



Using Application of Quality Function Deployment (QFD) to study and enhance the healthcare sector to combat the COVID-19 pandemic

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Abstract. Quality Function Deployment (QFD) integrates customer requirements into product and service design. Understanding customer needs is crucial for successful development. Quality Function Deployment (QFD), a set of concepts and tools often used in manufacturing engineering and services to link consumer needs with product design, can be used to improve customer satisfaction. This paper evaluates the healthcare sector in Benghazi during COVID-19 and recommends strategies using QFD to enhance response to future pandemics. QFD utilizes customer demands to meet client missions, with the House of Quality (HOQ) determining customer needs. Applied at Benghazi Medical Center, the methodology prioritized customer requirements, resource allocations, and technical needs during the pandemic. QFD is a system that utilizes customer demands to meet client missions by outlining what the customer wants in a service or product. House of Quality (HOQ) part of QFD was used in this research to determine customer needs and thus to ensure that customer demands are met. This methodology was applied for evaluating Benghazi medical center services during COVID-19 pandemic. The HOQ methodology can serve as a powerful tool for developing new products and services. The results show that providing seminars and workshops to the medical staff to educate and prepare them for current and future pandemics and supply with good medicine and medical equipment's are most factors should be considered.

Keywords: QFD, Customer demand, and Satisfaction, Education sector.

1 Introduction

A pandemic refers to a widespread epidemic affecting multiple continents or the entire world, often resulting in significant fatalities and economic disruption. Historical examples include the Asian flu (1957-58) and the Hong Kong flu (1968), both causing millions of deaths (Khan, Ali & Pamucar, 2021). The World Health Organization (WHO) recognized COVID-19 as an international public health emergency on January 30, 2020, and declared it a pandemic on March 11, 2020. Originating in Wuhan, China, COVID-19 symptoms include a persistent cough, fever, and shortness of breath, with human-to-human transmission being a key factor (Khan, Ali & Pamucar, 2021). The COVID-19 pandemic highlighted the vulnerability of individuals regardless of age, gender, race, or religion, and exposed the lack of immediate medical solutions. It resulted in socio-economic insecurity and revealed global governance limitations (Morens, Folkers & Fauci, 2009). To combat pandemics effectively, the healthcare sector needs to be resilient, capable of preparing for, withstanding, recovering from, and quickly adapting to adverse conditions.

1.1 Study objectives

This study aims to evaluate the HC sector during the COVID-19 pandemic within public and private hospitals in Benghazi city and recommend some strategies to enhance the HC sector and be able to combat any other pandemic in the future and have a quick reaction.

1.2 Quality Function Deployment (QFD)

Quality Function Deployment (QFD) is a strategic tool guiding design teams to meet customer needs throughout product development. "Deployment" in QFD identifies key requirements for each phase of the Product Development Process (PDP) and pinpoints necessary technical characteristics. Graphical representations aid in systematically identifying process elements and establishing relationship matrices among parameters. Rigorous data collection ensures a thorough exploration of the problem. QFD fosters consensus and understanding among teams, akin to brainstorming, and spans various design stages to effectively guide development. The entire QFD process is illustrated in Figure 1, showcasing three key aspects. The term "houses" is used for the phases of QFD, particularly the first phase, product planning. The QFD process consists of four sequential phases, where the output of one phase serves as the input for the next. The product planning phase, known as the House of Quality, provides results that inform the design of individual parts. These then serve as inputs for the process planning design stage, which in turn feeds into the production planning phase of QFD.

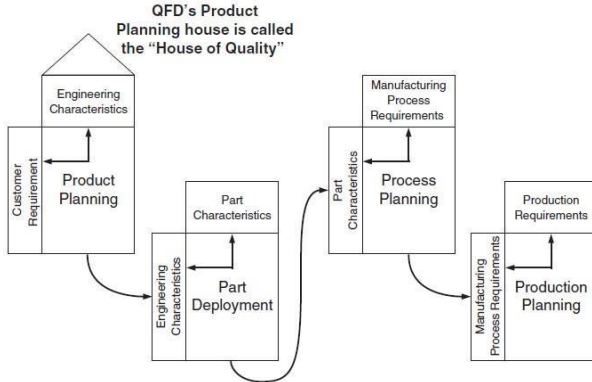


Fig. 1. Diagram showing the four houses of the complete QFD process

2 Methodology

The Quality Function Deployment (QFD) model, documented by Akao & Mazur (2003), evolved from Japanese companies' shift in product development approaches within total quality management (TQM). Initially focused on imitation, QFD transitioned to product development originality. Chan & Wu (2002a) noted about 650 QFD publications. Prasad (1998) highlighted QFD's focus on product quality, while Fisher & Schutta (2003) saw benefits for service industries. Day (1993) supported proactive over reactive product development, with Chan & Wu (2002b) explaining that efforts in process design and product planning yield higher returns than those in manufacturing, packaging, and delivery stages. In this paper, we passed out the survey and the results were summarized in table 5.

2.1 The House of Quality (HOQ)

Referring to Figure 1, the Quality Function Deployment (QFD) illustrates all four houses. Accordingly, Govers represented the HOQ with straightforward logic and fundamental elements, as depicted in Figure 2.

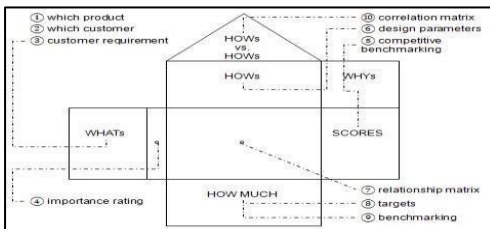


Fig. 2. The HOQ showing the "rooms" of the various steps in the QFD process (Govers, 1996)

As illustrated in Figure 2, delineated the House

of Quality (HOQ) components. In the left section of the HOQ diagram, one can find the "WHATs," determined by three key factors: products, customers, and customers' requirements. Additionally, an importance rating is assigned to assess the significance of the specified customers' requirements. On the right side, the "WHY" block is

situated, and the competitive benchmarking method is applied to assign scores for both the case company and its competitors. In the middle, the relationship matrix integrates the "WHATs" and "HOWs" through formulated relationships. The initial stage in employing the House of Quality (HOQ) involves pinpointing the customer needs, often referred to as "WHATs." Chan & Wu (2002b) provided a more detailed explanation, stating that the first task for a company's development team in constructing an HOQ is to identify the product's customers. This entails gathering information on their requirements for the product and determining the perceived importance of these needs. Therefore, the primary focus at the outset is to ascertain the identity of the customers. Customers can generally be categorized into three types, as defined by the American Supplier Institute (1994): internal customers (e.g., shareholders), intermediate customers (e.g., wholesalers), and ultimate customers (e.g., end consumers). There are three general types of customers, as American Supplier Institute (1994) defined, which are internal customers like shareholders, intermediate customers like wholesalers and ultimate customers like the ending consumers. And then, the following step is to find out what are the needs of customers for the products or service. According to the methods listed by American Supplier Institute (1994), there are eleven main ways to explore the customer needs. The brief contents of each method are shown in the (Table 2) below.

Table 2. Methods for collecting customer needs (American Supplier Institute, 1994)

Methods	Brief contents
Survey	Mail/Telephone questionnaires
Focus groups	Free discussion holds by selected customers
Individual interviewers	Get the emotional side of the purchasing decision
Product in use	Clinics
Listening and observing	Adopt the "mystery shoppers"
Natural field contact	Sales meetings, service calls, and trade shows
Feedback	Customers go-getter with employees to discuss
Complains	Letters/Hotlines
Warranty data	Service records
Sales records	Reports
Publications	Government/Labs/Journals/Magazines

3 Results and Discussion

3.1 Specifying Customer Requirements

A study was carried out to assess the service quality of Benghazi Medical Center and identify customer requirements. The survey utilized a five-point scale, ranging from "completely disagree" (1) to "completely agree" (5), with a questionnaire comprising 25 items representing seven dimensions: a) responsiveness, b) efficiency, c) quarantine procedures, d) hospital cleanliness, e) behavior towards patients and their companions, f) access to emergency, and g) in-hospital stay. Two versions of the survey, in soft and hard copy, were distributed among a sample of 198 individuals. However, some respondents were excluded as they had not visited the medical center during the COVID19 pandemic, resulting in 162 valid responses for analysis. Appendices A and B present the hard copy questionnaire versions in (Arabic and English) used to assess the quality level. The data collected enabled the calculation of the average evaluation for each dimension, with three dimensions falling below the average and thus identified as customer requirements in the House of Quality (HOQ). Tables 5 and 6 display the survey results and the identified customer requirements.

Appendix A shows the hard copy questionnaire used to measure the level of quality with the sample questions. From the data obtained we calculated the average evaluation of each dimension, three of them were under average and considered as customer requirements in HOQ. Table 5 and table 6 show the results of the survey and the customer requirements results and it were taken from the appendix A questionnaire by take the average of the rank from 1 to 5.

Table 5. Average evaluation of survey dimensions.

Dimension	Average evaluation	Condition of dimension
responsiveness	2.80	unsatisfied
efficiency	2.84	unsatisfied
quarantine procedures	3.11	satisfied
hospital cleanliness	3.08	satisfied
behavior towards patients and visitors	2.83	unsatisfied
access to emergency	3.12	satisfied
In-hospital stay	3.04	satisfied

Table 6. List of customer requirements.

Customer requirement	Explanation
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CR1. responsiveness	Respond faster to emergencies and sudden changes.
CR2. efficiency	Provide better service to the patients.
CR3. Behavior towards patients and visitors	Improving the behavior of the medical staff towards patients and their companions.

3.2 Resilient Strategies

The resilient strategies outlined in Table 7 were extracted from the work of Khan, Ali, and Pamucar (2021) and implemented within the House of Quality (HOQ). The objective of these strategies is to prioritize the enhancement of resilience in healthcare systems, aiming to prevent any potential breakdowns. Noteworthy strategies encompass antiviral treatment and the mitigation of mistrust between patients and healthcare workers.

Table 7. List of resilient strategies.

Resilient strategy	Explanation
RS1. Resilience education	Providing seminars and workshops to the medical staff to educate and prepare them for current and future pandemics.
RS2. The resilient supply chain of medicine and medical equipment	Strengthening the supply chain of essential medicines and other medical equipment.
RS3. Mass prophylaxis and vaccine stockpiling	Treatment to prevent diseases and stockpiling vaccines for future emergencies.
RS4. Continual provision of clinical services in crises	Access to both public and private clinical services.
RS5. Global disease detection and collaboration	Exchange of information, medical equipment, funding, or lending loans to developing nations.
RS6. Developing Continuity of Operations	Continual critical functions through alerting, notifying, activating, and deploying HC force.
RS7. Improve post-pandemic recovery planning	A pre-devised plan for getting things back on track after the pandemic is over.

3.3 HOQ Results

Results of HOQ shown in Table 8.

Table 8. The HOQ

		RESILIENT STRATEGIES						
Customer Requirements	Importance Weight Factor	RS1	RS2	RS3	RS4	RS5	RS6	RS7
CR1	5	9	9	1				
CR2	5	9	3	9	3	3	9	3
CR3	5	3						
Column Score		105	60	50	15	15	45	15
Relative Weight %		34.4	19.7	16.4	4.9	4.9	14.8	4.9
Rank Order		1	2	3	5	6	4	7

The hierarchical arrangement presented in table 8, displays the prioritization of strategies, ranging from the most crucial to the least significant. This information can be utilized and supplied to the medical center for more in-depth investigations.

4 Conclusion

This case study demonstrates the use of Quality Function Deployment (QFD) with House of Quality (HOQ) in medical services, showing how it aligns service design with customer expectations. At the Benghazi Medical Center, this method provided insights into service quality during the COVID-19 pandemic from a customer satisfaction perspective. By identifying critical customer requirements, hospitals can innovate strategies. The study used a questionnaire method, highlighting both methodological and practical benefits. The success of QFD hinges on robust data collection, and aggregating customer demands can be challenging. Despite these limitations, the model's advantages are significant. The House of Quality model clarifies the relationships between healthcare providers' facets and their responsiveness to customer needs. The introduced percentage score enables a detailed analysis of each quality aspect and necessary improvements. Customer survey data aids in comparison and decision-making. The research suggests that this application can assist healthcare providers nationwide with resource allocation. Future research should include financial aspects for deeper insights. As a result, we can see the most important factors are the following: Resilience education, and the resilient supply chain of medicine and medical equipment are very important.

5 Limitations and Future Work

This study faces two main limitations: one methodological and one data-related. Methodologically, it omits the technical correlation matrix from the Quality Function Deployment (QFD) model, focusing only on the House of Quality (HOQ). Data-wise,

a limited number of participants constrained the dataset, affecting result accuracy. Despite these issues, the paper offers a framework for applying QFD to improve aftersales service. Future studies should involve customers in designing questionnaires and use a pre-survey for feedback. Additionally, adopting the Analytic Hierarchy Process (AHP) can yield more accurate data through pair-wise comparisons of customer requirements.

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Appendix A: Questionnaire for the level of quality of Benghazi medical center.

Service evaluation questionnaire

Below is a questionnaire evaluating the services of Benghazi Medical Center (Hospital 1200) during COVID-19 pandemic. Please answer each point according to your own experience. If you do not find a suitable answer, leave it and move on to the next one.

Age Male Female

Have you ever visited the hospital during COVID-19 pandemic? Yes No Were you the patient? Yes No

If you were the patient, did you stay in the hospital? Yes No If you are the accompanying person, did the patient stay in the hospital? Yes No

#	Questions	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied
1	What do you think about the speed of providing a private room for the patient?					
2	What is your opinion about the doctor's responsiveness to patient's sudden changes?					
3	What is your opinion of the doctor's response to the patient upon admission to the hospital?					
4	What is your opinion of the responsiveness to patient requests by the medical staff?					
5	What is your opinion about giving medication doses to the patient at the specified times?					
6	What is your opinion about the doctor's follow-up with the patient after leaving the hospital?					
7	What do you think about sending test results quickly and safely?					
8	What is your opinion about the hospital providing the necessary medications to patients?					
9	What do you think about the doctor explaining how to use the medicine, how to maintain it after discharge, and all the necessary instructions for the patient's safety?					
10	What is your opinion about changing and sterilizing medical equipment?					

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