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A systematic approach to quality function deployment with a full illustrative example

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Abstract

This paper presents a systematic and operational approach to quality function deployment (QFD), a customer-driven quality management system for product development. After a comprehensive description of the relevant elements in house of quality (HOQ), the first and most influential phase of the QFD system, a 9-step model is proposed to help build such an HOQ. A number of 9-point scales are developed whose uses could help unify the various measurements in HOQ to avoid arbitrariness. Special attention is paid to the various subjective assessments in the HOQ process, and symmetrical triangular fuzzy numbers (STFNs) are suggested for use to capture the vagueness in people's linguistic assessments. Instead of using the quite subjective sales-point concept, entropy method is introduced to conduct competitive analysis and derive competitive priority ratings. A thorough explanation is given to address the concepts, computations and implementations in the proposed HOQ model, followed by a full example for a fried Chinese vegetable to illustrate step by step all the relevant details with the purpose of facilitating the understanding and application of the QFD process. Two difficult parts omitted from our model, especially the correlation matrices, are discussed in some detail finally, and possible approaches are also suggested to deal with them in a potentially more complete HOQ model.

Keywords: Quality function deployment; House of quality; Measurement scale; Symmetrical triangular fuzzy number; Entropy

1. Introduction

Quality function deployment (QFD) is "a system to assure that customer needs drive the product design and production process" (Ref. [1]). Typically, a QFD system can be broken down into four inter-linked phases to fully deploy the customer needs phase by phase (Refs. [1–5]). In QFD, each phase's important outputs (HOWs), generated from the phase's inputs (WHATs), are converted into the next phase as its inputs (new WHATs). So each phase can be described by a matrix of "WHATs" and "HOWs", which is easy and convenient to deal with in practice. The four QFD phases include: Phase I to translate customer needs into product design attributes which we will call technical measures; Phase II to translate important technical measures into parts characteristics; Phase III to translate important parts characteristics into process operations; and Phase IV to translate key process operations into day to day production requirements.

The first phase of QFD, usually called house of quality (HOQ), is of fundamental and strategic importance in the QFD system, since it is in this phase that the customer needs for the product are identified and then, incorporating the producing company's competitive priorities, converted into appropriate technical measures to fulfill the needs. In other words, HOQ

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links the "voice of the customer" to the "voice of the technician" through which process and production plans can be developed in the other phases of the QFD system. The structures and analyzing methods of the other three QFD phases are essentially the same as the first one, so we will study the HOQ phase only. In fact, most QFD studies focus mainly on its first phase (for exceptions, see Refs. [1,3,5]).

A house of quality (HOQ) involves the collection and analysis of the "voice of the customer" which includes the customer needs for a product, customers' perceptions on the relative importance of these needs and the relative performance of the producing company and its main competitors on the needs. It also requires the generation and analysis of the "voice of the technician" which includes the technical measures converted from the customer needs, technicians' evaluations on the relationship between each customer need and each technical measure, and the performance of the relevant companies in terms of these technical measures. With such a large amount of information to be collected and processed, building an HOQ may be too complex to be complete and comparable. Systematization of the HOQ process is thus a necessity. Many studies have been done (Refs. [1–9]) and a number of QFD information systems have also been proposed (e.g., Refs. [10,11]) towards this purpose. However, most of these works are incomplete in the sense that either they do not contain all the important elements of HOQ or their quantifications are not very satisfactory.

On the other hand, most information involved in the HOQ process is generated from human beings' perceptions and linguistic assessments that are quite subjective and vague. Both the "voice of the customer" and the "voice of the technician" contain ambiguity and multiplicity of meaning. "Customer need #1 *is very important*", "technical measure #2 *has weak relationship* with customer need #3" and "company #4 *performs well* on customer need #5" are examples of these "voices" which are imprecise in terms of breadth of meaning. Efforts should therefore be made to deal with the vagueness in these "voices" involved in the HOQ process. Among a few studies in this aspect, Khoo and Ho [12] provide a fuzzy QFD framework to perform QFD analysis using symmetrical triangular fuzzy numbers (STFNs). However, they exclude competitive analysis from their framework. Chan et al. [13] also use STFNs to analyze the "voice of the customer", but their study does not involve the "voice of the technician".

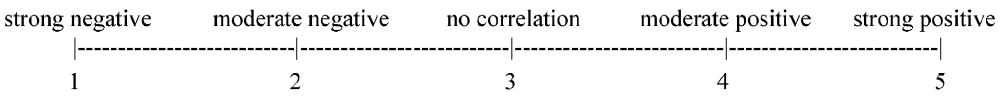
This paper presents a systematic and operational approach to the QFD process. After a detailed description and analysis of the HOQ elements, we provide a 9-step process to build an HOQ. Then, we suggest some feasible methods on how to collect and analyze the information from both the customers and the technicians. We especially address the various "voices" in HOQ using symmetrical triangular fuzzy numbers (STFNs) and some of the proposed HOW steps are fuzzified to produce fuzzy results, which are generally more representative than traditional crisp approaches of using simple numbers. We also suggest the use of entropy method to perform competitive analyses and obtain competitive priority ratings for both customer needs and technical measures. A fried Chinese vegetable example is given to fully illustrate our approach. Two difficult parts omitted from our model—the probability factors for achieving the goals set for the HOWs and especially the correlation matrices among the WHATs and HOWs—are discussed in some detail finally, and possible approaches are also suggested to deal with them in a potentially more complete HOQ model.

2. The HOQ process

2.1. The HOQ elements

According to many works (Refs. [1–9,14]), a typical HOQ contains some of the following elements or concepts:

1. *Customers*: At first the customers of a product or service concerned should be identified by the producing company.
2. *Customer needs* (*WHATs*): These are the requirements of customers for the product expressed in customers' languages.
3. *Structuring customer needs*: If there are many customer needs, grouping them into meaningful hierarchies or categories is necessary for easy understanding and analysis.
4. *Correlation matrix of customer needs*: This matrix contains the correlation between each pair of customer needs (WHATs) through empirical comparisons. The information is provided by customers and usually is difficult to obtain since a lot of pairwise comparisons are needed. The purpose of completing this correlation matrix is for the company to identify where trade-off decisions and further research may be required. Correlation is usually described by the following 5-point scale (Refs. [2,5,7,9]):



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