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Fuzzy DEMATEL method for developing supplier selection criteria

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ABSTRACT

Supply chain management (SCM) practices have flourished since the 1990s. Enterprises realize that a large amount of direct and indirect profits can be obtained from effective and efficient SCM practices. Supplier selection has great impact on integration of the supply chain relationship. Effective and accurate supplier selection decisions are significant components for productions and logistics management in many firms to enhance their organizational performance. This study pioneers in using the fuzzy decision-making trial and evaluation laboratory (DEMATEL) method to find influential factors in selecting SCM suppliers. The DEMATEL method evaluates supplier performance to find key factor criteria to improve performance and provides a novel approach of decision-making information in SCM supplier selection. This research designs a fuzzy DEMATEL questionnaire sent to seventeen professional purchasing personnel in the electronic industry. Our research results find that stable delivery of goods is the most influence and the strongest connection to other criteria.

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1. Introduction

A well-designed supply chain management (SCM) system is important for improving competitive advantage in an era of international economics and rapidly developing information technology (Li & Wang, 2007). The gap between product quality and performance is closing with intensifying competition in the global market. Scholars and industries consider how to manage enterprise operation more efficiently in this competitive arena (Sarmah, Acharya, & Goyal, 2006). Effective supplier decisions are significant components for productions and logistics management in many firms, and a correct forecast is crucial for the electronic related industry (Hsu, 2003). In other words, accurate supplier forecasts help enterprises find proper supply chain partners and consequently enhance organizational performance.

The success or failure of supply chain management depends upon a suitable SCM system and appropriate suppliers. Many firms apply collaborative commerce by establishing strategic partnerships with suppliers, and involve them in the early stages of product research and development (Araz & Ozkarahan, 2007). Experts agree that supplier selection is one of the most important functions of a purchasing department, helping businesses save material cost and increase competitive advantage (Saen, 2007).

Supplier selection also acts as the pivotal role in an enterprise's transport business development, with future competitive ability in an industrial environment (Jayaraman, Srivastava, & Benton, 1999). Only those suppliers who meet the firms' needs can provide material and parts with comparative low cost and high quality. In an effective supply chain, enterprises must first find outstanding suppliers, and then establish long-term partnerships with these suppliers to increase enterprises' competitive abilities (Shin, Collier, & Wilson, 2000). Today's business environment emphasizes supplier relationship development for sustainable enterprise management (Krause & Ellram, 1997). Considerable research supports supply chain performance as highly influential in enterprise competitiveness (Quayle, 2003; Sako, 2004). This finding has led to considerable academic and real world interest, regarding supplier development strategies.

Many methods have been used in predicting industrial performance, including the Grey theory (Lin & Yang, 2003), and the two-stage fuzzy piecewise regression analysis method (Huang & Tzeng, 2008). Ni, Xu, and Deng (2007) applied a method with extended Quality Function Deployment (QFD) and data mining to investigate supplier selection (Ni et al., 2007). Li and Wang use a grey-based decision-making method to deal with fuzziness in supplier selection (Li & Wang, 2007). Pi and Low propose a supplier selection method that use Taguchi loss functions and the Analytic Hierarchy Process (AHP) to obtain weights of major criteria (Pi & Low, 2006). However, the method needs more data, such as customer data, maintenance records, and information from different marketing areas. Gencer and Gurpinar adopted the Analytic

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Network Process (ANP) to investigate supplier selection implementation in an electronic firm. Compared with AHP, ANP includes interaction among criteria (Gencer & Gurpinar, 2007).

However, few methods and studies have capable of demonstrating the relationship between factors that might affect SCM performance. Therefore, this study pioneer in using the fuzzy decision-making trial and evaluation laboratory (DEMATEL) method to select which supplier suit enterprises. The advantage of the DEMATEL method is the capability of revealing the relationship between these factors which influence other factors in supplier selection. This study obtains direct and indirect influence among criteria using the DEMATEL technique, and computes the causal relationship and strength among supplier selection factors. The DEMATEL technique does not need large amounts of data.

This paper is organized as follows: In Section 2, we present a literature review of SCM and Supplier selection. Section 3 describes the methodologies of fuzzy DEMATEL. Section 4 outlines an empirical study to show the process of fuzzy DEMATEL method to determine selection criteria of SCM supplier. Section 5 carries our conclusions and suggestions.

2. Concepts of supply chain management and supplier selection

The economic environment from the late 1980s to early 1990s forced enterprises to face international market competition with greater competitive capability. Enterprises today must have better production technology internally and externally, such as supplier capability and customer requirement for competitive ability. Enterprises must change their attitudes toward the supplier from enemy to partner and view them as a resource in order to increase the supply chain to rapid response in a dog-eat-dog environment (Cousins & Menguc, 2006). Supply chain management is an essential enterprise activity under international market competition. A successful supply chain management must focus on several aspects, such as supplier selection and relationship management, information technology application, internal and external supply chain. The following section explores important literatures according to the points above, for systematic research.

2.1. Supply chain management (SCM)

SCM can apply an integrally systematic model to control information flow, material and service of enterprises to satisfy customer requirements. Managers have traditionally focused on managing internal operations to promote profits. SCM emphasizes integrating internal activities and decisions with external enterprise partners to promote competitive capability (Li & Wang, 2007). Supply chain management has attracted increasing attention from academics the past 20 years. Academic publications, seminars, profes-

sional development plans and school courses manifest the importance of SCM. Research adjusts constantly to create various technologies to assist implementing supply chain management for enterprise performance. Private enterprises and listed companies recognize that good SCM promotes success (Cousins, Lawson, & Squire, 2006).

SCM integrates with comprehensive managerial functions such as purchase, operational management, information technology and marketing (Tessarolo, 2007). External integration development of supply chain promotes large-scale product schedule performance. This performance increases when internal integration and internal group members combine with external customers and suppliers to enhance mutual product recognition (Lee & Rhee, 2007). Improper management of the supply chain relationship results in direct or indirect bad effects. For example, manufacturers in the wholesale or retail market face different marginal costs and uncertain situations, maximizing profit through a strategic decision rather than optimum profit. Hence, the retail dealer will price products higher, order smaller quantities or serve fewer customers (Choi & Krause, 2006).

Supplier selection greatly impacts the supply chain relationship. Improper management of the supply chain relationship affects SCM effect directly. Hence, this study uses a quantitative method to solve the problem and promote SCM performance through good supplier selection.

2.2. Supplier selection

Supplier differentiation refers to differences derived from supplier characteristics such as organizational culture, manufacturing procedure, technology capability and geographic location distribution (Chang, Wang, & Wang, 2007). Adopting the proper supplier group to promote competitive capability and supplier performance is the greatest task. Supply performance refers to valid and continuous action encompassing the past, present and future.

An effective and efficient supply performance evaluation method becomes increasingly important in supply chain subjects (Dickson, 1996). This research sorts through previous literatures to grasp which evaluation criteria draws the greatest attention in previous literatures (Chang et al., 2007; Kreng & Wang, 2005; Noorul & Kannan, 2006; Prahinski & Benton, 2004; Wang & Hu, 2005; Weber & Current, 1993; Weber, Current, & Benton, 1991; Zadeh, 1965). The criteria used in relevant literatures are listed in Table 1.

3. The fuzzy DEMATEL method

The DEMATEL method was first conducted by The Battelle Memorial Institute through its Geneva Research Centre in 1973 {Gabus, 1973, #17}. DEMATEL is an extended method for building and analyzing a structural model for analyzing the influence

Table 1
Criteria of supplier selection.

	Dickson	Weber	Current	Prahins-ki & Benton	Kreng & Wang	Wang	Noorul & Kannan	Chang et al.
Quality	X	X	X	X	X	X	X	X
Service		X		X		X		X
Flexible		X						
Price	X		X	X	X	X	X	X
Delivery	X	X	X	X	X	X	X	
Lead-time					X			
Reaction to demand change				X		X		X
Production capability							X	
Technical capability			X				X	
Reliability of delivery					X			

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