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Applying fuzzy linguistic quantifier to select supply chain partners at different phases of product life cycle

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Abstract

Owing to rapidly growing global competition, enterprises are increasingly focusing on their core competencies. The focal company faces the challenge of creating alliances with more suppliers to create outsourcing synergy and provide heterogeneous products for customers. This study proposes a fuzzy multiple attribute decision making (FMADM) method based on the fuzzy linguistic quantifier. An attempt is made to ensure that the evaluation results satisfy the current product competition strategies, and also improve the effectiveness and efficiency of the entire supply chain. The fuzzy concept is applied to both the ordinal and cardinal information. Furthermore, the fuzzy linguistic quantifier guided order-weighted aggregation (FLQG-OWA) operator can be used to satisfy the enterprise product development strategy based on different phases of product life cycle.

Keywords: Supply chain management; Fuzzy multiple attribute decision making; Fuzzy linguistic quantifier; Ordered weighted aggregation operator; Product life cycle

1. Introduction

Recently, owing to rapidly intensifying global competition, local market and new technologies, enterprises have been focusing increasingly on their own core competencies and outsourcing the remaining functions to third parties (Perona and Saccani, 2004). Accordingly, a supply chain is formed by increasing supplier numbers and frequently replacing existing suppliers with new ones. To succeed in supply performance assessment relies on executing the supply chain system based on the workable mechanism of supplier management. The new paradigm requires that the producer be able to mass customize products based on customer demand. Thus speed, flexibility, quality and cost

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are becoming increasingly important in the fast changing competitive environment (Olhager and Selldin, 2004). An effective supplier assessment and selection process is essential for improving the performance of a focal company and its supply chains (Perona and Miragliotta, 2004).

However, the weights not only represented the importance of attributes or criteria that decisively influenced the evaluation result, but also correlated with product life cycle and even more with enterprise product development strategy (Aitken et al., 2003). Additionally, cycle time also influenced supplier selection and even performance representation, and the future development of long-term relationships and commitments (Sharland et al., 2003). In a rapidly changing market, enterprises should carefully manage their product life cycle. The competitive criteria generally differ during different phases of product life cycle; for instance, availability and technology are needed at the "introduction" phase, and cost, quality and speed are needed at the "maturity" phase. The supplier evaluation mechanism thus should also be matched up concurrently.

This investigation aims to develop a supplier selection procedure by considering different fuzzy linguistic environments and different product life cycle phases. Section 2 illustrates the criteria for supply performance and supplier management, and then outlines the intention and motive of fuzziness. Sections 3 and 4 describe the procedure involved in this approach. Moreover, Section 5 presents the algorithm for this approach. Section 6 then presents a numerical example detailing how to apply this approach. Subsequently, Section 7 presents a sensitivity analysis study by considering the effect of various supply chain strategies. Finally, Sections 8 and 9 present discussions and conclusions obtained using this approach.

2. Criteria versus fuzziness

This section demonstrates the criteria for supply performance and supplier management from published literatures, and then outlines the intention and motive of fuzziness associated with this topic.

2.1. Criteria for supply performance and supplier management

Choi and Hartley (1996) evaluated suppliers based on consistency, reliability, relationship, flexibility, price, service, technological capability and finances, and also addressed 26 supplier-selection criteria. Furthermore, Verma and Pullman (1998) ranked the importance of the supplier attributes of quality, on-time delivery, cost, lead-time and flexibility. Additionally, Vonderembse and Tracey (1999) described that supplier and manufacturing performance were determined by supplier selection criteria and supplier involvement. Vonderembse and Tracey described that the supplier selection criteria could be evaluated by quality, availability, reliability and performance, while supplier involvement could be evaluated by product R&D and improvement, and supplier performance could be evaluated by stoppage, delivery, damage and quality. Furthermore, manufacturing performance could be evaluated by cost, quality, inventory and delivery.

Krause et al. (2001) devised a purchasing strategy based on competitiveness in cost, quality, delivery, flexibility and innovation. Tracey and Tan (2001) developed supplier selection criteria, including quality, delivery, reliability, performance and price, and assessed customer satisfaction based on price, quality, variety and delivery. Moreover, Kannan and Tan (2002) determined supplier selection based on commitment, needs, capability, fit and honesty, and developed a system for supplier evaluation based on delivery, quality, responsiveness and information sharing. Kannan and Tan also evaluated supplier selection and performance based on the weights of evaluation attributes or criteria with crisp values that depend on subjective individual judgments.

Muralidharan et al. (2002) compared the advantages and limitations of nine previously developed methods of supplier rating, and combined multiple criteria decision making and analytic hierarchy processes to construct multi-criteria group decision making model. The attributes of quality, delivery, price, technique capability, finances, attitude, facility, flexibility and service were used for supplier evaluation, and the