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Supplier selection in the airline retail industry using a funnel methodology: Conjunctive screening method and fuzzy AHP

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ABSTRACT

Since a company can only perform as well as it is allowed to by its suppliers, the importance of supplier selection in supply chain management has been increasingly recognized. Supplier selection can best be described as a highly complex process, due to the involvement of many, sometimes conflicting, qualitative and quantitative criteria. The objective is to select the most suitable supplier(s) that meet a company's specific needs. This paper investigates supplier selection in the airline retail industry. We discuss a number of issues that make airline retail complex and distinguish it from conventional retail. The supplier selection problem is solved by means of a two-phased methodology. In the first phase, a conjunctive screening method is used, which aims to reduce the initial set of potential suppliers prior to the comprehensive final choice phase. In the second phase, a fuzzy analytic hierarchy process (AHP) is used, in which suppliers are evaluated against the main criteria and sub-criteria. By combining the decision-maker's preferences, using the developed methodology will eventually result in a ranking of suppliers that makes it possible to select the most suitable supplier(s). The proposed methodology is applied to one of the largest airlines in Europe, the Royal Dutch Airlines (KLM), and the results are discussed extensively in this paper. We conclude by proposing avenues for future research regarding the general applicability and further extensions.

1. Introduction

Rather than competing as individual entities, firms nowadays try to align their strategies, activities and operations along their supply chains to realize a competitive advantage. A supply chain is a network of entities that sequentially extracts raw materials, transforms those raw materials into intermediate and finished goods, and distributes the finished goods to consumers. Nowadays, supply chain management stresses the importance of buyer–supplier relationships, as a result of which, purchasing has become a strategic function (Ferreira & Borenstein, 2012). In addition, since purchasing represents a 50–60% of a firm's total turnover (Bowersox, Closs, & Cooper, 2002), it is considered one of the primary determinants of a firm's profitability (De Boer, Labro, & Morlacchi, 2001). The importance of supplier selection can be attributed to its direct contribution to a firm's ability to optimize the quality, quantity, reliability and price of purchased goods and services (Sarkis, Talluri, & Gunasekaran, 2007). In addition, by means of appropriate supplier selection, firms attempt to cope with increasingly changing business environments (Luo, Wu, Rosenberg, & Barnes, 2009), while effectively manage supply and financial risks at the same time. The general consensus in literature is that supplier selection is an extremely important and complex task within the purchasing function (e.g. De Boer et al., 2001; Dickson, 1966; Kilincci & Onal, 2011; Luo et al., 2009; Sarkar & Mohapatra, 2006; Weber, Current, & Benton, 1991; Wu & Barnes, 2011).

Since selecting the most suitable supplier(s) from a large number of potential suppliers is often perceived as a time-consuming and daunting task (Luo et al., 2009; Sarkis & Talluri, 2002), conceptual supplier selection models advocate some type of screening method prior to a more complex and comprehensive comparison (e.g. De Boer et al., 2001; Luo et al., 2009). However, a vast majority of the supplier selection applications in literature focus solely on the complex and comprehensive comparison. We propose a two-stage decision-making process designed to solve the supplier selection problem in airline retail. These two subsequent stages are defined as the qualification phase and the final choice phase, respectively. The aim of the qualification phase endeavors is, firstly, to reduce the initial set of potential suppliers to a set of

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"qualified" suppliers prior to the final choice phase, and secondly, to cope effectively with possible adverse effects due to the compensatory nature of the method applied in the final choice phase. To achieve both objectives, we propose the non-compensatory conjunctive screening method for the first phase (Gilbride & Allenby, 2004). For the final choice phase, we propose the improved fuzzy analytic hierarchy process (AHP), using fuzzy preference programming (FPP) (Rezaei, Ortt, & Scholten, 2013).

Supplier selection involves evaluating and selecting the most suitable supplier(s) by comparing multiple supplier alternatives against a set of qualitative and quantitative criteria. As such, supplier selection can be characterized as a multi-criteria decision-making problem. A frequently used method to solve the multi-criteria decision-making problem of supplier selection is the AHP (e.g. Chan, Chan, Ip, & Lau, 2007; Ishizaka, Pearman, & Nemery, 2012; Mafakheri, Breton, & Ghoniem, 2011; Ordoobadi, 2010). AHP makes it possible to systematically structure and model a multi-criteria decision-making problem (Saaty, 1977, 1980). A major advantage of AHP is its ability to handle both qualitative and quantitative criteria. A considerable drawback of AHP is the need for exact numerical values (crisp numbers) for the pair-wise comparison judgments, while decision-makers (DM) are often reluctant or unable to express judgments in crisp numbers in real-world situations, due to the complexity and uncertainty involved (Kilincci & Onal, 2011). The proposed fuzzy AHP, uses triangular fuzzy numbers (TFNs) as a pair-wise comparison scale for taking human vagueness and uncertainty into account in decision-making, which substantially diminishes the drawback of conventional AHP.

The main aim of this paper is to design a supplier selection methodology for the airline retail industry using an innovative methodology. The main contributions are the following:

Firstly, since a vast majority of the existing supplier selection studies focuses on supplier selection from a manufacturing perspective (e.g. Chen, Lin, & Huang, 2006; Choy, Lee, & Lo, 2003; Huang & Keskar, 2007; Kahraman, Cebeci, & Ulukan, 2003; Kahraman & Kaya, 2010; Sarkis & Talluri, 2002), this study adds knowledge by providing insights into supplier selection from a retailer's perspective. Secondly, existing studies on supplier selection look at various industries (e.g. automobile, pharmaceutical, telecommunications, electronic). However, there has only been one other scientific article (Chan et al., 2007) that applied supplier selection in the airline industry. Hence, this study will contribute to this area by gaining insights from the application of a scientifically sound supplier selection methodology to the airline industry. Thirdly, although there is extensive literature available on airport retail (e.g. Chung, Wu, & Chiang, 2013; Graham, 2009; Lu, 2014; Perng, Chow, & Liao, 2010), there is very little information regarding airline retail (Schoinas and O'Connell, 2011). Because of, at least, market features, we expect that inflight retail will need to adopt different practices compared to airport retail. Fourthly, although an AHP approach has been applied frequently to solve supplier selection problems (e.g. Bottani & Rizzi, 2008; Kahraman & Kaya, 2010; Kahraman et al., 2003), AHP requires exact numerical values (crisp numbers) for the pairwise comparisons, while decision makers (DMs) are often reluctant or unable to express judgments in crisp numbers in real-world situations, due to the complexity and uncertainty involved. By applying the improved fuzzy AHP as developed by Rezaei et al. (2013), we contribute by a new approach to supplier selection. Fifthly, although conceptual supplier selection models propose the application of multiple phases in supplier selection (e.g. De Boer et al., 2001; Luo et al.; 2009; Monczka, Handfield, Giunipero, Patterson, & Waters, 2011), a vast majority of the supplier selection applications in existing literature focuses only on the more complex and comprehensive comparison of the final choice. In this study we propose a novel two-phased methodology and apply it to a real-world case.

The remainder of this paper is structured as follows. Section 2 provides a literature review with regard to supplier selection methods and criteria, and the airline retail industry. Section 3 explains the proposed two-phased supplier selection methodology in detail. Section 4 provides insight into the actual application of the developed methodology to the airline company. Section 5 discusses the obtained results. Section 6 describes a number of tests that have been used to validate the methodology. The paper ends with concluding remarks and avenues for future research in Section 7.

2. Literature review

As mentioned earlier, supplier selection is considered an extremely important task in purchasing and supply chain management. Luo et al. (2009) identify three recent trends, which further emphasize the importance of the supplier selection. Firstly, due to the increased desire for outsourcing, firms spend a larger share of their revenues on externally sourced goods and services, which directly increases the impact of the supplier's performance on buyers (Weber & Ellram, 1992). Secondly, since supply chain management nowadays advocates long-term partnerships with fewer but reliable suppliers (Ho, Xu, & Dey, 2010), a buyer's dependence on its supplier's performance has increased (Power, Sohal, & Rahman, 2001). Thirdly, the fact that, nowadays, buyers and suppliers look for a closer relationship, increases the role and contribution of suppliers in the performance of the purchaser.

Furthermore, the supplier selection process is a process that is highly complex, for two main reasons. Firstly, as Weber et al. (1991) have emphasized, the supplier selection process is highly complex due to the involvement of multiple and often conflicting criteria of a qualitative as well as a quantitative nature. To realize a satisfactory supplier selection, potential suppliers have to be assessed against these criteria, and as these criteria may be conflicting (e.g. cost vs. quality), trade-offs are typically required (Chen et al., 2006). Secondly, the increased sourcing and purchasing opportunities provided by the intensified globalization of world trade, facilitated by enhanced communication methods, has also increased the complexity of the supplier selection process (Kahraman & Kaya, 2010; Luo et al., 2009).

2.1. Supplier selection methods

Although existing literature on supplier selection is dominated by one-phase methods, meaning that most studies simply ignore the qualification phase, conceptual supplier selection methods frequently define multiple subsequent phases (e.g. De Boer et al., 2001; Luo et al., 2009; Monczka et al., 2011). A general principle of these multiple-phase approaches is that the initial set of potential suppliers is screened, after which the "qualified suppliers" are subjected to further scrutiny. In this paper, these two subsequent phases are defined as the "qualification phase" and "final choice phase", respectively. Due to the importance of these two phases for the supplier selection methodology in this research, appropriate methods for both phases are briefly discussed here.

2.1.1. Qualification methods

The first two methods that are suitable for the qualification phase are the categorical method and cluster analysis. They seem like similar approaches, where suppliers are grouped into categories with the aim of maximizing the differences between suppliers in different groups, while at the same time minimizing the differences between suppliers in the same group, according to a distinct set of criteria. However, the difference between the two methods is that the categorical method is qualitative in nature (e.g. positive,