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Applying a direct multi-granularity linguistic and strategy-oriented aggregation approach on the assessment of supply performance

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Abstract

Supply performance has the active continuity behaviors, which covers the past, present and future of time horizons. Thus, supply performance possesses distinct uncertainty on individual behavior, which is inadequate to assess with quantification. This study utilizes the linguistic variable instead of numerical variable to offset the inaccuracy on quantification, and employs the fitting linguistic scale in accordance with the characteristic of supply behavior to enhance the applicability. Furthermore, the uniformity is introduced to transform the linguistic information uniformly from different scales. Finally, the linguistic ordered weighted averaging operator with maximal entropy applies in direct to aggregate the combination of linguistic information and product strategy to ensure the assessment results meeting the enterprise requirements, and then to emulate mental decision making in humans by the linguistic manner.

Keywords: Supply chain management; Linguistic variable; Fuzzy linguistic quantifier; Linguistic ordered weighted averaging operator; Product life cycle

1. Introduction

The growing speed of product proliferation and shortening product life cycle signal the inevitable challenge of producing customized products with minimum inventory. The evolution of business model defines how a business performs its production cycle to satisfy customer demand according to the position of the decoupling point. Outsourcing and integration become evidently important for the control of the success of supply chain. Thus, an effective and efficient approach in supply performance assessment is critical to increasing reforming operations of supply chains.

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To succeed in the market-oriented and global competitive environment, enterprises need to frame the corresponding strategy rapidly with the product orientation (Aitken et al., 2003) and market reaction (Lee, 2003). Furthermore to extend the strategy concurs for the supply chain system and criteria on supply performance assessment (Carbonara et al., 2002). Due to supply performance assessment concerns the extensive extent and layers which cannot be assessed by only a few attributes and behaviors. Moreover, owing to the difference between the characteristic of supply behaviors, the assessment should not continue with the same scale that makes the aggregation obsessive.

Clearly, supply performance is a dynamic continuity behavior which comprises of the past, present and future. Although some behaviors (e.g. unit price and defect) can be assessed by specific definition at some particular duration, some behaviors (e.g. quality philosophy and R&D ability) cannot be assessed quantitatively especially for the whole period so that they may have to be assessed by human linguistics. However, human linguistics is embedded in the sense of fuzziness and comparability (Zadeh, 1983). For group decisions especially, decision makers often make the assessment results unlikely on the same behavior due to self-background such as knowledge, skill, attitude and experience (Muralidharan et al., 2002). Different cognitive linguistic scales may also be used. Thus, supply performance assessment has to properly deal with the uniformity of multi-granularity linguistic information (Herrera et al., 2000).

Therefore, supply performance involves not only future uncertainty but also past and present inaccuracy. Formerly, crisp values were used to represent supply behavior, however, the overall supply performance was difficult to represent objectively. Moreover, the weighted operation, which endues with weights by subjectivity, represents not only the importance of the assessed behavior, but also relate to the aggregation result. To assign the weight with a crisp value is more difficult than the direct linguistic assessment, because the important degree possesses the fuzzy property in human linguistics. Hence, this study uses a fuzzy linguistic quantifier (Herrera et al., 1995) to represent the fuzzy majority concept (Kacprzyk, 1986) of importance under different strategies.

The next section illustrates the attributes for assessment of supply performance. Section 3 outlines the research method and purpose of this study. Sections 4–7 present the procedure involved in this approach. Section 8 then presents a numerical example detailing how to apply this approach. Finally, Section 9 presents conclusions obtained using this approach.

2. Attributes for assessment of supply performance

Choi and Hartley (1996) evaluated supplier-performance based on consistency, reliability, relationship, flexibility, price, service, technological capability and finances, and also addressed 26 supplier-selection criteria. Verma and Pullman (1998) ranked the importance of the supplier attributes of quality, on-time delivery, cost, lead-time and flexibility. Vonderembse and Tracey (1999) discussed the supplier and manufacturing performances could be determined by supplier selection criteria and supplier involvement. Furthermore, they concluded 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. Additionally, 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 for supplier rating. The attributes of quality, delivery, price, technique capability, finance, attitude, facility, flexibility and service were used for supplier evaluation, and the