prominent technique for SSP. Correspondingly, there is a large literature on approaches based on AHP to deal with SSP. These papers usually differ in selection criteria and application area and can be classified into two main groups: AHP and Fuzzy AHP.

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