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Product planning in quality function deployment using a combined analytic network process and goal programming approach☆

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Abstract

Quality function deployment (QFD) is a customer-oriented design tool with cross-functional team members reaching a consensus in developing a new or improved product to increase customer satisfaction. QFD starts with the house of quality (HOQ), which is a planning matrix translating the customer needs into measurable product technical requirements (PTRs). A robust evaluation method should consider the interrelationships among customer needs and PTRs while determining the importance levels of PTRs in the HOQ. This paper employs the analytic network process (ANP) to fulfill this requirement. Furthermore, the proposed analytic procedure should take into account the multi-objective nature of the problem, and thus, incorporate other goals such as cost, extendibility and manufacturability of PTRs. This paper presents a zero–one goal programming methodology that includes importance levels of PTRs derived using the ANP, cost budget, extendibility level and manufacturability level goals to determine the PTRs to be considered in designing the product. A numerical example is presented to illustrate the application of the decision approach.

Keywords: Quality function deployment; House of quality; Dependence; Analytic network process; Zero–one goal programming

1. Introduction

Global competitiveness has recently become the biggest concern of both manufacturing and service companies, which seek for higher levels of quality for their products and services and continuous improvement to keep up with the rapid pace of development and change throughout the world. Total

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quality management, which offers a vast selection of techniques to ensure the improvement of quality and productivity, has been a topic on the research agenda for the last four decades.

Quality function deployment (QFD) is one of these techniques that aim the satisfaction of the customer at the very beginning, namely the product design phase. It enables the companies to become proactive to quality problems rather than taking a reactive position by acting on customer complaints. As an interdisciplinary team process, QFD is used to plan and design new or improved products or services. QFD employs a cross-functional team to determine customer needs and translate them into product designs through a structured and well-documented framework.

QFD helps the companies to maintain their competitiveness using three strategies: decreasing costs, increasing revenues, and reducing the time to produce new products or services (cycle time reduction). QFD allows for the company to allocate resources and to coordinate skills and functions based on customer needs, and thus, may result in lower production costs by ignoring aspects meaning little or nothing to the customer. Its systematic nature also evaluates the necessary decisions for change and development at the beginning of the design process, reducing and even avoiding the mid-project changes and corrections. Enabling to develop the right product or service for the customers with the lowest possible cost, QFD attracts the customers, which results in higher selling rates, leading to higher revenues. In this way, QFD facilitates the entire development process, minimizing the corrections and waste during this phase, and as a matter of fact, optimizing the time required for introducing a new or improved product or service to the market.

After World War II, the concept of product development evolved from copying and imitation to a product development based on originality. The importance of design quality became apparent. This dramatic change entailed the development of a totally new concept, the QFD. QFD was first conceptualized in the late 1960s (Akao, 1997). It was immediately adapted by various companies but it did not draw much public attention. A few years later, in 1972, QFD was implemented at the Kobe shipyards of Mitsubishi Heavy Industries Ltd. Even though its application was followed by successful implementations throughout Japan, e.g. at Toyota, it remained a Japanese tool until the early 1980s. Following the article by Kogure and Akao (1983) and through Ford Motor Company and the Cambridge Corporation, QFD has entered the borders of the US and has started to play an important role at companies such as General Motors, Chrysler, Digital Equipment, Hewlett-Packard, AT&T, Procter and Gamble, and Baxter Healthcare (Prasad, 1998).

There are two major organizations as sources of QFD, namely the American Supplier Institute (ASI) and GOAL/QPC that both developed their own models having many similarities to each other. The ASI employs a basic four-matrix method developed by Macabe, a Japanese reliability engineer, while GOAL/QPC uses a multiple matrix developed by Akao that incorporates many disciplines into a less structured format consisting of a matrix of matrices (Shillito, 1994).

The basic concept of QFD is to translate the desires of customers, i.e. the voice of customer, into product technical requirements (PTRs) or engineering characteristics, and subsequently into parts characteristics, process plans and production requirements. In order to establish these relationships QFD usually requires four matrices: product planning, parts planning, process planning, and production planning matrices, respectively. Product planning matrix translates customer needs into product design requirements; part planning matrix translates important design requirements into product/part characteristics; process planning matrix translates important product/part characteristics into manufacturing operations; production/operation planning matrix translates important manufacturing