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Dealing with subjectivity in early product design phase: A systematic approach to exploit Quality Function Deployment potentials

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Abstract

Quality Function Deployment (QFD), as a customer-driven tool, is generally used in the early phase of new or improved products/services design process, and therefore most of the input parameters are highly subjective in nature. The five major input components of the QFD, which are laid in the House of Quality (HOQ), namely, the customer requirement, the technical attribute, the relationship matrix, the correlation matrix, and the benchmarking information, play a central role in determining the success of QFD team. Accurate numerical judgment representations are of high importance for the QFD team to fill in the values of each of those components. In this paper, a generic network model, based on Analytic Network Process (ANP) framework, will be proposed to systematically take into account the interrelationship between and within those components simultaneously and finally derive their relative contribution. In particular, with respect to a rapidly changing market, the incorporation of the new product development risk, the competitors' benchmarking information, and the feedback information into the network model may be considered as a novel contribution in QFD literature. Not only does this network model improve the QFD results' accuracy, but it also serves as a generalized model of the use of ANP in QFD with respect to the previous research. A simple illustrative example of the proposed network model will be provided to give some practical insights.

Keywords: QFD; ANP; Benchmarking; New product development risk; Feedback

1. Introduction

Superior product design, potential for breakthrough innovation, low project and product cost, shorter lead time, better communication of cross-functional teamwork, and increased customer satisfaction and market

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share are among many other advantages that make Quality Function Deployment (QFD) an important, and yet unique, tool for successful new product development (Chan & Wu, 2002a; Griffin & Hauser, 1992; Hauser & Clausing, 1988; Presley, Sarkis, & Liles, 2000; Xie, Tan, & Goh, 2003). It enables firms in making strategic decisions while ensuring full knowledge of the customer, the technology, and with the team's support (Hauser, 1993).

Essentially, the QFD starts and ends with the customer. The Voice of Customer (VOC) (Griffin & Hauser, 1993) is the main driver and will be propagated through all subsequent downstream processes, and as a result, greater customer satisfaction is created in the end product/service. According to a study by Griffin (1992), the two most critical factors that determine the QFD's successful use in providing definite strategic product development benefits are the high commitment of all team members in all functional areas, and the paradigm that treats QFD as a cross-functional investment in people and information.

Since the focus of the QFD is on the early phase of new products/services design or redesign process, most of the input parameters are therefore highly subjective in nature (Kim, Kim, & Min, 2007; Xie et al., 2003). Based on the survey results over 400 companies in the US and Japan, Cristiano, Liker, and White (2000) showed that the QFD analysis may only require a simple and practical decision aid based upon the experience and judgment of the team. This is mainly attributed to the fact that the QFD was born out of an industry need for ensuring design quality. Hence, the accuracy level of these subjective experience and judgment will significantly determine the quality of the QFD results.

In view of this, a method or approach that is capable to systematically analyze and accurately quantify those subjective experience and judgments of the QFD team is highly required. In the literature, the Analytic Hierarchy Process (Saaty, 1983, 1994), of which generalized form is called the Analytic Network Process (Saaty, 1996), is known as one of the most powerful management science tools to serve this purpose. The AHP/ANP has been widely accepted as a realistic, flexible, simple, and yet mathematically rigorous modeling technique in multiple criteria decision making field (Liberatore, 1987; Saaty, 1986; Sarkis & Sundarraj, 2006; Vaidya & Kumar, 2006). The AHP/ANP framework can be considered as a powerful and necessary tool for making any strategic decision since it is capable of taking into consideration multiple dimensions of information from multi-party, either qualitative or quantitative, into the analysis (Dyer & Forman, 1992; Meade & Presley, 2002; Meade & Sarkis, 1998). In using the AHP in new product development field, Calantone, Di Benedetto, and Schmidt (1999) wrote that "*the AHP helps managers make more rational decisions by structuring the decision as they see it and then fully considering all of the information*". In other words, the AHP/ANP effectively facilitates managers in quantifying their subjective judgments, experience, and knowledge of the complex system in an intuitive and natural way (Dey, 2004; Mustafa & Al-Bahar, 1991) by systematically taking into account all the relevant factors and their relative effects as well as interactions simultaneously.

The trend of the AHP/ANP's use to assist QFD practitioners develop new or redesign existing products has been remarkably increasing (Armacost, Componation, Mullens, & Swart, 1994; Cohen, 1995; Lu, Madu, Kuei, & Winokur, 1994; Zakarian & Kusiak, 1999). Recently, Ho (2007) gave a review of the use of other methods in combination with the AHP, and found that the combination of the AHP and QFD is one of the most commonly used technique in the literature. Furthermore, due to its very exceptional strength in addressing the inner-relationship and interrelationship among the QFD components, the ANP has also increasingly been used in QFD recently (see Büyüközkan, Ertay, Kahraman, & Ruan, 2004; Ertay, Büyüközkan, Kahraman, & Ruan, 2005; Kahraman, Ertay, & Büyüközkan, 2006; Karsak, Sozer, & Alptekin, 2002; Pal, Ravi, & Bhargava, 2007; Partovi, 2006, 2007).

The use of ANP in QFD, in general, can be categorized into two types. The first type, of which model has been used by quite many researchers (Büyüközkan et al., 2004; Ertay et al., 2005; Kahraman et al., 2006; Karsak et al., 2002; Pal et al., 2007), is mainly based on the network model described in Saaty and Takizawa (1986). Compared to the recent development of the ANP method, it might be considered as rather preliminary (see Section 2.2). While the second type, which can be considered as a better advancement of the use of ANP in QFD, employs the network model proposed recently by Partovi (Partovi, 2006, 2007). However, the model is still rather restricted in the sense that it uses ANP in addressing only two elements of House of Quality (HOQ), namely, the relationship matrix and the correlation matrix (the roof of HOQ).

To fill in the niche of using ANP in QFD more effectively, this paper therefore proposes a generic network model which serves as a generalized model from the previous research work. In particular, it takes into