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Int. J. Production Economics 91 (2004) 235–249
international journal of production economics
www.elsevier.com/locate/dsw

Prioritizing engineering characteristics in quality function deployment with incomplete information: A linear partial ordering approach

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Received 7 March 2002; accepted 13 September 2003

Abstract

Quality function deployment (QFD) has been used as the concurrent engineering tool to save the production cost and time. It is not easy to get information or knowledge for the prioritization of customer attributes and engineering characteristics during the QFD planning process. This research suggests a linear partial ordering approach for assessing the knowledge from participants and prioritizing engineering characteristics. The linear partial information will be used in extracting weights of customer attributes and relationship values of customer attributes between engineering characteristics. Using the linear partial ordering can reduce the cognitive burden of designers and engineers of QFD planning team. Four types of dominance relation that are frequently used in multi-attribute decision making with incomplete information are used to determine the priorities of engineering characteristics when the linear partial orderings of participants are given. The dominance relations between engineering characteristics can be established by solving a series of linear programming problem.

Keywords: Quality function deployment (QFD); Incomplete information; Linear partial ordering; Multi-attribute decision-making (MADM)

1. Introduction

Many firms are facing rapid changes stimulated by technological innovations and changing customer demand. These firms realize that getting high-quality products to customer in a timely manner is crucial for their survival in the competitive marketplace. Product development process is a complex managerial process that involves multi-functional groups with different perspectives. Quality function deployment

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0925-5273/$ - see front matter
doi:10.1016/j.ijpe.2003.09.001

(QFD) is a new product development process which stresses cross-functional integration. QFD ensures quality throughout each stage of the product development and production process.

QFD was originally developed and used in Japan at the Kobe Shipyards of Mitsubishi Heavy Industries, Ltd. in 1972. QFD has been used successfully by Japanese manufacturers of customer electronics, home appliances, construction equipment, synthetic rubber, textile, software system, etc. Akao (1990) and Hauser and Clausing (1998) introduced basics of QFD process and a lot of successful cases of QFD. Also, Cohen (1995) explains the detailed process of QFD and provides several applications of QFD. Govers (2001) emphasized that special attention must be paid to product policy and cross functional project approach to make QFD a valuable technological and organizational aid for innovation projects. During the 1980s and 1990s many kinds of US companies began employing QFD after the initial success at Fuji-Xerox in 1983. Many successful cases across a broad range of industries have been reported until now.

During the QFD planning process, product design team needs to know how to make a selection of design features. Due to the complexity of decision process, the design team will often rely upon ad hoc procedures to assist in this product development (Wasserman, 1993). Such procedures are often completely ‘‘arbitrary’’, however, and subject to the ‘‘whims’’ of the design team rather than to the need of customer (Franceschini and Rossetto, 1995). As many researchers have pointed out, more convenient methodology is needed to get information from design team and provide an unforced evaluation of the QFD tables.

This paper proposes a methodology for prioritizing engineering characteristics in QFD with incomplete information. The methodology uses a linear partial ordering to assess the knowledge and information from QFD team and apply the MADM method to derive priorities or weights of engineering characteristics. The linear partial information will be used in extracting weights of customer attributes and relationship values between customer attributes and engineering characteristics. And then, dominance relations in multi-attribute decision-making (MADM) procedure with linear partial information are used to derive the priorities of engineering characteristics. The dominance relations between engineering characteristics can be established by solving a series of linear programming problem. Due to the easiness in articulating preferential information, using linear partial information can reduce the cognitive burden of designers and engineers of QFD planning team and give a practical convenience in using QFD planning process.

The remainder of this article is organized as follows. Section 2 includes the definition of QFD and short review of the prior researches in QFD, and explains the necessity of incomplete information. Five types of linear partial information will be introduced and discussed in Section 3. Also, a methodology based on MADM and incomplete information will be developed to prioritize engineering characteristics in Section 3. An illustrative example is shown in Section 4.

2. Background

2.1. *Quality function deployment*

QFD can be defined as an overall concept that provides a means of translating the needs of customers through the various stages of product planning, engineering and manufacturing into a final product. QFD is accomplished through a series of charts which are a conceptual map, providing the means for inter-functional communications. The chart is usually called a house of quality (HOQ). HOQ relates the variables of one design phase to the variables of the subsequent design phase. Four linked houses in Fig. 1 implicitly convey the voice of the customer through to manufacturing.

In this paper, HOQ of the product planning phase (Phase I in Fig. 1) is described in detail. HOQ charts of other phases can be analyzed in a similar way. The ‘‘voice of the customer’’ is represented on the left side of HOQ. The customer attributes (CA) are usually very qualitative and vague. CA importance, the relative importance among the customer attribute, plays an important role in identifying critical customer attributes