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Supplier selection with Shannon entropy and fuzzy TOPSIS in the context of supply chain risk management

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Abstract

Supplier selection is the process of finding the right suppliers, at the right price, at the right time, in the right quantities, and with the right quality. The aim of this paper, is supplier selection in the context of supply chain risk management. Thus nine criteria of quality, on time delivery and performance history and six risks in the supply chain including supply risk, demand risk, manufacturing risk, logistics risk, information risk and environmental risk considered for evaluating suppliers. Shannon entropy is used for weighing criteria and fuzzy TOPSIS is applied for ranking suppliers. Findings show that, in the spare parts supplier selection problem, demand risk is the most important factor.

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1. Introduction

Supply chain management is described as the management of a network of interconnected organizations involved with the preparation of product and service packages needed by the end customers in a supply chain (Harland 1996). Supply chain management covers all the movement and storage of raw materials, work-in-process inventory, and finished goods from the point of origin to the point of consumption (Heidarzade et al., 2015). Supply chain management is a holistic and strategic approach to demand, operations, procurement, and logistics process

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management. Ogulin (2003) suggests three distinctive waves of supply chain management in the new economy: operational excellence, supply chain integration and collaboration, and virtual supply chains. Enterprises along the supply chain need to develop organizational, procedural, technical, and strategic capabilities and capacities to respond to four emerging requirements: customer focus, technology adoption, relationships management, and leadership styles (Chow et al., 2008). Business leaders, academics, and policy makers recognize that the management of supply chains is crucial in the highly competitive global business environment, and it has become clear that well managed supply chains provide operational and strategic advantages to organizations, regions, and countries (Silvestre, 2015). In today's competitive environment, companies are required to optimize business processes and promote the performance of their entire supply chains. Successful operation of a supply chain relies on every single business involved, and an efficient and flexible supply chain allows the firm to choose the right suppliers at the right time for the right materials, not only substantially reducing purchasing cost, but also significantly improving corporate competitiveness (Xia and Wu, 2007). Many factors such as international competitors, demanding customers and rapid technological change profoundly impact the markets. Therefore, successful competition in this environment requires to reduce operational costs and enlarge profit margins. For most industrial firms, the purchasing of raw material and component parts from suppliers constitutes a major expense. Hence, among the various strategic activities involved in the supply chain management, the purchase decision has profound impacts on the overall system (Guo and Li, 2014). Additionally some companies have started to strategically improve their supplier's capabilities. However with a large number of suppliers and limited resources in supplier development, not every supplier in the supply base can be improved. Thus, for a strategic supplier development program, supplier selection decision is very important.

In the context of supply chain management, supplier selection decision is considered as one of the key issues faced by operations and purchasing managers to remain competitive (Bai & Sarkis, 2010). Selecting the right suppliers can influence the overall purchasing cost (the cost of raw materials and component parts), which is responsible for a large percentage of the final product cost (Pazhani et al., 2015). Supplier selection decisions are complicated by the fact that various criteria must be considered in decision making process (Karsak & Dursun, 2015). Dickson (1966) noted that quality, on-time delivery, and performance history are most significant criteria in supplier selection. Selecting the right supplier will result in reducing operational costs, increasing profitability and quality of products, improving competitiveness in the market and responding to customers' demands rapidly (Abdollahi et al., 2015). Moreover, customer satisfaction is also enhanced by determining the best supplier.

Managing risks is a daily issue to supply chain and logistics management. The ability to respond to and mitigate these risk events enables the company to be ahead of its competitors and diminishes the expected long-term damage to its business. The critical drivers for supply chain profitability are responsiveness, efficiency, and reliability (Hendricks and Singhal, 2005). The occurrence of risk events in different stages of the supply chain can put negative influences on supply chain performance. The management of risk events is termed as supply chain risk management (SCRM), which has become a key part of the business strategy. SCRM has got more attention with the movement to global supply chains and the increasing occurrence of internal and external risk events that cause disruptions of supply chain operations (Aqlan & Lam, 2015). In order to select the right supplier, various criteria should be distinguished and evaluated with respect to different suppliers' attributes. Therefore, this problem can be considered as a multiple criteria decision making (MCDM) problem (Yu et al., 2013). When supply chain is faced with risk events, selecting the right suppliers becomes more essential than ever for the business. Several factors such as unquantifiable information, incomplete information, unobtainable information and partial ignorance cause the imprecision in decision making. Since conventional MADM methods cannot effectively handle problems with such imprecise information, therefore fuzzy multiple attribute decision-making methods have been developed owing to the imprecision in assessing the relative importance of attributes and the performance ratings of alternatives with respect to attributes (Kiani Mavi and Kiani Mavi, 2014). One of prevalent MADM methods for weighing criteria is Shannon entropy and for ranking alternatives technique for order preferences by similarity to ideal solution (TOPSIS). Hence, the aim of

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