Structured methodology for supplier selection and evaluation in a supply chain

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A B S T R A C T

Supply chain management (SCM) is one of the most important competitive strategies used by modern enterprises. The main aim of supply chain management is to integrate various suppliers to satisfy market demand. Meanwhile, supplier selection and evaluation plays an important role in establishing an effective supply chain. Traditional supplier selection and evaluation methods focus on the requirements of single enterprises, and fail to consider the entire supply chain. Therefore, this study proposes a structured methodology for supplier selection and evaluation based on the supply chain integration architecture.

In developing the methodology for supplier selection and evaluation in a supply chain, enterprise competitive strategy is first identified using strengths weaknesses opportunities threats (SWOT) analysis. Based on the competitive strategy, the criteria and indicators of supplier selection are chosen to establish the supplier selection framework. Subsequently, potential suppliers are screened through data envelopment analysis (DEA). Technique for order preference by similarity to ideal solution (TOPSIS), a multi-attribute decision-making (MADA) method is adapted to rank potential suppliers. Finally, the Taiwanese textile industry is used to illustrate the application and feasibility of the proposed methodology.

This study facilitates the improvement of collaborator relationships and the management of potential suppliers to help increase product development capability and quality, reduce product lifecycle time and cost, and thus increase product marketability.

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1. Introduction

During the recent swift progress of network technology and economic globalization, modern industry has been trending towards the increasingly precise division of labor. Consequently, individual enterprises focus on developing their core capabilities and outsource non-core affairs to other partners or suppliers with different professional capabilities to upgrade their competitive advantage by applying these external and special sources and technology knowledge. On the other hand, consumer-behavior is widely changed because of the increasing consumers' ideology; hence, product lifecycles are becoming shorter and every enterprise must offer diverse and custom made products to immediately satisfy consumer needs. These pressures drive enterprises to actively invest in supply chain management (SCM), and to establish strategic alliances against their competitors.

Generally, SCM occurs when several enterprises establish their own supply chain. These enterprises must find more efficient suppliers to increase supply chain competitiveness. Among various available suppliers, how to choose more

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collaborative suppliers who can develop long-term relationships is a key issue in establishing a supply chain and enhancing its efficiency.

Many previous studies on supplier selection and evaluation defined numerous evaluation criteria and selection frameworks for supplier selection. For example, Dickson [7] surveyed buyers to identify factors they considered in awarding contracts. Out of the 23 factors considered, Dickson concluded that quality, delivery, and performance history are the three most important criteria. Another study by Weber et al. [26] derived key factors thought to influence supplier selection decisions. These factors were taken from 74 related articles that have appeared since Dickson's well-known study. Based on a comprehensive review of vendor evaluation methods, they surmised that price was the highest-ranked factor, followed by delivery and quality. These empirical researches revealed that the relative importance of various selection criteria such as price, quality, and delivery performance is similar. Increasing emphasis on just-in-time manufacturing strategies since the 1980s has increased the importance of strategic vendor evaluation and multiple vendor criteria. Weber et al. [29] considered factors, including geographical location, which he regarded as more important than those selected by Dickson. Table 1 summarizes some of the criteria that are considered important by Dickson [7], Weber et al. [26], Weber and Current [27], Weber and Desai [28]. Regarding the analytical methods employed in the supplier selection process, De Boer et al. [5] extensively reviewed decision methods for supporting supplier selection. Ho et al. [10] reviewed the literature of the multi-criteria decision-making approaches for supplier evaluation and selection. Related articles appearing in the international journals from 2000 to 2008 are gathered and analyzed to address the most popular criterion considered by the decision makers for evaluating and selecting the most appropriate supplier. Their studies summarized decision methods used for pre-qualifying suitable suppliers, including categorical methods, EDA, cluster analysis, and case-based reasoning systems. Decision models for the final choice phase comprehended the linear weighting, total cost of ownership, mathematical programming, and statistical and artificial intelligence-based models, as illustrated in Fig. 1. For example, Talluri et al. [23] presented a so-called chance-constrained DEA approach to evaluate the performance of suppliers in the presence of stochastic performance measures. Price was considered as an input, whereas quality and delivery were used as outputs. The model was compared with the deterministic DEA to highlight its usefulness. Saen [22] presented a so-called imprecise DEA to evaluate the performance of suppliers in the presence of both quantitative and qualitative data. The author addressed that the supplier reputation (SR), one of the output measures considered in the case study, could not be quantified legitimately. The proposed model allowed the decision makers to provide a complete rank ordering of the suppliers on SR. Besides, the proposed model could handle the fuzzy data in the forms of bounded data. Wu et al. [30] presented a so-called augmented imprecise DEA for supplier selection. The proposed model was able to handle imprecise data (i.e., to rank the efficient suppliers) and allow for increased discriminatory power (i.e., to discriminate efficient suppliers from poor performing suppliers). A web-based system was developed to allow potential buyers for supplier evaluation and selection. Wadhwa and Ravindran [25] modeled the supplier selection problem as a multi-objective programming problem, in which there are three objective functions, such as minimization of price, lead time, and rejects. Three solution approaches, including weighted objective method, goal programming method, and compromise programming, were used to compare the solutions. Hou and Su [11] developed an AHP-based decision support system for the supplier selection problem in a mass customization environment. Factors from external and internal influences were considered to meet the needs of markets within the global changing environment.

Table 1
Important criteria for supplier selection from literature.

Evaluation criteria	Dickson importance ranking	Weber importance	Reference quantity
Price	6	Very important	61
Deliver on time	2	Very important	44
Quality	1	Extremely important	40
Equipment and capability	5	Very important	23
Geographic location	20	Important	16
Technical capability	7	Very important	15
Management and organization	13	Important	10
Industrial reputation	11	Important	8
Financial situation	8	Very important	7
Historical performance	3	Very important	7
Maintenance service	15	Important	7
Service attitude	16	Important	6
Packing ability	18	Important	3
Production control ability	14	Important	3
Training ability	22	Important	2
Procedure legality	9	Very important	2
Employment relations	19	Important	2
Communication system	10	Very important	2
Mutual negotiation	23	Important	2
Previous image	17	Important	2
Business relations	12	Important	1
Previous sales	21	Important	1
Guarantee and compensation	4	Very important	0