Support Tool for Supplier Evaluation and Selection

Subjects: Operations Research & Management Science

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The supplier selection process is considered one of the most relevant decisions in supply chain management due to its effect on the product quality and on buyer performance. Supplier selection is often unstructured, and is generally based on the lowest-price proposal. However, this type of selection involves a high risk, sometimes resulting in project delays, poor quality of acquired goods, and large financial losses. Price is undoubtedly an important criterion when choosing a supplier; however, other equally important criteria must be considered. Therefore, supplier selection should be formulated as a multi-criteria decision-making (MCDM) problem.

Keywords: supply chain management ; multiple criteria analysis ; PROMETHEE-GAIA ; decision making ; logistics

1. Introduction

The role of small and medium-sized enterprises (SMEs) in market revitalization, and therefore in economic development, is as important as that of big companies. Today, with globalization and technological progress, SMEs are under increasing pressure to use technology in more sophisticated ways to meet their customers' expectations, reduce costs, and remain innovative and competitive. The good performance of enterprises, in particular, that of SMEs, depends on several decisions; one of these decision is supplier selection. SME performance, and eventually competitive advantage, depend on these decision-making processes [1].

The literature shows many different approaches or techniques to solve the problem of supplier selection and evaluation; most of the approaches are based on multi-criteria decision making frameworks [2][3][4][5][6], using two methods [7] the so-called "American School" of multi-criteria decision support [8] and the "European School" [9]. In the area of the American School, for example, Analytic Hierarchy Process (AHP) [10][11] Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [12][13][14], Analytic Network Process (ANP) [15][16][17], VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) [18][19] or Decision-Making Trial and Evaluation Laboratory (DEMATEL) [20][21] methods demonstrated its effectiveness in supplier selection and evaluation problems. Moreover, the European School methods are extensively used in this subject and, for example, include methods such Elimination and Choice Expressing Reality (ELECTRE I) [22] [23], ELECTRE II [24][25], ELECTRE III [26][27], PROMETHEE II [28][29][30] or Complex Proportional Assessment (COPRAS) [31][32]. There are numerous works that have used a kind of mixed-mode and fuzzy expansions of MCDM methods related with this issue, presented in [33][34] which have recognized their value in the supplier evaluation and selection problem. However, despite the extensive studies on the development of MCDA methods, it is noteworthy that none of them is universal and despite the same input data, the results obtained by using different MCDC methods may be different [35][36].

The main purpose of applying decision-making methods is that both alternatives and criteria are fixed a priori and the decision occurs once. Of course, this basic assumption limits the accuracy of the results, especially when values change over time and the pair-wise decision matrix is not fixed as is the case with the supplier selection problem.

Further, several researchers have highlighted the relevance of supply chain management in the food industry [37][38]. However, decision-making and supplier selection in the food industry have been scarcely addressed, and more research is needed to obtain an in-depth understanding of the selection criteria preferred by companies and to facilitate management's success in supplier selection. Therefore, the present study focused on a medium-sized agrifood company, in order to analyze its supplier selection process, the criteria used, their strengths, weaknesses and thus classify them, through the establishment of a ranking and so select suppliers.

A PROMETHEE-GAIA (Preference Ranking Organization Method for Enrichment of Evaluations—Geometrical Analysis for Interactive Assistance) method was applied. This method allows for the hierarchical organization of the firm's main suppliers according to a set of criteria. Our results can be useful in assisting the firm to improve its supplier selection process, but also in helping similar firms to provide a reference for the more relevant criteria and show the applicability of multiple criteria methods in the supplier decision-making process.

2. The Supplier Selection Problem

Supplier selection can be defined as a decision-making process by which potential suppliers are reviewed, evaluated, and selected to participate in the company's supply chain [39][40][41]. The importance of supplier selection stems from both external and internal factors. Concerning the former, factors such as global markets and increasing competitive pressure have rendered supplier selection increasingly important. The increasing number of competitors has forced companies to focus on core competences, and to outsource less profitable activities to suppliers [42]. Consequently, suppliers have turned out to be key in obtaining products of a higher quality in the required amount and time, at a reduced cost, and with the features demanded by the customer [19][43][44]. In this scenario, supplier selection has emerged as a critical decision, and the buyer–supplier relationship has become a strategic asset that is based on close collaboration and sustainability [2][45]. Competition is nowadays between supply chains rather than between companies [39].

Regarding internal factors, supplier selection has been pointed out as one of the most relevant activities of the purchasing function [16][41]. Purchased materials and components represent 40–60% of production costs [46], and can be as high as 70% [41]. Thus, supplier selection has a direct impact on supply chain operational performance [40]. Indeed, supplier selection affects inventory management, as well as production planning and control [41]; it supports product quality improvement, consumer satisfaction, reduction of operational and material purchasing costs [43], and a flexible and rapid material purchasing process [47]. Furthermore, it has been stated that supplier selection decisions affect the overall performance of an organization, its cash flow, and its profitability; as such, it is a critical factor for every company's prosperity, and for maintaining a strategically competitive position [38][41][48]. Supplier selection has frequently been highlighted as a critical management decision [16] and a potential source of competitive advantage [49].

3. Supplier Selection Criteria

In spite of the existence of different models to represent the supplier selection process, there is a concordance between the stages identified. De Boer's model [4][50] contains four steps—problem definition, criteria formulation, qualification, and final choice—and has been a guide for a number of works [4][16][41][51]. Later, this model was complemented with more stages around three groups of decisions: previous analysis, supplier evaluation, and final decision (**Figure 1**).

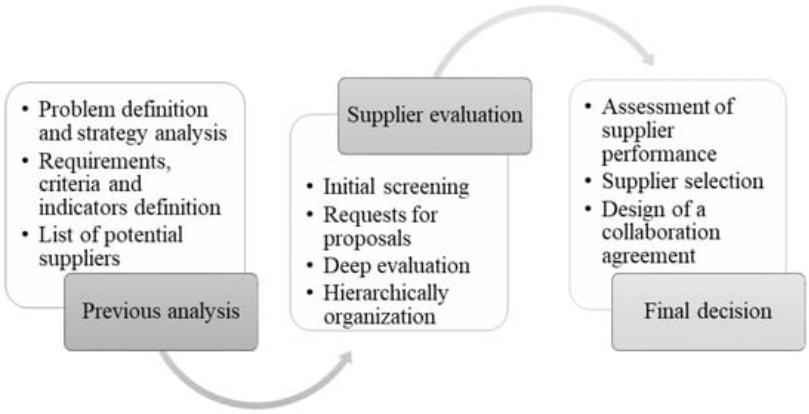

Figure 1. Supplier evaluation and selection process. Source: Adapted from Wetzstein et al. [12].

Previous analysis concerns the definition of requirements and strategy analysis, criteria selection and indicator development, and the compilation of a list of potential suppliers [51][52]. Supplier evaluation is an initial screening. At this point, the firm considers only the main criteria and reduces the number of potential suppliers to approximately eight. Then, the firm sends requests for proposals to those suppliers to obtain more information about them. This information allows the firm to use more criteria and to organize the candidates hierarchically [51]. The kind and number of criteria depend on the stage of the supplier selection process. Firstly, an initial set of suppliers is evaluated through a limited number of main criteria; then, the number of suppliers is narrowed down and the analysis intensifies with the use of more criteria. Finally, after negotiations with the potential suppliers [51] and assessment of their performance [52], one supplier is selected. Then, a collaboration agreement is designed, as well as a procedure to analyze procurement and sourcing [16].

The main stage in a supplier selection process is the definition of the evaluation criteria for the potential suppliers. A large number of papers address this topic, in which numerous criteria are collected (**Table 1**). This decision is even harder in the current context due to global competition and increasing customer expectations, which make supplier selection a multicriteria problem [43] with both quantitative and qualitative elements [53]. The criteria highlighted most often are quality, cost, and delivery [4][16][48][53][54]; in some cases, delivery refers to delivery, flexibility, and service level [42]. In addition to

these factors, analysis of suppliers' facilities and capacity could also be considered. Therefore, factors such as cultural similarity, geographical location, historic performance, financial status, innovation capability, political situation, and risk are mentioned as secondary elements [4][48][53].

Table 1. Main criteria, description and authors.

Criteria	Description	Authors
ECONOMIC		
Quality	**The capability to offer products that conform to specifications, meet customer requirements and government regulations. It relates to the use of quality systems and continuous improvement programs, material and process control, maintenance and calibration, planning, and staff training.**	[3][19][40][41] [42][48][50][51] [52][55][56]
Delivery	**Refers to the duration of time from placing to receiving an order (lead time), on-time delivery (as per time scheduled), and delivery reliability. In addition, the delivery conditions are also important, that is, product presentation, cleanliness and packaging, and provision of the standard documentation required throughout the process.**	[3][16][19][41] [44][48][50][51] [52][55][56][57]
Cost	**Includes the costs of transportation, inventory, material, maintenance, labour, and other elements related to product manufacturing. Thus, this attribute considers the total estimated cost for each alternative.Can be represented by productivity. Higher productivity indicate a greater supply, cost, and production control ability, better operating management efficiency, and better customer acceptance.**	[3][16][40][41] [42][44][48][50] [51][52][55][56] [57]
Relationship	**Concerns to the ability of the buyer and the supplier to complement each other's capabilities in order to maintain a long-term partnership with few reliable suppliers. The ability to maintain a good communication channel and a long-term relationship buyer-supplier is essential and they can even present a differential advantage when selecting a supplier.**	[19][40][41][42] [51][56]
Facilities and capacity	**Evaluates the capacity of the firm to provide specific solutions to achieve the technical requirements and the company's desired specification. To this end, a proper infrastructure and resources, an undated assets maintenance (vehicles and equipment), and suitable work stations and physical location are required.**	[3][40][44][50] [51][56][57]
Service	**Indicates the after-sales service level provided by the seller. It can include the supplier's service level in terms of lead time, flexibility, and customer service.**	[3][42][44][48] [51][56]
Flexibility	**Indicates the ability to adjust product volume, product mix, product characteristics, or manufacturing processes as demanded by the buyer, using existing machines or equipment.**	[19][41]
Culture	**Relates to the generation of trust, both within the organization and among members in the supply chain, and to the management attitude towards the supplier, which allows him/her to successfully face unexpected future events.**	[19][41]
Geographical location	**It indicates how far the supplier is located from the company.**	[42][44][48][50]
Performance history	**Previous experiences in providing the service can influence future firm performance.**	[40][48][57]
Financial status	**The supplier's financial situation and stability and payment conditions are important factors to consider in this category.**	[40][42][51][58]
Innovation	**The capability of develop R&D activities in order to improve differentiation while reducing costs. Usually, a higher R&D expense on sales denotes stronger technology ability [56].**	[42][51]
ENVIRONMENTAL	**The presence of environmental controls and programs that ensure environment-friendly product characteristics. Hamdan and Cheaitou [43] classify these factors into two groups: product-related and organization-related. The first group relates to the use of environment-friendly resources and materials, as well as advanced technologies for recycling materials, to produce environment-friendly items. The second group relates to awareness about the environmental issues pertaining to the operations, structure, and culture of the organization. It refers to the existence of policies that enable the vendor to follow environmental norms.**	[19][41][43][44] [51]
SOCIAL (safety)	**The supplier's concern about accidents, and the provision of a safe and healthy working environment. Security is one of the most important criteria, because accidents have a significant social, environmental, and financial impact.**	[19][40][41][51]

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