

A fuzzy-QFD approach to supplier selection

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Abstract

This article suggests a new method that transfers the house of quality (HOQ) approach typical of quality function deployment (QFD) problems to the supplier selection process. To test its efficacy, the method is applied to a supplier selection process for a medium-to-large industry that manufactures complete clutch couplings.

The study starts by identifying the features that the purchased product should have (internal variables “WHAT”) in order to satisfy the company’s needs, then it seeks to establish the relevant supplier assessment criteria (external variables “HOW”) in order to come up with a final ranking based on the fuzzy suitability index (FSI). The whole procedure was implemented using fuzzy numbers; the application of a fuzzy algorithm allowed the company to define by means of linguistic variables the relative importance of the “WHAT”, the “HOW”–“WHAT” correlation scores, the resulting weights of the “HOW” and the impact of each potential supplier.

Special attention is paid to the various subjective assessments in the HOQ process, and symmetrical triangular fuzzy numbers are suggested to capture the vagueness in people’s verbal assessments.

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1. Introduction

Leading business management publications emphasize the need to understand manufacturing decisions and practices for a firm to improve its competitive position. Various publications argue that manufacturing decisions and choices have to be consistent with the corporate strategy for effective operations management. The aim of this study was to get a better understanding of a particular, strategic operating decision area, i.e. the supplier selection process. As more manufacturing organizations are adopting TQM and JIT concepts, the role of the supplier and supply chain management become increasingly important (Verma and Pullman, 1998a, b). In a time of global markets such as ours, the success of an enterprise often depends on its ability to choose its suppliers. Supplier selection is sometimes highly complex, since it incorporates a great

variety of uncontrollable and unpredictable factors that affect the decisions involved.

All in all, this should prompt careful attention to the way in which such decisions are reached and justified, and would consequently suggest (among other things) the use of decisional models to support procurement decision-making. Moreover, supplier assessments or ratings should be done routinely to ensure that incoming materials meet relevant quality standards (Li et al., 1997). There is much discussion on this topic in the literature and various procedures have been proposed to help deal with the problems posed by supplier selection. Several factors that may complicate the decision-making process, such as incomplete information, additional qualitative criteria and imprecise preferences, are often not taken into account (De Boer et al., 1998). In this article, we propose and illustrate a decisional model for supplier selection that is based on TQM methods such as *quality function deployment (QFD)*, adopting an analysis based on fuzzy logic.

The paper is organized as follows: in Section 2, we illustrate some of the topics that are considered strategic in

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the suppliers selection. In Section 3 the QFD methodology and fuzzy logic are discussed. In Section 4, a case study of an industry that manufactures complete clutch couplings is used to illustrate the application of the proposed method. Finally, a discussion of the fuzzy-QFD methodology and the conclusions are presented in Sections 5 and 6.

2. Supplier selection

The procurement phase has been acknowledged a strategic role and outside suppliers exert an ever increasing influence on the success or failure of a business.

The following points describe some of the topics that are considered strategic:

(1) *The evolution in supplier–customer relations*: Modern procurement strategies demand new investigation methods, especially where co-operation agreements are involved. There has been a progressive change in the relationship between buyer and vendor, in the sense that the conventional idea of two opposite parties involved in short-term negotiations has been replaced by more durable co-operative relationships. Moreover, to ensure a market advantage, companies tend to restrict the number of suppliers they purchase from; this means that they establish more stable and durable relations with a narrow group of suppliers, thus obtaining significant cost savings and ongoing quality improvements. This new approach charts a very different course from the traditional multiple-source approach, that was generally characterized by relations in which orders were placed with suppliers who offered the lowest price at a specific moment in time.

(2) *The definition of assessment criteria for the specific situation*: Supplier selection decisions are complicated by the fact that various criteria have to be considered in the decision-making process (Weber et al., 1991). These criteria may have quantitative as well as qualitative dimensions, and may also be conflicting. Preference for a given supplier is generally assumed to depend on an assessment, case-by-case, of the quality, price, delivery and service he can provide. The number and the set of the assessment criteria involved should depend on the product/service in question. A study carried out by Dempsey (1978) considered 20 different vendor attributes: though it offers some precious insight into the decisional process, such an approach can prove excessively complex and consequently pose some problems. Parker (1990) claims that the majority of buyers cannot take more than 8 or 9 factors into account in their decision-making process, so researchers tend to develop smaller, more customized sets of attributes as the final aim of their research work. The relative importance of these selection criteria has been estimated in various procurement situations. To be more precise, Patton (1996) demonstrated that the predictive capacity of supplier selection models and the relative importance attributed to the assessment criteria varies considerably according to the nature of the choice that has to be made. In a market of products destined for the industry, the features of the

products are a great deal more important than aspects relating to customer support services or price (Bennion and Redmond, 1994). In a comparative study of single-versus multiple-source procurement situations involving different types of industry and different products, it emerged that the accent should focus on price, quality and delivery methods in multiple-source situations, whereas technical support and product reliability are more important in the case of single-source purchasing situations (Lambert and Harrington, 1989). According to Rich (1995), traditional purchasing methods have often reflected a focus on tactical price considerations, rarely extending the horizon to embrace the true parameters of “strategy generation” and, as a consequence, the purchasing process has suffered a prolonged absence from the corporate agenda. Price myopia devalues the strategic nature of purchasing by ignoring critical features of supplier management, such as service levels and standards of operational performance. In fact, there is a close correlation between price myopia, constantly changing supply sources and poor operational service levels. The criteria for developing a partnership with a supply chain member organization are typically driven by the expectation of quality, cost efficiency, delivery dependability, volume flexibility, information and customer service (Olhager and Selldin, 2004; Motwani et al., 1998; Li et al., 1997; Choi and Hartley, 1996).

In literature not many works propose tools for the identification of the best criteria for selecting suppliers. Mandal and Deshmukh (1994) propose interpretive structural modeling (ISM) as a technique based on group judgment to identify and summarize relationships between supplier choice criteria through a graphical model. The important vendor selection criteria have been analyzed to obtain an ISM which shows the inter-relationship of criteria and its levels. These criteria have also been categorized depending on their driver power and dependence. Dependent variables are very important for vendor selection whereas independent variables are important for vendor development. Mandal and Deshmukh include among independent factors the vendor’s production facilities and capacity, technical capability and financial position. Vokurka et al. (1996) developed an expert system that covers multiple phases in the supplier selection process, among which there is the formulation of supplier selection criteria. More recently Bharadwaj (2004) proposed a cross-sectional survey to investigate whether a difference exists in the decision criteria used by electronics manufacturers in procuring differing component parts. The survey results suggest that the content and structure of the decision criteria used by business customers to assess their suppliers do not differ across an array of electronic components.

(3) *Procedural problems*: As in the majority of decisional processes, supplier selection involves two basic but distinct actions: assessing and choosing. The assessment phase generally consists in identifying the attributes and criteria relevant to the decision and consequently in measuring or

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