



Listening to the Customers: How Quality Function Deployment (QFD) Addresses the Expectations of People in Various Fields Especially in Education

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Abstract

Quality Function Deployment is a versatile methodology, which systematically helps, enhancing the quality of products, services, etc., by incorporating the wishes and needs of the customers. It can be applied in almost every field of life, including transport system, library management system, online admission system, examination system, engineering, agricultural, software, and so on. The rationale of this article is to express the versatility of QFD. This broader objective is achieved by describing what QFD is; and how it works. Relevant literature indicates its application integrated with other methodologies. Special focus of this article is how QFD be used to improve various sections of education in Pakistan. The familiarity with QFD will motivate educational practitioners, researchers and many other to apply it in their relevant fields of interest to get improved quality of product or services with less cost and time.

Key Words: Customers, Quality Function Deployment, Education

Introduction

Quality Function Deployment (QFD) is meant for translating needs, demands or requirement of potential customers into technical solutions that are, then, incorporated in the final products for the purpose of improving the quality. Sullivan (1986) says that Quality Function Deployment (QFD) is ‘‘an overall concept that provides a means of translating customers’ requirements into the appropriate technical requirements for each stage of product development and production (i.e., marketing strategies, planning, product design and engineering, prototype evaluation, production process development, production, sales’’ (P.39). Two important aspects are involved in QFD as the ultimate goal of QFD. These are Total Quality Control (TQC) and Quality. Feigenbaum (1983) explains the ‘‘Total Quality Control as an effective system for integrating the quality-development, quality-maintenance, and quality improvement efforts of the various groups in an organization’’ (P.6). on the other hand, ‘‘quality can be viewed as exception, as perfection, as fitness for purpose, as value for money and as transformative’’ (Harvey, 1993, p.9). As far as the quality of the product is concerned, Bergman & Klejsjö (1994) mentions, ‘‘The quality of a product (article or service) is its ability to satisfy the needs and expectations of the customers’’ (p.16).

As QFD was primarily built up for the development of quality products in the light of voice of the customers (VOCs). However, the implication of QFD has been extended to a number of fields such as decision-making, planning, services, design, education and research and more other potential fields (Chan & Wu, 2002).

The focus of this article is to explain the QFD method and its application to various fields especially the education and research. This article would introduce this useful technique to specially the researchers in the field of education who, at present, mainly use traditional method of survey. QFD would attract the education researchers and academicians because it provides a procedure through which the practical solution of the problem under study is proposed in a way that stakeholders are involved to build the concept of improved product and services.

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Objectives

The intended objectives of this article are stated below.

- i) To explain comprehensively the QFD and how it works, i.e., details of its various sections
- ii) To mention how QFD helps in various fields
- iii) To highlight QFD and its integration with other methodologies
- iv) To draw special focus on how QFD be used to improve various aspects of education
- v) To point out how QFD methodology can help improve the education in Pakistan

Quality Function Deployment: An Overview

Shigeru Mizuno and Yoji Akao originally developed QFD in Japan in 1966 as a procedure to produce quality product (Bergman & Klefsjö, 1994). However, its real onset and rise was observed in 1972 after Mitsubishi Heavy Industry and Akao's published article in Standardization and Quality Control, 1972 (Abu-Assab, 2012). Since after its initial development, QFD was introduced in US in 1980, and later in other countries (Chan & Wu, 2002).

QFD consists of a systematic procedure that helps in such a way whereby customers' demands, opinions and expectations provide a guideline to design and produce a quality product or service. The explanation of terms/words coined the QFD can be helpful in understanding this technique.

- Quality - Meeting the expectations/needs of the Customer
- Function - What is necessary to be done? It refers to focus to be given to which aspect.
- Deployment - Who will be responsible to take action and when?

Akao (1990) stated that the proper application of QFD successfully and significantly reduces both of the cost and time as well as development of the product or process. The utmost aim of applying QFD is the achievement of end product or process having the enhanced qualities based on customer-driven requirements and expectations. Singh & Rawani (2018) view QFD as a quality management tool being practiced in achieving the quality product or service.

The wishes or expectations of customers are called Voice of Customer (VOC) that are actually the source of finding the technical solutions (called as voice of engineering (VOE)).

According to Soewardi and Edhi (2017), QFD is an organized and systematic methodology which helps product designers to identify the required attributes of product according to voice of customer. Sahari et al. (2017) explained the QFD as quality and planning tool which enables product designers and developers to identify the detailed information of customers' needs and requisites before development of final product or process that qualify the standard demanded by most of the customers.

QFD: HOQ Structure Elements

House of Quality represents a matrix that correlates the customers 'requirements (Zare Mehrjerdi, 2010). As the top structure of House of Quality looks like a house, therefore, it was named House of Quality (Zare Mehrjerdi, 2010). The diagrammatical representation of a typical House of Quality (HOQ) is given in Figure-1.

HoQ is a matrix that helps in developing a conceptual map for designing a product (Clausing, 1994). It is the place where the gathered customers' requirements are so organized that demonstrate various areas of customers' interest, findings and their prioritizing. Sullivan (1986) cited five fundamental aspects linked to QFD

1. Voice of the customer (VOC) expressed as the needs of customers.
2. Representation of the customer's voice in technical terms (technical attributes).
3. Product quality deployment- translates the voice of customer into counterpart characteristics.
4. Deployment of the quality function. Assigning the responsibilities to specific department of person to achieve customer-required quality.
5. Quality tables- the matrices developed to integrate the voice of customer into final product.

The inclusion and representation of all the key relationships into diagram is known as the house of quality (Sullivan, 1986).

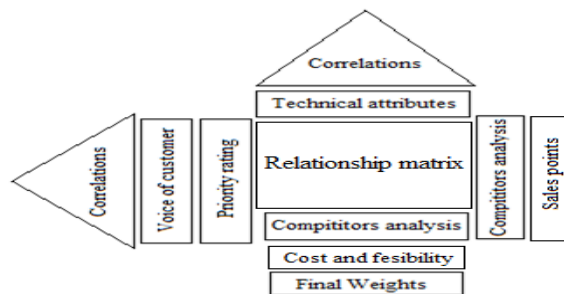


Figure 1: House of Quality (HOQ)

Source: (Griffin & Hauser, 1993)

Researcher, practitioners and product developers accumulate data for HOQ by different means. In coming part, different sections of QFD and their roles are described.

Voice of Customers (VOC).

Who is Customer?

The initial step to build house of quality (HOQ) begins with the Voice of Customer, that are, in fact, their demands and needs. Before proceeding further, it is imperative to know who is the customer?

“The customer concept is vital” in QFD method as it implies ‘the people or organizations that are the reason for our activities’, i.e., those for whom we want to create value” (Bergman & Klefsjö, 1994, p.27). There may be many categories of the customers relevant to the organization whose interest or expectation may not coincide. Therefore, every organization identify its customer “for whom are we trying to create value?” (Bergman & Klefsjö, 1994, p.28). A customer may be consumer, client or purchaser; and interested party -the person or group showing concern with the success of the organization that may include customer, owner, employees, supplier, investors, and society (Bergman & Klefsjö, 1994).

Finding the potential customer is of significant importance in conducting research under QFD. Different means are used to know about the taste and perception of prospective customers. Japanese firms use a simple way. They place their product in public place and offer potential customers to observe it. Meanwhile technical team listens and records what people comment. But, for formal research, one to one interview or focus groups in-depth interview may be conducted (Griffin & Hauser, 1993; Tan, et al., 1998).

VOC Importance Rating

After identifying and selecting the customers’ demands and needs, the next substantial step in QFD is to rate precisely the importance of VOCs because it largely influences the Final Weights (FWs) of the Technical solutions (TSs) based on which a quality design of a product or service is developed to the maximum satisfaction of the customers (Mehdizadeh, 2010).

Usually the customers are requested to assign importance level to each demand by applying a qualitative-numeric ordinal scale. Assigning a smaller number means low importance and large number refers to high importance. This is the most commonly used and simple way for priority rating of VOCs; and it has been observed that various types of priority rating scales for importance of WHAT are reported in literature. Table-1 summarizes some of them.

Table 1. Customer Importance Rating Scales

Authors	Customers Priority Rating Scale
Bouchereau & Rowlands (2000)	1, 2, 3
Dikmen, et al., (2005)	1 – 9
Tanik (2010)	1 – 10

Majid & David (1994)	1 – 5
Masui, Sakao, Kobayashi, & Inaba, (2003), Olewnik & Lewis (2008)	1, 3, 9
Park & Kim (1998)	Proportions of 1

Technical Solution (TSs)

It refers to the ‘technical descriptor’ or Voice of Engineer (or expert) who decides how to do after having been identified what to do by marketing team. Many terms are being used by the researchers, practitioners, product developers for technical characteristics that deals with HOWs, like engineering characteristics (EC), Technical Solutions (TSs), Solution of Voice of Customers, (SVOCs), etc. Technical team selects those TSs that are expected to affect at least one or more needs and demands (Chan & Wu, 2005). Sometimes arrow signs or positive/negative signs are used to show the direction of improvement. There should not be any ambiguity or vagueness in understanding TCs (Hauser & Clausing, 1988).

Relationship Matrix (RM)

Relationship matrix is one of the most essential segments of the QFD process. It shows the strength of the relationship between VOCs and TSs. It indicates how much each VOC relate to each TS. The relevant literature suggest that three or five-points qualitative-numeric rating scales are usually adopted to indicate different levels of strengths of relationships, i.e., weak, medium and strong. Tan, et al., (1998) applied 1, 3, 5 numeric values, while Jeong & Oh, (1998) preferred 1, 3, 10; and Bouchereau and Rowlands (2000); Dikmen et al.(2005) ; Ghiya, et al., (1999) and Majid & David (1994) reported 1,3 and 9 values. It is also revealed that five-point scales consisting of 1, 3, 5, 7, 9 values as stated by Chan et al. (1999); and 1, 2, 3, 4, 5 by Crowe & Cheng (1996) to represent Very Weak, Weak, Medium, Strong and Very Strong relationships.

Final Weights (FWs) of Technical Solutions

The entire journey of QFD process which proceeds from the selection of VOC through formulating many other elements and finally ends at FWs of Technical Solutions. FWs set the directions that how customer’s satisfactions can be achieved one by one.

Application- How QFD Helps in Various Field.

Kabukcu (2016) applied QFD in fashion industry as “QFD is a customer-driven product development technique that translates customer’s needs into design requirements (DRs). It ensures that the voice of customers is implemented into final products or services to increase customers’ satisfaction (p.209). Kamal, et al. (2016) applied QFD in redesigning cultural fashion product and found it a useful tool in the development of product by applying effective use of Voice of Customer for the collection of customers’ needs in order to fulfill the market requirement.

Bolar et al. (2017) implemented QFD in infrastructural maintenance activities, and found it a valuable decision-making tool to address the customers’ dynamic needs and demands. These demands can be collected through well managed repeated survey or proper communication with the customer and manufacturers before starting maintaining infrastructural activities within their available limited resources.

Tripathi et al. (2019) devised a new rounding policy by successfully adopting QFD in establishing the ICU rounding process. They also implemented this new policy and reported that principles of QFD proved to be of practical application in a multidisciplinary clinical process like rounds.

Lin & Pekkarinen (2011) developed a QFD framework by integrating the HOQ and modular logic in designing logistic services having the capacity to dispense high-quality logistic services by converting customers’ expectations into service design.

The requirements of patients for effective medical treatment is the critical aspect that needs to be addressed seriously. For this purpose, QFD methodology assist hospitals to identify and then convert the customers’ needs into suitable service provision (Camgöz-Akdağ et al., 2013). Application of QFD is most advantageous in service

industry, distinctively for hotel business or hospitality industry where execution of QFD gives profitable consequences (Paryani, 2010).

The QFD is proved to be beneficial during implementation stages of project in the construction industry. The use of QFD not only gives short-term solution but also provides long-term solution to maximize the quality of construction or the housing projects (Dikmen et al, 2005). QFD is being applied in after sales service department of international construction machinery manufacturing firms to determine the opinion of customers regarding after sale service (Pakdil et al., 2012).

So, Quality function deployment (QFD) has world-wide utilization in almost every field of life. It is implemented through the interpretation of Voice of customers and their technical solution or attributes.

QFD and its Integration with other Methodologies

Some extensions or adaptation of QFD are practice to make QFD more workable and effective by integrating various approaches as mentioned below. Here we deal with five variations that are mentioned more often in the literature.

Entropy Method

Entropy method developed by Shannon and Weaver (1947) to measure the expected information in the data by using following equation.

$$e_i = E(p_1, \dots, p_m) = -k \sum_{i=1}^m p_i \ln(p_i)$$

Where p_1, \dots, p_m are the probabilities and $k = 1/\ln(m)$ is a positive constant that normalised e_i between 0 to 1. Intuitively, larger variation from p_1 through p_m values comprises of larger information available in the data and small variation determines small information. In case of no variation (all data values are constant) means that no information is available and, therefore, entropy value becomes 1. QFD researcher and practitioners usually use this theory to compute competitive priority between competitors for each VOC. They use entropy information criteria in two ways based on the information available.

- 1) Chan, et al. (1999) used entropy theory to assign a low competitive priority in two situations as :
 - a) If a company performance is already very good, then there is no need for improvement
 - b) if company performance is very low then it will be difficult for the company to improve.
- 2) Wu and Lin (2012) used entropy theory with a different aspect. They computed competitive priority based on information- more information refers to more weight and vice versa. The following technique indicates that more variation, more information but smaller value of entropy. So to increase its weight, subtract from 1, i.e.

$$d_i = 1 - e_i$$
$$W_i = d_i / \sum_{i=1}^n d_i$$

Analytical Hierarchy Process (AHP)

Saaty (1980) developed Analytical Hierarchy Process (AHP) that deals with decision making about the problems related to multiple criteria. A matrix consisting of pairwise comparisons is generated to compute the importance weight of each criteria. AHP has been largely practiced by researchers and practitioners due to its scope and ease of application. (Ho, 2008). The following three steps are included in AHP to develop the priority rating.

- a) create hierarchy
- b) AHP priority analysis and, then
- c) find consistency.

AHP has extensive application in finance, environment, business, marketing, health, agricultural, industry, service, manufacturing, military, logistics, social, political and many other areas.

Fuzzy Methods

It is to point out that the major issue related to QFD . deals with qualitative data. The whole structure of the HOQ contain qualitative data with diverse scales and different lengths. The vagueness and inaccuracy hidden in the qualitative data are difficult to quantify accurately (Tsai, et al., 2003). Zadeh (1965) introduced fuzzy sets theory in 1965. This method can help to use linguistic variables as fuzzy qualitative data; and can model the vagueness in a proper way. The rationale of this technique is that instead of using crisp rating (exact values), ranges of values are used. Fuzzy scales can help to reduce vagueness and is more representatives of variability, (Bouchereau and Rowlands, 2000)

Conjoint Analysis (CA)

Conjoint analysis (CA) is a research method used for establishing the priorities when selections are to be made among different levels. It has also been used to compute the importance of attributes of a new product. CA first introduced in 1964 by Luce & Tukey, and later suggested for market research by Green & Rao in 1971, (Green & Rao, 1971; Luce & Turkey, 1964). CA determines the preference structure for technical attributes which have multiple levels.

Kano's Model

Professor N. Kano introduced this model in 1984 (Kano, et al., 1984). Kano model divides the demands and needs of customers into following three different classes (Bayraktaroglu & Özgen, 2008; Shen, et al., 2000).

One dimensional attribute

These attributes and their increased performance promote the customer's satisfaction. Usually, customer wants to know about these. For example, in purchasing a car, the number of kilometers a car covers in one liter of fuel- more the kilometers more is the customer's satisfaction.

Attractive attributes

These attributes, in fact, generate additional satisfaction of the customer. Their absence does not cause disappointment because the user does not require these. Anyhow, more attractive attributes more satisfaction of the customer. For example, power rear view mirror.

Must-be attributes: These are the basic and important needs. Customers always require the presence of these attributes in the product/service. Absence of any attribute means dissatisfaction of the customer. For example, no scratches, standard rim etc.

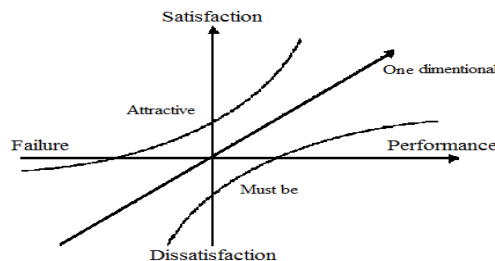


Figure 2: Kano's Model

Source: (Bayraktaroglu & Özgen, 2008; Tan & Shen, 2000)

QFD and Education

Education is the broad service providing sector of any society. Being a vital organ of the society, quality is its central concern. A number of methods, techniques and strategies are applied to achieve the ever-demanding goal of quality because the quality of education, directly or indirectly, have the impact on almost every domain of the society.

The development in any field cannot be achieved without research keeping in view the present and future orientation of progress. There are multiple methods of research developed by researchers to solve the problems

of varied nature because any problem cannot be resolved by any method. That is why, researchers remain in continuous effort to develop new methods of research to address emerging problem that cannot be solved by existing techniques. QFD is also research method that offer a unique way to deal with the problem. QFD method is being used to conduct quality research in the field of education.

Motwani et al. (1996) conducted a research under QFD to evaluate MBA program at Grand Valley state University focusing to extract ideas how the university could do to improve it.

QFD, as customer-oriented and total quality management technique, was adopted by Owlia & Aspinwall (1998) in higher education for improving process and design outlining of a QFD model for quality planning based on the views of three groups of customers. Raharjo et al. (2007) used QFD and the Analytic Hierarchy Process (AHP) to propose a methodology for the improvement of higher education and its quality; and concluded that higher education institutional quality could be improved if the institution take steps “to develop the overall facility, re-evaluate existing curriculum, reduce unnecessary bureaucracy, improve lecturers’ qualifications, and provide more leadership/team training” (P.1112).

Zheng et al. (2011) conducted a survey through a questionnaire about the satisfaction of students for curriculum in Nanjing Higher Vocational School, identified analytic findings by using GAP-QFD and provided direction for curriculum reform. Murgatroyd (1993) examined how Quality Function Deployment (QFD) methods could be applied for designing, developing, and delivering courses under a program through distance education. Sahney et al. (2004) writes that educational and learning organizations are also taking into account the consumer’s demands through the use of methodologies such as Total Quality Management (TQM) and QFD to enhance the performance of institution.

The application of QFD methodology in higher education guides to evaluate various ideas of enhancing the knowledge level of students and promote teaching techniques by identifying elements necessary for development (Bakhru, 2018).

How QFD Can Help Improving Education in Pakistan.

Customer Requirements and Desires (CRD)

It is already discussed that every organization decides about who are the customers, for whom it is going to create value. As far as the education is concerned, there could be as many customers as the stakeholder are. For example, parents, children, teachers, administrators, owners, employers, etc. The requirements of any one or many of them will be their voices (Customer Requirements and Desires-CRD). If we include parents as customers, their CRD are actually taken as Voice of parents (VoPs). In the same way, the CRD of students will be denoted as the Voice of Students (VoSs).

So, as basic first step of the project to resolve any problem for the purpose of improving education, conduct a survey to collect possible requirements and needs of customers (in this case, parents, students or any concerned person) as their CRD or voice of customer along with how important each of the Voices is on ordinal rating scales from 1 to 5, where 1 to 5 ranges in ascending order of importance.

After the collection of CRD or Voice of parents or any concerned customer, the next step is to find out the solution of these voices.

Technical Solution Requirement (TSR)

Once the Voice of Customers as VoPs or VoSs have been identified and collected, their Importance Ratings (IRs) are determined. In the next step, the Technical Solution Requirements (TSRs) as Solution of Voice of Parents (SVoPs) or Solution of Voice of Students (SVoSs) or any other are determined. Technical Solutions Requirements (TSRs) are the technical requirement to meet Customer Requirements and Desires (CRD) or their voices. The TSRs are the technical translation of CRDs to attain utmost gratification of clients (Bouchereau and Rowlands, 2000). Hauser and Clausing (1988) recommended that each TSR is supposed to resolve at least one CRD. The selection of TSRs are very important phase is QFD; and are called the heart or soul of QFD methodology (Govers, 1996). The research finds out and finalize SVoPs as customers with the consultation of teachers, education experts, owners and stake holders.

Developing the Relationship Matrix (RM)

The Relationship Matrix (RM) consists of rows and columns in which rows are actually Customer Requirements and Desires (CRD) / Voice of Parents (VoPs) or any customer, and columns are the Technical Solution Requirement (TSR) / Solution of Voice of Parents (SVoPs) or any customer. RM expresses strengths of relationship between each CRD or VoPs as customers and TSR or SVoPs or any customer involved in the study. The RM explains how CRD are accomplished through TSR/SVoPs (Han et al., 2001). Using the ordinal scale is the norm where small scales represent weak relationships and bigger numbers show the strong relationship. Under the application of QFD methodology to education system, determine strength of relationship between VoPs and SVoPs or any customer(s) involved.

Determination of the Final Weights (FWs) of TSRs/SVoPs

The method used for determining FWs is calculated by the following equation 1, (Jeong and Oh, (1998); Bouchereau and Rowlands, (2000); Hoyle and Chen, (2007), Iqbal, et al. (2014).

$$FW_j = \sum_{i=1}^r R_{ij} * I_i \quad i = 1, 2, \dots, r, \quad j = 1, 2, \dots, c \quad (1)$$

FW stands for the Final Weight of TSRs/SVoPs; R denotes Relationship Matrix; 'I' represents the customer priority rating; 'i' is the number of VoPs, and 'j' is the number of SVoPs if the parents are included as customers.

Conclusion

The aim of under taking this research was to invite the attention of the researchers, especially in the field of education to the application of QFD, which being used extensively in almost every field of study or services. In this article, we achieved the objective by describing the nature of QFD and how it works. We described its various sections and comprehensively explained the application of QFD in various field of life. QFD combined with other methodologies can be used. This aspect is also highlighted with the intention of familiarizing the novice researcher with the development adopted by experts in using QFD. In order to improve education system in Pakistan, we have described all the important steps of QFD to be followed. Following the steps to improve education, QFD can be used to improve many other systems, for example, transport system, admission system, library management system, online admission system, examination system, banking system, hoteling services, logistics, sports, engineering, agricultural, environment, software, e-business, medicine, hospitality. etc.

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