A Fuzzy Model for Exploiting Quality Function Deployment

LIANG-HSUAN CHEN AND MING-CHU WENG
Department of Industrial Management Science
National Cheng Kung University
Tainan, Taiwan, R.O.C.
(Received and accepted February 2003)

Abstract—Quality function deployment (QFD) is the product development process to maximize customer satisfaction. The engineering design characteristics related to product performance are specified for this purpose. For dealing with the fuzzy nature in the product design processes, fuzzy approaches are applied to represent the relationships between customer requirements (CRs) and engineering design requirements (DRs) as well as among the DRs. A new measure for evaluating the fuzzy normalized relationships is derived. A fuzzy model is formulated to determine the fulfillment level of each DR for maximizing the customer satisfaction under the resource limitation and the considerations of technical difficulty and market competition. The producing range of fulfillment level of each DR and those of customer satisfaction can provide the QFD team with more information. An example is used to illustrate the model. © 2003 Elsevier Ltd. All rights reserved.

Keywords—Quality function deployment (QFD), Fuzzy numbers, Fuzzy linear programming.

1. INTRODUCTION

Quality function deployment (QFD) originated in Japan in the 1970s and became increasingly popular in the western world in the 1980s. It has been successfully applied in many Japanese organizations to improve processes and to build competitive advantages [1]. Today, companies are successfully using QFD as a powerful tool that addresses strategic and operational decisions in businesses [2,3]. Quality function deployment is a systematic approach for ensuring that customers' voices are deployed in the product planning and design stages. The desires of customers on a product are taken into account through conducting a survey by the marketing department and are treated as a set of customer requirements (CRs). A number of engineering design requirements (DRs) that affect CRs are also identified to maximize customer satisfaction. In general, a QFD team is organized to determine the improvement levels of DRs by analyzing the relationships between CRs and DRs as well as among the DRs, considering the cost and other organizational constraints.

However, QFD still has several limits in applications and therefore can be improved further. QFD team members usually subjectively determine the relationships between CRs and DRs and among the DRs based on past experience, due to the lack of precise information from customer requirements. Moreover, information for product design is often limited and imprecise, particu...
larly when developing an entirely new product, such that engineers usually do not have complete
knowledge about the impacts of engineering characteristics on customer requirements (CRs).
These considerations have made the applications of some studies using crisp data restricted, such as Park and Kim [4] and Trappey et al. [5]. Instead, some researchers presented computer-

aided systems to aid engineers in designing engineering factors. Fung et al. [6] proposed a fuzzy
customer requirement inference system in which the product attributes could be mapped out.
Moskowitz and Kim [7] provided a decision support system for optimizing product designs. Tem-
poni et al. [8] developed a reasoning scheme for inferring requirement relationships between CRs
and DRs, as well as among the DRs. Nevertheless, the development of these systems usually
requires professional knowledge and experiences to establish rules and facts in ensuring that the
systems can work well.

Some models are also formulated for determining the levels of engineering design requirements
based on fuzzy set theory. Kim et al. [9] proposed a fuzzy theoretical modeling approach to QFD
by formulating fuzzy multiobjective models, assuming that the function relationships between
CRs and DRs and that among the DRs can be identified using benchmarking data of customer
competitive analysis. But it would be difficult, particularly when developing an entirely new prod-
uct. Some researchers ever developed fuzzy approaches to address complex and often imprecise
problems in customer requirement management by applying fuzzy sets, fuzzy arithmetic, and/or
fuzzy defuzzification techniques [10-13]. However, the interrelationships among the engineering
characteristics were not properly incorporated in these models.

Instead of the fuzzy approaches mentioned above, this study considers not only the inherent
fuzziness in the relationships between CRs and DRs, but also those among DRs. Two kinds of
fuzzy relationships are aggregated, based on Wasserman's study [14], to obtain the fuzzy normal-
ized relationship matrix in which each cell is represented by a fuzzy number. Unlike the existing
approaches [15], we proposed new expressions for those fuzzy numbers to obtain more short-
ened $\alpha$-cuts, such that fuzzy technical importance ratings for engineering design requirements
can be determined in terms of $\alpha$-cuts with less uncertainty. Under the resource limitation and
the considerations of technical difficulty, and market competition, we then formulated a fuzzy
LP model to determine the optimal fulfillment degrees of DRs at each $\alpha$-cut for achieving the
optimal customers' satisfaction. An illustrative example is used to demonstrate the feasibility of
the proposed approach.

In the following section, a fuzzy normalized relationship matrix of QFD is introduced, and
new expressions are derived for the $\alpha$-cuts of each fuzzy relationship value. Fuzzy technical
importance rating for each engineering design requirement at each $\alpha$-cut is then determined.
Section 3 formulates the QFD planning problem as a fuzzy model to determine the fulfillment
levels of DRs to produce the maximum customer satisfaction. An example is given to demonstrate
our approach in Section 4. Finally, conclusions are provided in Section 5.

2. FUZZY RELATIONSHIP MATRIX

The relationships between CRs and DRs in QFD are represented in the matrix form, which is
also called the house of quality (HOQ), as shown in Figure 1. The matrix has two dimensions,
i.e., customer wants and engineering design requirements. A triangular-shaped matrix placed
over the engineering design requirements corresponds to the correlations between them. A point
system is applied to evaluate the relationships between CRs and DRs, as well as among the DRs
based on the strength of relationship in the existing approaches [14]. In the figure, $R_{ij}$ denotes
the score of the relationship between the $i^{th}$ CR and the $j^{th}$ DR, and $r_{jn}$ is the correlation score
for the $j^{th}$ and $n^{th}$ DRs.

For obtaining relative relationship degrees of DRs with respect to some CR and dealing with
the dependence among DRs, Wasserman [14] proposed a normalized transform on the relationship
دریافت فوری

متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات