



An integrated approach for supplier portfolio selection: Lean or agile?



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ABSTRACT

Supply chain environment is more dynamic and unpredictable than the past; therefore, it needs to be highly flexible in order to reconfigure in response to changes in their environment on the spur of the moment. This study presents a framework for supplier selection based on product-related and organization-related characteristics of the suppliers to be more competitive in the market and flexible to overcome probable changes in demands, supplies etc. Product-related and organization-related characteristics are those which are named in this study as lean and agile criteria respectively. Comprehensively digging up the literature, we extract the best criteria representing both leanness and agility of an organization. The aim of this paper is to select an appropriate supplier portfolio based on two aforementioned concepts. Supplier selection problem is solved using a combination of multi-criteria decision making (MCDM) methods. Due to the interaction between the criteria, analytical network process (ANP) is applied for determining the weight of each criterion for each alternative (supplier), and then data envelopment analysis (DEA) is used to rank them. The reason that DEA is used in this study is that when the number of suppliers increases, ANP approach tends to work inefficiently. Moreover, for determining the accurate interdependencies between the proposed criteria, fuzzy decision making trial and evaluation laboratory (DEMATEL) is applied. The framework is applied on a real case to demonstrate its applicability and feasibility.

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1. Introduction

Nowadays, the supply chain environment is more dynamic and unpredictable than the past. Nature of the supply chain is characterized by parameters such as product demand, product variety, product life-cycle, and other factors (Agarwal, Shankar, & Tiwari, 2006). Because these factors are fluctuating ceaselessly and are not constant, firms must intelligently delineate their strategy in supply chain to overcome this volatile environment. In addition, firms must note that their chosen strategy can influence their competitiveness in the market. Thus, firms must have an exhaustive perspective on competitiveness ingredients to promote and sustain their situation in the market. This purpose can be obtained by increasing their efficiency and by responding quickly to the needs of the market. Many enterprises have pursued the “lean” thinking paradigm to improve the efficiency of their business processes (Mason-Jones, Naylor, & Towill, 2000). Moreover, becoming more responsive to the needs of the market is not just about the speed, it also requires a high level of maneuverability that today has come

to be termed “agility” (Christopher, 2000). A part of a firm that possesses a great portion of key activities is purchasing department. De Boer et al. (2001) declare that by increasing the significance of purchasing functions, purchasing decisions have become more important. One of important issues in purchasing department is supplier selection. Supplier selection is undeniably regarded as the cornerstone of successful purchasing and supply management to maintain and enhance the competitive edge (Wang, 2010). That is because good supplier selection makes a significant difference to an organization's future that can reduce operational costs and improve the quality of its products and make rapid responses to the customers' demand. One of the most important components of the supplier evaluation and selection is criteria formulation. Wang, Huang, and Dismukes (2004) state that in lean supplier selection, supplier attributes involve low cost and high quality, and in agile supplier selection, supplier attributes involve speed, flexibility, and quality. Most of the previous researches have focused on lean performance of suppliers and only a few of them have focused on the agile performance of suppliers. However, no one have considered suppliers with these characteristics simultaneously, and the advantage of considering these two groups of suppliers concurrently is to achieve low cost and high quality, along with the capability of performing swiftly and flexibly when

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required (Wang et al., 2004). After the final selection phase firms must have a different behavior for relationship management with these two types of suppliers.

In this paper a theoretical framework for supplier selection based on the two groups of “lean” and “agile” suppliers is presented and a guideline for supplier relationship management (SRM) for these suppliers has been proposed. To determine the precise interdependencies between the suggested criteria, fuzzy decision making trial and evaluation laboratory (DEMATEL) is applied on the problem. Moreover, ANP application finds the weight of each sub-criterion and finally DEA approach is utilized to rank the suppliers regards to their score in each criterion. The reason that ANP has not been used for the ranking is that, when it comes to larger problems with so many alternatives, ANP tend to be inefficient in ranking the alternatives, but such a problem has not been reported in using DEA.

The remainder of this paper is organized as follows: A review on the literature on various criteria and methods used for supplier selection is presented in the next section. In Section 3 the proposed methodology is presented and the criteria formulation is discussed. In Section 4 a numerical example is presented to demonstrate the applicability of the model. Section 5 concludes the paper with a discussion of the implications of this study, future research directions, and concluding remarks.

2. Literature review

In the supplier selection arena, there are numerous researches that use different methodologies to solve the problem. One of the most recent studies that has provided a reviewed the literature on application of decision-making techniques in supplier selection is the work of Chai, Liu, and Ngai (2013). In this paper the literature review has been investigated from two perspectives: (1) various criteria used for supplier selection and (2) various methods used for supplier selection.

2.1. Various criteria used for supplier selection

The number of factors that one could consider for supplier selection is not only large but also depends on the context (for example strategic or transaction-oriented, etc.), type of the product, nature of the markets, and so on. Since 1960s, supplier selection criteria and supplier's performance have been a focal point of many researchers. The researches implemented for formulating supplier selection's criteria are listed in Table 1.

2.2. Various methods used for supplier selection

The receptivity of decision makers to the use of formal decision tools in terms of formulation of decision criteria, the qualification

of suitable candidate-suppliers and recognition of the need for a new supplier are topics that have been argued widely in the literature (De Boer & Van der Wegen, 2003). As inferred from Table 2 many different methods are used for supplier selection problems.

Few works have considered both agile and lean criteria in an integrated way to model supplier selection problem. Besides, based on the proposed framework, we can use different concepts to maintain the competitiveness in the market such as different suppliers that are presented with different levels of leanness and agility. Examples of recent studies that have used ANP or DEMATEL for supplier selection problem are Yang and Tzeng (2011), and Büyükoçkan and Çifçi (2012), but they have not considered the inefficiency of ANP method in selecting between numerous alternatives. However, we proposed a solution to this issue by combining DEA and ANP methods.

Our study contributes to supplier selection knowledge area in three ways. First, this is the first study in which a framework for agile criteria is presented based on Johnsen and Ford (2006). Secondly, the selection of suppliers is performed in a way that their leanness and agility can be calculated separately. This leads to better understanding of suppliers capabilities and provides better managerial insights towards the problem. In fact, a Pareto solution will be provided that non-dominated suppliers can be considered as the ideal suppliers. Thirdly, the proposed methodology in this paper is the first that integrate ANP, DEMATEL and DEA in a supplier selection context.

3. Proposed methodology

The proposed supplier selection framework is illustrated in Fig. 1. Each section will be explained in details in the following subsections. It should be noticed that i stands for each indicators index. So, $i = 0$ stands for lean criteria, while $i = 1$ serves as agile one. The advantages of the proposed method over existing ones are that first when there are numerous alternatives, ANP fails to rank them efficiently and correctly. However DEA has shown good ranking capability over other methods, therefore we combined these two methods to solve the above stated problem. It also should be noticed that DEA is unable to consider hierarchical form of criteria formation; thus, ANP approach is still needed. Secondly, to identify the network configuration of ANP in a scientific way DEAMTEL is applied to the problem.

3.1. Formulation of criteria

Businesses wanting to estimate suppliers' performance should first observe suppliers according to evaluation criteria (Chang, Chang, & Wu, 2011). In the past, price was the key factor to choose a supplier because cost reduction is the main consideration for a decision maker. However, in today's competitive global business

Table 1
Various criteria used for supplier selection.

Research articles	Contributions
Dickson (1966)	Identified 23 important evaluation criteria based on a survey of 273 purchasing manager from United States and Canada
Weber et al. (1991)	Reviewed and classified 74 articles addressed the supplier selection problem
Ghodsypour and O'Brien (2001)	Stated that cost, quality, and service have considerable effects on supplier selection parameters
Kahraman, Cebeci, and Ulukan (2003)	Mentioned that selection criteria typically fall into one of four categories: supplier criteria, product performance criteria, service performance criteria, and cost criteria
Wu and Barnes (2010)	Advanced Dempster-Shafer and optimization theories for formulating criteria to use in partner selection decision-making in agile supply chains
Chang et al. (2011)	Used fuzzy DEMATEL method for selecting the most effective and efficient criteria. Their research result that the stable delivery of goods has the most influence and the strongest connection to other criteria
Setak, Sharifi, and Alimohammadian (2012)	Reviewed supplier selection and order allocation models based on an extensive search in the literature and stated that price, quality, and delivery is the most common criteria used for supplier selection

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