

QFD Application in improving Car Dashboard Design

NGUYEN VUONG CHI^{1*}, NGUYEN THUY QUYNH LOAN²

¹Department of Transportation Engineering, Ho Chi Minh City University of Technology

²School of Industrial Management, Ho Chi Minh City University of Technology

E-mail: nvchi@hcmut.edu.vn

Abstract: This paper presents a review of Quality Function Deployment(QFD), especially in House of Quality (HOQ) - a first matrix of QFD. The paper then illustrates the steps to develop a HOQ based on "Voice of customer" (VOC) about car dashboard. HOQ is a base to generate improvement ideas for some parts of car dashboard. Namely, two functions selected for design improvement are a forced exhaust system and a multipurpose cup holder. The ideas of design improvement are developed based on CAD model application.

Keywords: QFD, HOQ, VOC, car dashboard, CAD.

Introduction:

QFD is increasingly common use in many areas of manufacturing and services. QFD was first proposed in Japan by Yoji Akao in 1966. However, it did not emerge as a viable and formalized to quality control in planning until 1972, when it was introduced QFD at Mitsubishi's Kobe shipyard [1]. In the late 1970s, Toyota automobile manufacturer implemented QFD and further developed the concept of QFD in the detailed process [2]. In 1986, Ford Motor and Xerox were two first companies QFD applications in the US. Since then, QFD has been used as a common tool for product development and quality improvement in the whole world [3]. Currently, QFD is used widely in industries such as electronics, automotive, aeronautics, space, medical, insurance, software engineering, banking, food processing, construction and marketing... [4]. Many multinational companies such as IBM, HP, Baxter Healthcare, Texas Instruments, General Motors, Digital Equipment, Black and Decker, and Philips International and so on have applied QFD in production and operation. The main reasons of QFD application are to save time in designing and developing product, to focus on customer satisfaction, and to improve information to all levels of the organization [5]. This paper reviews QFD process and illustrates a case of QFD application in improving the design of a car dashboard.

Literature review and Methodology:

– QFD concept

QFD is a technique for developing a quality design to satisfy consumers by translating customer needs into design targets and making major quality assurance points to be used throughout the production stage [3]. The main idea of QFD is to establish the necessary control points before production in order that product quality can be ensured in the planning stages. Based on the principles of total quality management (TQM), QFD focuses on providing value by understanding customer needs and deploying this information throughout the

development process as well as the production process and system control. QFD is a widely used systematic process utilized by cross-functional teams to identify and resolve issues arising from the provision of products, processes, services, and strategies intended to enhance customer satisfaction [6]. QFD is a method of indicating the development or deployment of the features or engineering characteristics that provide a quality product or service.

– QFD Process

QFD is a process of visual linkages to help QFD teams focusing on the needs of customers throughout the total development cycle. It provides the means in translating customer needs into appropriate the engineering characteristics for each stage of a product/process development life-cycle [7]. QFD consists of 4 matrices (or houses) from design of product to design of manufacturing process (Figure 1) [8]:

- Product planning (house of quality): transferring wishes of customer into product characteristics, evaluation of competitor products, and identification of important engineering characteristics.
- Product design (parts deployment): choosing best design to fulfil targets, identifying critical parts and components, conducting further R&D if needed.
- Process design (process planning): identifying critical parameters, setting process control/improvement methods
- Production design (production planning): designing instructions for production, defining measurements, frequency and tools to be used.

Each matrix is represented each stage of the QFD process. In the first stage, the engineering characteristics or features are the most important. Almost customer needs are met by the values of the engineering characteristics at the bottom of matrix that become the input to the next stage in the QFD process.

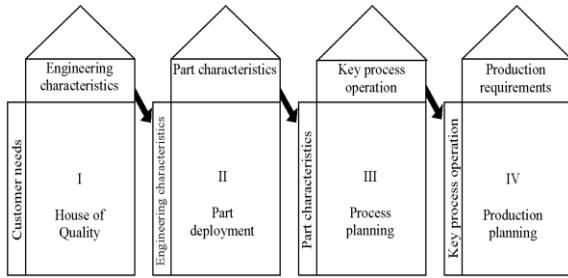


Figure 1: The link of QFD matrices [8]

– **House of Quality**

House of quality (HOQ) is the first matrix of QFD. It consists of six steps (or 6 rooms):

- 1) Identifying the customer needs (WHATs) in the left room of the house: Determine who are the customers and what are the customer needs, then classify and prioritize their needs and assess relative importance of the needs;
- 2) Comparing the competitiveness of the product/service in the room right: customers compare the product/service competitiveness of a company with one or more competitors;
- 3) Translating the customer needs into engineering characteristics (HOWs) in the room under the roof: List the engineering characteristics/features of product/service that meet the customer needs;
- 4) Identifying the relationship between the WHATs and the HOWs (relationship matrix) in the central room: Identify the relationships between the engineering characteristics/features and the customer needs, and determine the levels of these relationships;
- 5) Determining the relationships among the engineering characteristics/features of the roof matrix: This matrix is where the contradictions of the engineering characteristics/features are demonstrated;
- 6) Designing quality target value of the product/service in the basement room: Select the standard design features, set the target value, determine the cost and important levels of each design features of the product/service.

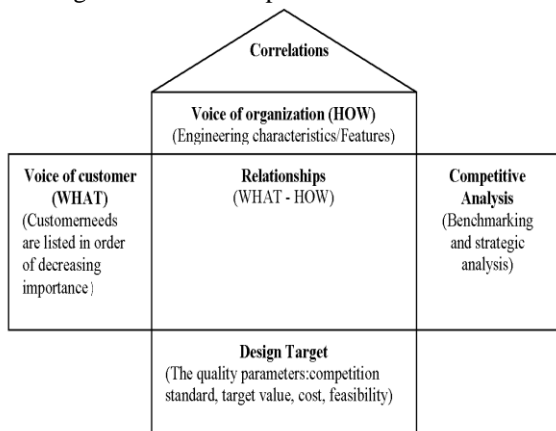


Figure 2: House of Quality – HOQ [8]

The highlight point of HOQ is to set the target values that are oriented to the customer needs and how to achieve the engineering characteristics. The ranking

of the competitor products can also be done by benchmarking techniques. The HOQ matrix is a multifunctional tool that can be used in the organization. For engineering, it's a way to summarize the basic data in a form can be used. For marketing, it represents the voice of the customer and managers use it to find new opportunities.

– **Methodology**

This paper uses desk research method. Namely, it is review of concepts related to QFD, especially in HOQ, and then illustrates a case of HOQ application in design of car dashboard.

Results:

This part illustrates the case of HOQ application to improve some parts in a car control panel (Dashboard) of a researcher team (QFD team) of a university in Pakistan [9]. The HOQ development of car dashboard was followed the steps in the literature review, in which the highlight point was the first step - customer need identification.

– **Identify customer needs for car dashboard**

A questionnaire was designed to collect “Voice of Customer” (VOC) to correctly identify the customer needs and they were then translated into the engineering characteristics/features. This study identified the customer needs by surveying customers used cars in the past few years or experts related to cars such as technicians and sales personnel of Toyota and Honda. Two surveys were conducted in the study. The first survey was conducted to find out the functions of car dashboard for improvement, the results showed two functions such as a forced exhaust system and a multipurpose cup holder. The second survey was conducted to understand the “Voice of Customer” on the functions of the forced exhaust system and the multipurpose cup holder, and then be converted to the customer needs (in the left room of HOQ in figure 3). Based on the results of the customer’s evaluation, the importance of each customer need was shown in column 14 of Figure 3. The importance of the customer needs is scored from 1 to 5 (5 - the most important and 1 - the least important).

– **HOQ of car dashboard**

In Figure 3 (at row 13 and 15), the feature of the “Area of the blower” got the highest score (135) with ranking 1. The area of the blower was related to the customer needs such as incorporate a forced exhaust system, not interfere with vehicle operation, efficient operating system, user friendly, attractive design, cost effective, reliable design, and flexible design. The feature “Speed of the blower” had the second high score (114) with ranking 2. The speed of the blower was related to the needs of customers such as incorporate a forced exhaust system, efficient operating system, and attractive design, cost effective. The feature “Clamping force” of the multipurpose cup holder had the third high score (93) with ranking 3. The clamping force was related to the

needs of customers such as multipurpose container, good ergonomics, user friendly, automatic operating systems, reliable design, and flexible design. In addition, there were the positive correlations between clamping force and container diameter, clamping force and spring stiffness in the roof matrix of HOQ. Similarly, there were the positive correlations between the area of the blower and area of the duct, speed of the blower and climate condition, speed of the blower and operation time. It was recognized that three features could respond all of customer needs and had positive correlation to several remaining features. Therefore, these features were prioritized for the improvement.

The analysis above reflects the usefulness of the HOQ analysis in defining the features of car dashboard to provide a compact design for the forced exhaust system and the multipurpose cup holder in meeting the customer's needs and expectations.

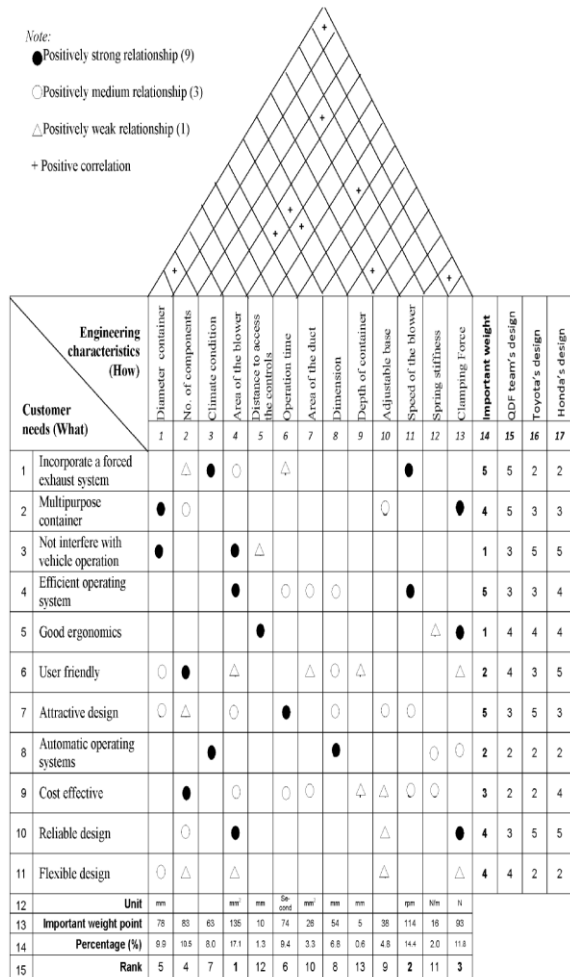


Figure 3: HOQ of car dashboard

Improvement ideas

Based on the results of HOQ analysis, the QFD team has generated innovative design ideas for the forced exhaust system and the multipurpose cup holder as follows:

Figure 4: Existing exhaust system in car

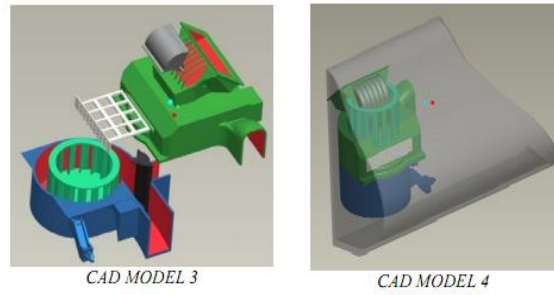
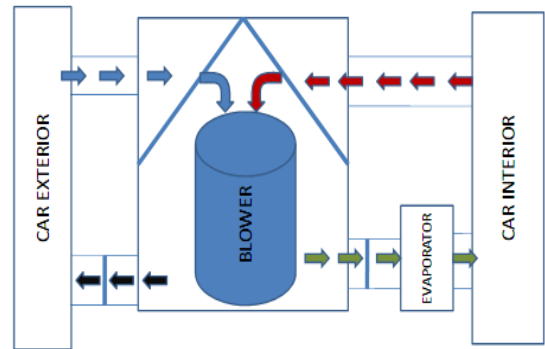


Figure 5: Idea generation for the blower of car A/C system



Honda cup holder



Self-adjustable cup holder

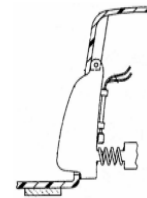
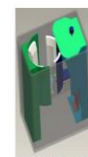


Figure 6: Existing cup holder

Idea 1



Idea 2



Idea 3



Figure 7: Idea generation for the multipurpose cup holder

Conclusion:

In today's competitive world, customer satisfaction is a vital goal to be accomplished at an affordable cost. One important factor in customer satisfaction is the effective identification of customer needs. This study aimed to illustrate QFD application to improve quality of product design using priorities of customer needs in terms of case in car dashboard. QFD provides a structured approach for translating VOC into design requirements and guiding product development process and improving the success rate for new products. Two functions of the car dashboard chosen for the improvement are the forced exhaust system and the multipurpose cup holder. Based on customer surveys, the question "WHATs" had found a VOC and converted into the customer's needs. Engineering characteristics (HOWs) are developed to achieve the needs of customers. HOQ was built by developing the relationship between the WHATs and HOWs. The innovative ideas were developed based on the CAD model for the design of the forced exhaust system and the multipurpose cup holder. The case of QFD in this paper is a good practice for Vietnamese manufacturers in QFD application aimed at improving the design quality and then achieving greater competitive advantage.

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