QFD Approach for the Optimization of Hospital Cleaning Processes and the Implementation of Digital Transformation

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Abstract: Today, the use of digital transformation applications in healthcare services has provided significant improvements in hospital service management. These developments not only focus on patient care and treatment processes but also play a crucial role in improving hygiene and cleanliness processes in healthcare settings. This study aimed to follow a systematic way to improve the quality of service in a university hospital and Gemba and Focus Group studies were carried out. The current situation of the hospital, including the relationships between expectations and requirements, as well as competitors, was taken into consideration. The Quality Function Deployment (QFD) method was used as an analysis and improvement tool. The importance levels of customer expectations were calculated with the QFD. Technical requirements have been determined in order to meet customer expectations. The findings show that hygiene and control-oriented factors have the highest priority; It has revealed that cleaning processes should be supported not only by routine applications, but also by measurable, traceable and digital solutions. The integration of traceability applications with RFID, QR code systems, and blockchain-based models demonstrates that processes can be made more reliable and optimized. As a result, the study highlights the strategic importance of managing cleaning and hygiene processes in terms of preventing infection and operational efficiency of work processes in healthcare institutions. The study proposes a QFD-based improvement roadmap integrated with digital transformation.

Keywords: Digital Transformation, QFD, Healthcare Institutions, Optimization

1. Introduction

Digital transformation is the process of redesigning an organization's existing business processes, service structures, and decision-making mechanisms using digital technologies (Vial, 2019). Its primary goal is to ensure that processes are executed faster, more efficiently, more transparently, and with fewer errors. Digital transformation is not merely the use of technological tools; it refers to a holistic structural transformation that requires radical changes in organizational culture, employee roles, workflows, and service design (Verhoef et al., 2021). Digital transformation is an indispensable requirement for businesses to increase their competitive strength and sustain their existence. In today's world, it is crucial to recognize that data is the most important power and to ensure that businesses utilize data. Digital transformation is a fundamental requirement for businesses to enhance their competitive edge and sustain their operations. In today's world, it is crucial to recognize that data is the most important power and to ensure that businesses use this power in the best possible way (Ersöz and Ersöz, 2025).

With digitalization, people, ideas, systems, and institutions have entered a period of rapid change (Çetinkaya, 2009). Hospitals, which occupy a privileged position in the service sector due to their focus on human health, are organizations that must improve their institutional performance regardless of whether they are private or public (Pakdil, 2002). Services are activities that can be diagnosed separately, whose demands can be anticipated, and which are abstract in nature, meaning they cannot be physically touched (Cowell, 1991). Services are economic activities that provide benefits in terms of time, place, form, and psychology (Parasuraman et al., 1985).

Quality Function Deployment (QFD) stands out as a powerful management tool that systematically translates customer expectations into technical requirements (Ersöz and Aktepe, 2011). The primary objective of QFD is to identify the needs of internal and external customer groups, such as patients, caregivers, and healthcare workers, and to integrate these needs into operational processes by matching them with technical requirements. As in many other sectors, it is used as an effective tool in efforts to improve service quality in the healthcare sector (Güllü and Ulcay, 2002). This method enables a strong

link to be established between the expectations of patients and their relatives regarding hygiene and the practices of the personnel involved in cleaning processes (Aktepe et al., 2011). Thus, not only the perceived quality of the service but also its operational efficiency is improved. Improving cleaning processes in hospitals enables not only service quality but also the balancing of operational load, the control of microbial risks, the standardization of complex workflows, and the objective evaluation of employee performance. Therefore, cleaning processes should no longer be considered a support service in modern healthcare institutions; they should be approached as an operational process of strategic importance that makes intensive use of digital technologies.

This study aims to determine the expectations and needs of internal customers (hospital staff, consultants, shareholders, nurses) and external customers (patients, caregivers, visitors, etc.) regarding cleaning and hygiene processes in hospitals, as well as critical quality factors related to hygiene. Furthermore, areas for process improvement have been identified by linking these factors to technical requirements. The study determines customer expectations through Gemba observations and Focus Group Studies conducted at a university hospital; prioritizes these expectations using the Analytic Hierarchy Process (AHP), and applies the Quality Function Deployment method to identify technical requirements that can be proposed within the scope of Digital Technologies.

Following the introduction section of the article, Section 2 describes QFD-focused applications in healthcare institutions in the literature. Section 3 outlines the QFD and AHP techniques and highlights the strategic importance of digital transformation in hospitals, particularly its role in improving operational efficiency and hygiene management. Section 4 presents the application part of the study and includes the findings. Section 5 presents the results of the study and includes evaluations.

2. Related Works

When reviewing the literature, numerous studies utilizing the QFD technique have been identified. Within the scope of this study, QFD-focused applications in healthcare institutions were examined. The effectiveness of the QFD method in quality improvement efforts within the healthcare sector is emphasized. In a study applied to private medical centers, patient expectations were systematically converted into technical requirements. The study concluded that the healthcare facility in question could gain a competitive advantage by paying attention to staff training and courtesy, reorganizing treatment fees in comparison to competitors, and developing a method to make laboratory results more easily accessible to patients (Yapraklı and Güzel, 2010). Studies conducted using integrated approaches that incorporate the OFD method are also available in the literature. In this context, a study conducted at a university hospital has proposed a QFD model that can be used by university hospitals. The study found that the customer expectations with the highest importance levels were, in order, Reliability, Physical Characteristics, Assurance, Enthusiasm, and Empathy (Aktepe et al., 2011). A study conducted at a state hospital concluded that the most important issue for patients was the implementation of periodic checks on cleaning staff (Kaya, 2014). The QFD method was used to determine patients' expectations and needs regarding the blood collection process in the laboratory services of a private hospital in Istanbul, and these requirements were analyzed. Fast processing, a hygienic environment (general cleanliness, use of sterile gloves, etc.), and the reliability of results were the most important factors (Gündoğdu and Görener, 2017). In a QFD study conducted at a private hospital, the primary technical requirements identified were the lack of sufficient signage in the hospital and the absence of necessary infrastructure for patients with disabilities, highlighting that these technical requirements are ergonomic elements (Aktepe et al., 2018). With advancing technology, technical requirements also reveal the need to take steps towards becoming a digital hospital. In this context, the study conducted by Naralan Nursaçan and Çetiyokuş (2020) determined that the technical requirements with the highest importance level are: creating an alert system for healthcare units using wireless body sensors, followed by the need for healthcare counseling via the internet and mobile applications and increasing the number of wireless access points. (Naralan Nursaçan and Çetiyokuş, 2020). Galdino Junior et al. (2022) In the QFD analysis study for the operating room of Onofre Lopes Teaching Hospital, technical training was determined to be the technical requirement with the highest

importance level, followed by the requirements for shared management practices and the adoption of technical standards for the planning, programming, development, and evaluation of physical projects in healthcare facilities (Galdino Junior et al., 2022).

The reviewed literature indicates that QFD is an important tool used to improve service quality in healthcare. However, in today's rapidly evolving digital landscape, there is a limited number of comprehensive studies that outline the digital requirements or expectations for cleaning and hygiene processes. In particular, the integration of digital technologies with the QFD matrix has not been addressed in critical areas such as microbial control, task verification, process traceability, and employee performance monitoring in these processes. This study contributes to this gap in the literature by presenting a framework that aims to implement QFD in conjunction with digital technologies for hospital cleaning processes.

3. Digital Transformation

Today, digital transformation has become a crucial factor for businesses to enhance their competitive strength and ensure their sustainability. Considering the reality that data is a significant power, it is critically important for businesses to utilize this power in the most effective way (Ersöz and Ersöz, 2025). Digital transformation is the process of redesigning businesses' existing processes, service delivery, and decision-making structures using digital technologies (Vial, 2019). The fundamental objectives of digital transformation are to ensure that processes are carried out quickly, efficiently, transparently, and with low error rates.

As in all service sectors, the use of information and communication technologies (ICT) plays an important role in establishing a well-organized system in the healthcare sector (Kuo et al., 2013). Hospitals that use ICT for the benefit of patients and staff are referred to as digital hospitals (Austin, et al. 2018). Digital hospital applications are defined as systems that aim to increase staff efficiency and service quality and ensure patient safety (Sligo et al., 2017). Healthcare institutions that benefit from digitalization applications in service delivery can expand their service areas, increase efficiency and patient satisfaction, evaluate data more consciously during the decision-making process, and reduce costs through more effective use of resources (Sharma et al., 2016).

In this study, the QFD approach was used to analyze and systematically optimize processes related to hospital cleaning and hygiene, focusing on the necessity of digital technologies. Therefore, it is possible to implement the technical requirements identified in the QFD matrix more effectively. This article proposes an integrated model that includes components such as RFID/QR code-supported task verification systems (Cheng and Kuo, 2016; Çetin, 2024), information system-based process management modules, and blockchain-based traceability (Tebrizcik et al., 2025).

4. Methodology

The QFD method was employed in the study. First, the target customer group to be included in the study was identified. In line with the consensus of the QFD team, Focus Group Studies, Gemba Analysis, and expert opinions were used in the customer voice listening phase. With Gemba analysis, the functioning of processes is observed on site. The AHP (Analytic Hierarchy Process) method was used in the customer voice evaluation phase. Focus Group Study results and expert opinions were used as inputs when creating pairwise comparison matrices in the AHP method. The group that determines the technical requirements for meeting customer requests and needs in practice includes the chief physician of the university hospital, the head nurse, clinical nurses, the hospital manager, the cleaning supervisor, and the cleaning staff.

4.1 Quality Function Deployment

The concept of Quality Function Deployment was first used in shipyards by Mitsubishi Heavy Industries and Engineering Company in Kobe, Japan. In 1972, Toyota, which plays a significant role in the automotive industry worldwide, implemented it, and it became a widespread quality method in other

sectors as well (Delgado Hernandez et al., 2007). Initially developed with a focus on the manufacturing sector, the QFD approach has spread to many areas such as banking, healthcare, education, and research. This technique seeks to reflect the expectations of the customers directly in the features of the product or service. It aims at bringing an improvement in the current situation by determining the feature expectations of customers from a certain product or service and the needs related to these features. The methodology provides a perspective that focuses on the centrality of the customer's voice within the process of improvement. Its success is linked to the correct and full accomplishment of the steps followed within the application process. QFD is a four-stage process, whose first stage is referred to as 0. The stages are as follows (Cohen, 1995):

Phase 0: Planning
Phase 1: Listening to the customer's voice
Phase 2: Building the house of quality
Phase 3: Analysis and interpretation of results

Phase 0. Planning Phase

The planning phase, located on the right side of the House of Quality shown in Figure 1, encompasses the steps of securing organizational support, clarifying objectives, selecting the target customer group, determining the timeframe for QFD implementation, defining the product/service concept, establishing the team to implement the implementation, designing the process, and providing the necessary hardware and infrastructure. The most critical element for the success of QFD in an organization is securing strong organizational support.

At this stage, the system's objectives should be identified, then its boundaries well set, while the priorities must be combined with logical justifications. A target customer profile aligned with the objectives identified in the planning should also be established. Another important point at this stage is the correct selection of the product or service concept on which QFD will focus. Thus, by choosing the right concept, duplication and time losses will be greatly reduced, and the system will be positioned to fully address the established objectives.

Phase 1. Listening to the Customer's Voice

The second stage of the QFD process is identifying customer needs. This stage is referred to as “Voice of the Customer” in QFD literature. At this point, customer expectations regarding the product or service are systematically collected and prioritized according to their importance. The voice of the customer means learning users' thoughts about the product or service and using this information as a basis for improving processes. Thus, listening to the voice of the customer provides organizations with the opportunity to improve their products and services. Many methods can be used to hear the voice of the customer, i.e., to convert customer opinions into concrete data, such as surveys, focus group studies, customer panels, pilot applications, one-on-one interviews, customer visits, fairs, and commercial events.

In addition to these traditional tools, Gemba analysis is used in the QFD process to understand customers more accurately and realistically, and product or service attributes are classified using the Kano Model (Savaş and Ay, 2005). Once customer's wants and needs have been identified, they can be prioritized using appropriate decision-making techniques (AHP, FAHP, ELECTRE, etc.). In the literature, Doğan and Akbal (2020) demonstrated the effectiveness of this approach by using the Analytic Hierarchy Process (AHP) method to weight customer demands in QFD applications.

Phase 2. Building the House of Quality

The Quality House is the first step in planning the improvement process in quality function deployment. Figure 1 shows the matrices and their locations that constitute the Quality House. The Quality House is a matrix structure that systematically reveals the relationship between customer demands and technical

requirements. This structure is considered the most important tool for quality function deployment in customer-focused product and service development processes (Chan and Wu, 2002).

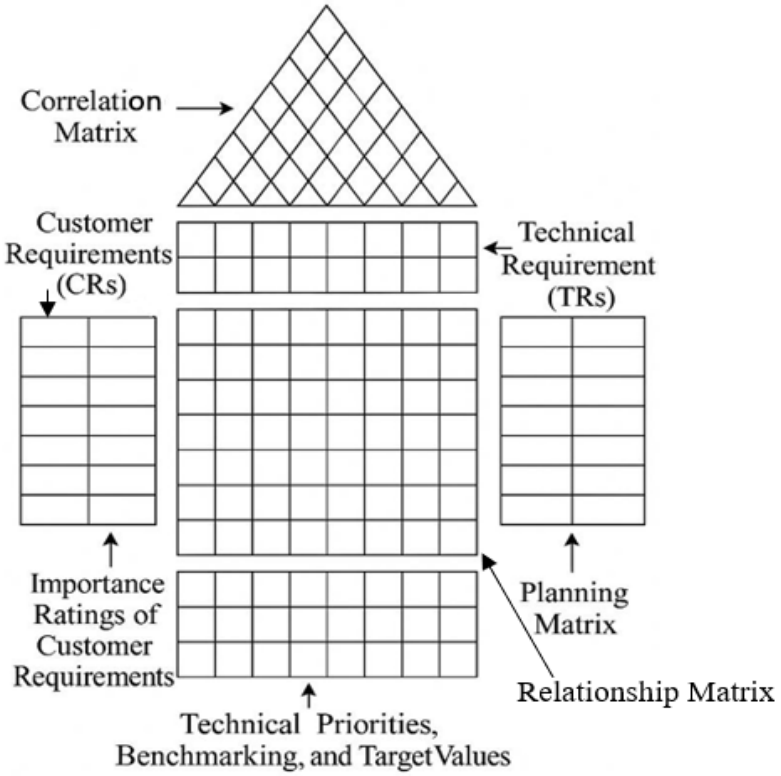

Figure 1. House of Quality

i. Determining Customer Requirements and Their Prioritization

In the first stage, the needs identified from customer feedback are placed in the quality house. The importance levels of these needs are usually calculated using surveys or multi-criteria decision-making techniques.

ii. Construction of the Planning / Competitive Matrix

The planning matrix shows the importance levels of customer requirements and comparative performance with competitors. This stage allows the business to observe its position within the market. The matrix is created by performing the following calculations.

- Customer Requirements: The identified needs are written in the “Customer Requirements” column.
- Importance Rating: The results obtained for the degree of importance through expert opinions are weighted using the AHP method and written in the “Importance Rating” column of the matrix.
- Company Today: This refers to the weighting of how the business is perceived by customers today, based on the evaluation of Survey, Focus Group, and Gemba analysis results together with experts. In this study, through Focus Group sessions, the values for the ‘Company Today’ column were generated by scoring on a 1–5 scale in consultation with experts (chief physician, head nurse, clinical nurses, hospital director, cleaning supervisor, and cleaning staff).
- Company Target: Scores on a 1–5 scale were assigned to indicate how the business aims to position itself in the future. While determining the ‘Company Target’ values, hospital officials were asked to evaluate the organization’s desired future position.

- Competitor Company: This refers to conducting a competitiveness assessment by comparing the business with its competitors. In this study, two private hospitals located in Istanbul and Ankara were considered for the competitor analysis. Weighted scores on a 1–5 scale were assigned for these hospitals, and the 'Competitor Company' values were generated accordingly.
- Improvement Ratio: These are the calculated values that represent the extent of improvement required to achieve the targeted service quality. In this study, Equation 1 was used.

$$Improvement\ Ratio = \frac{Company\ Target - Company\ Today}{Company\ Today} \quad (1)$$

- Service Delivery Contribution: This is considered to determine whether a change to be made to the product or service will bring about progress. This concept is also referred to as the "Point of Sale Score" in the literature. Points are awarded based on the contribution of the change to service delivery. The scores given mean 1.5 "Significantly increases sales potential," 1.2 "Increases sales potential," and 1.0 "No change from the old model" (Naralan Nursaçan and Çetinyokuş).
- Absolute Weight: The calculated importance of the needs is taken as the absolute value. It is computed using Equation 2.

$$Absolute\ Weight = Importance\ Rating * Improvement\ Ratio * Service\ Delivery\ Contribution \quad (2)$$

- Relative Weight: The value obtained by dividing the absolute weight (importance score) of each customer requirement by the total of the 'Absolute Weight' column.

iii. Determination of Technical Requirements

The technical specifications required to meet customer demands are determined through expert opinions and brainstorming sessions. These specifications represent the engineering translation of customer requirements.

iv. Relationship Matrix

In this step, the relationships between customer requirements and technical requirements are examined. The strength of the relationship (strong, moderate, weak) is indicated by symbols or numerical coefficients. In this study, the American scoring system presented in Table 1 was used to determine the relationship between technical requirements and customer expectations.

Table 1. Scoring System

Relationship Degree	American Scoring System
Strong Relationship	9
Medium Relationship	3
Weak Relationship	1

v. Correlation Among Technical Requirements

Technical specifications may have positive or negative effects. The roof matrix visualizes these correlations, revealing potential conflicts or synergies.

vi. Determination of Technical Priorities

In the final stage, priority scores are calculated for each technical requirement. This is done by summing the products of the importance levels and the correlation coefficients. This is one of the important parts

of the OFD study. It assists the institutions where the study is conducted in determining what can be done to improve service quality. The calculations are provided in Equation 3 and Equation 4.

$$Technical\ Priority\ Score = \sum (Importance\ Rating * Relationship\ Score) \quad (3)$$

$$Normalized\ Technical\ Priority\ Score = \frac{Technical\ Importance\ Rating}{\sum Technical\ Importance\ Rating} \quad (4)$$

Phase 3. Analysis and Interpretation of Results
Once all these stages are completed, the final form of the quality house is obtained. This final structure is examined by the QFD team, and the results are analyzed and evaluated.

4.2 Analytic Hierarchy Process (AHP)

AHP is a multi-criteria decision analysis method that can evaluate the criteria and alternatives in a hierarchical structure during decision problem-solving. In the first step, the objective, criteria and the alternatives are defined. Then, the pairwise comparison matrices are elaborated with expert judgment by taking Saaty's 1-9 importance scale into consideration, and the weights of the criteria are determined based on these comparisons. Thereafter, the set of matrices is normalized and the weights of the criteria are decided. The consistency of the decision maker is checked through the Consistency Ratio - CRR; if it is less than 0.10, the matrix is considered to be consistent. Finally, the priority value of each alternative is determined by the product of the weights of the criteria with the values of the alternatives, and the alternative having the maximum value will be selected as the best alternative (Saaty, 1980).

5. Findings

The application reveals customer requirements in terms of improving service quality using the QFD method at a university hospital operating in the healthcare sector. In this context, the steps of the QFD approach were discussed in detail and implemented. In addition, two private hospitals were included in the study, and a competitor analysis was conducted based on evaluations made with experts. In this application, the two companies will be referred to as Competitor A and Competitor B hospitals.
Weighting customer needs allows for a numerical evaluation by determining the importance levels of these requirements (Doğan and Akbal, 2020). AHP management was used for this purpose. With AHP, each customer requirement is evaluated and prioritized through pairwise comparisons.

Table 2. Importance Levels of Customer Requirements

Customer Requirements	**Importance Rating**
Ensuring the cleanliness of wet floors, toilets, and sinks	0,12
Ensuring that room cleaning is performed to the required standards	0,1
Ensuring that textile products are replaced with hygienically safe products at appropriate intervals or when needed	0,08
Control of microbial load after cleaning	0,14
Control of dust particles after cleaning	0,07
Preventing patient dissatisfaction regarding cleaning	0,1
Preventing caregiver dissatisfaction regarding cleaning	0,05
Ensuring cleaning control processes are effective (checking all rooms and areas)	0,09
Physical cleaning control	0,05
Equal distribution of tasks among employees	0,04
Ability to assess employee performance	0,04

Compliance of cleaning equipment with standards	0,04
Compliance of cleaning consumables with human health standards	0,04
Optimal use of cleaning consumables	0,04

The findings obtained during the prioritization of customer expectations within the scope of QFD show that hygiene and safety factors are particularly prominent in patients' expectations regarding cleaning services, as presented in Table 2. According to the table, the expectations with the highest importance ratings are: control of microbial load after cleaning (0.14), assurance of cleanliness of wet floors, toilets, and sinks (0.12), cleaning of rooms in accordance with standards (0.10), and preventing patient dissatisfaction with cleaning (0.10). This result reveals that priority in cleaning processes should be given to factors that directly affect patient safety. Expectations given medium importance include the effectiveness of cleaning control processes (0.09), changing textile products at appropriate intervals (0.08), and controlling dust particles after cleaning (0.07). Factors with lower importance levels in the comparisons are supportive elements such as ensuring companion satisfaction, physical cleaning control, distribution of tasks among employees, and the suitability and optimal use of equipment and consumables. The distribution above shows that the most important customer expectations regard hygiene safety, whereas process management and organizational factors are secondary. For this reason, in the QFD application, customer expectations about the provision of microbiological safety and hygiene standards will serve as the most critical input to determine the technical requirements necessary to plan process improvements. These findings will guide technical requirements in subsequent stages of QFD.

Table 3. Customer Requirements and Technical Characteristics

Customer Requirements	**Technical Requirements**
CR1: Ensure the cleanliness of wet floors, toilets, and sinks	TR1: A QR-supported system for routine cleaning, detailed cleaning, and demand-based cleaning processes based on job analysis should be established TR6: ATP (adenosine triphosphate) testing, microbial air sampling for infection prevention, ensuring sterility TR8: Cleaning quality should be determined and controlled by statistical sampling analysis conducted by the Quality Unit, and verification should be performed through the information system. TR9: Compliance with cleaning procedures should be ensured through digital guides and training content. TR11: Personnel should undergo regular, practical, and monitorable training provided by the Quality Unit.
CR2: Ensure that room cleaning is performed to the required standards	TR6: ATP (adenosine triphosphate) testing, infection prevention through microbial air sampling, ensuring sterility TR8: Cleaning quality must be determined and controlled by the Quality Unit through statistical sampling analysis, and verification must be performed through the information system TR9: Ensuring compliance with cleaning procedures through digital guides and training content TR11: Personnel must undergo regular, practical, and monitorable training conducted by the Quality Unit
CR3: Ensure that textile products are replaced with hygienically safe products at appropriate intervals or when needed	TR7: Textile management (dirty and clean textiles must be physically separated; entry/exit points, storage, and environmental conditions; textile exchange must be planned via the information system; workflow between all units) using an RFID traceability system

	TR8: Cleaning quality should be determined and controlled by the Quality Unit through statistical sampling analysis, and verification should be performed through the information system TR14: In the event of infection or any adverse event, the current and past processes should be secured using blockchain technology through the code assigned to the patient
CR4: Control of microbial load after cleaning	TR4: Workload should be made trackable with an information system TR6: ATP (adenosine triphosphate) testing, infection prevention through microbial air sampling, ensuring sterility
CR5: Control of dust particles after cleaning	TR5: Monitoring dust and particles with an IAQ (Indoor Air Quality) device and controlling threshold values
CR6: Preventing patient dissatisfaction regarding cleanliness	TR10: Mobile notification channels should be established to facilitate the reporting of complaints. TR13: Visual information regarding material usage should be provided to patients and their companions via a mobile application. TR14: In the event of an infection or any adverse event, the current and past processes should be secured using blockchain technology via the code provided to the patient.
CR7: Preventing caregiver dissatisfaction regarding cleanliness	TR10: Mobile notification channels should be available to facilitate easy reporting of complaints. TR13: Visual information regarding material usage should be provided to patients and their companions via a mobile application. TR14: In the event of an infection or any adverse event, the current and past processes should be secured using blockchain technology via the code provided to the patient.
CR8: Ensuring the effectiveness of cleaning control processes (checking all rooms and every area)	TR1: A QR-supported system for routine cleaning, detailed cleaning, and demand-based cleaning processes based on job analysis should be established TR6: ATP (adenosine triphosphate) testing, infection prevention through microbial air sampling, and ensuring sterility TR8: Cleaning quality should be determined and controlled by statistical sampling analysis conducted by the Quality Unit, with verification performed through the information system TR12: A performance module should be created through the information system using a unique digital profile (defined via card/QR code) for each employee TR14: In the event of an infection or any adverse event, the current and past processes must be secured using blockchain technology via the code given to the patient
CR9: Physical cleaning inspection	TR8: The quality unit should determine and control the statistical sampling analysis for cleaning quality and verify it through the information system. TR9: Compliance with cleaning procedures should be ensured through digital guides and training content. TR11: The quality unit should regularly provide personnel with practical and monitorable training.

CR10: Equal distribution of tasks among employees	TR3: Task distribution should be balanced using multi-criteria decision-making techniques, fuzzy logic-based evaluations, and goal programming TR4: Workload should be made trackable using the information system
CR11: To be able to determine employee performance	TR12: A performance module should be created in the information system for each employee using a unique digital profile (defined via card/QR code).
CR12: Ensuring that the equipment used for cleaning complies with standards	TR13: Patients and caregivers should be provided with visual information regarding material usage via a mobile application.
CR13: The cleaning supplies used must be safe for human health	TR13: Patients and caregivers should be provided with visual information regarding material usage via a mobile application.
CR14: Using the optimal amount of consumables for cleaning	TR13: Patients and caregivers should be provided with visual information regarding material usage via a mobile application.

In the second phase of the QFD process, the expectations of patients and their relatives regarding cleaning services were converted into technical requirements (Table 3). For example, the expectation of "ensuring the cleanliness of wet floors, toilets, and sinks" was met by implementing routine and demand-based cleaning processes using a QR-supported systematic approach. Similarly, the expectation of "controlling the microbial load after cleaning" was supported by ATP tests, the expectation of "controlling dust particles" was supported by an IAQ device, and the expectation of "ensuring textile hygiene" was supported by RFID (Radio Frequency Identification)-based traceability systems. In addition, other organizational expectations that have been identified include measuring employee performance, balancing task distribution, and facilitating complaint reporting. These organizational expectations were converted into technical requirements through training, performance monitoring, and information systems to be implemented by the quality unit. Thus, the study revealed that the findings obtained from customer requirements can be met more effectively through optimization techniques and digital technologies, and that these solutions contribute to the optimization of cleaning processes. After matching customer expectations with technical requirements, these expectations were prioritized by comparing them with the company's current situation, goals, and competitors. Thus, the improvement rate, absolute and relative weights of each expectation were calculated; the results are presented in Table 4. Improvement rates, absolute and relative weights, service delivery contributions, and comparisons with competitor companies were added to Table 5. This clearly revealed which customer expectations were critical in terms of competitive advantage and where the company's goals should be focused. When examining Table 4, it can be seen that the criterion with the highest relative weight in terms of customer expectations is TR8, namely "The statistical sampling analysis to be performed by the Quality Unit should be determined and controlled, and verification should be done through the information system" (11.18%). In this criterion, the company currently ranks lower than its competitors but has significant potential for improvement with the targeted enhancements. Similarly, TR6, namely "ATP (adenosine triphosphate) testing, microbial air sampling for infection prevention, ensuring sterility" (11.74%), and TR14, namely "In the event of infection or any adverse event, the current and past processes should be secured using blockchain technology through a code given to the patient" (11.72%) also stand out with their high relative weights and are areas where the company can differentiate itself from its competitors.

Table 4. Technical Priority Scores

Customer Requirements	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TR10	TR11	TR12	TR13	TR14
CR1	9	3	1	3	0	9	0	9	9	1	9	0	1	3
CR2	3	3	1	3	3	9	1	9	9	3	9	0	1	3
CR3	1	1	0	1	0	1	9	9	1	1	1	0	0	9
CR4	3	1	3	9	1	9	0	1	1	0	1	0	1	3
CR5	0	0	1	3	9	1	0	1	1	0	0	0	1	1
CR6	3	0	0	1	3	3	3	3	3	9	3	1	9	9
CR7	3	0	0	0	3	3	3	3	3	9	3	1	9	9
CR8	9	0	0	0	3	9	3	9	3	3	3	9	0	9
CR9	1	0	0	0	0	0	1	9	9	1	9	0	0	3
CR10	3	0	9	9	0	0	0	1	3	0	0	0	0	0
CR11	0	0	0	3	0	0	0	3	1	3	3	9	0	3
CR12	0	0	0	0	0	0	0	0	3	0	0	0	9	0
CR13	0	0	0	0	0	0	0	0	0	1	3	0	9	1
CR14	0	0	0	1	0	0	0	1	3	1	3	3	9	1
Technical Priority Score	3,31	0,88	1,07	2,83	1,79	4,65	1,59	4,82	3,84	2,37	3,73	1,44	2,86	4,38
Normalized Technical Priority Score	0,084	0,022	0,027	0,072	0,045	0,118	0,040	0,122	0,097	0,060	0,094	0,036	0,072	0,111

Tablo 5. Planning Matrix

Customer Requirement	Importance Rating	Company Today	Company Target	Competitor A	Competitor B	Improvement Ration	Service Delivery Contribution	Absolute Weight	Relative Weight (%)	Company Target	Competitor A	Competitor B
CR1	0,12	2	5	4	4	1,5	1,5	0,27	18,415	■	□	□
CR2	0,1	3	5	4	4	0,67	1,5	0,1	6,821	■	□	□
CR3	0,08	3	5	5	4	0,67	1,5	0,08	5,456	■	■	□
CR4	0,14	2	5	3	3	1,5	1,5	0,32	21,485	■	■	□
CR5	0,07	2	5	3	3	1,5	1,5	0,16	10,742	■	□	□
CR6	0,1	3	5	4	4	0,67	1,2	0,08	5,456	■	■	□
CR7	0,05	2	5	4	4	1,5	1,2	0,09	6,138	■	■	□
CR8	0,09	2	5	4	3	1,5	1,2	0,16	11,049	■	□	□
CR9	0,05	3	4	5	4	0,33	1,5	0,03	1,705	□	■	□
CR10	0,04	2	4	3	3	1	1,2	0,05	3,274	■	□	□
CR11	0,04	2	5	4	3	1,5	1,2	0,07	4,911	■	□	□
CR12	0,04	3	4	5	5	0,33	1	0,01	0,909	□	■	■
CR13	0,04	3	4	5	5	0,33	1	0,01	0,909	■	■	■
CR14	0,04	2	4	4	4	1	1	0,04	2,728	■	□	□

■ = Present / Adequate
□ = Absent / Insufficient

Criteria of medium importance include “Establishing a QR-supported system for routine cleaning, detailed cleaning, and demand-based cleaning processes based on job analysis” (8.37%) and “Making the workload traceable with an information system” (7.15%); Criteria with low relative weight are mostly organizational and supportive elements (e.g., equipment compliance with standards, balanced distribution of personnel tasks). These results show that it is critical for the company to make improvements over its competitors, especially in high-priority hygiene and control factors, in terms of both patient safety and competitive advantage

6. Conclusion

QFD is a systemized strategy that translates customer expectations into necessary technical requirements and activities, extending them to all stages of the development of any product or service. Precise identification of customer expectations and their correct reflection in technical requirements are very important for organizations seeking a competitive advantage.

In this study, customer expectations for hospital cleaning processes were determined through Gemba observations and focus group studies, and these expectations were systematically translated into technical requirements using the QFD technique. The results indicated that cleaning service quality is a key factor in patient safety and satisfaction; hence, cleaning process controls must be managed not just through routine practices but also through a structure that is measurable, monitorable, and continuously improved.

The QFD technique has been shown to prioritize customer expectations and enable them to be met more effectively through digital solutions. The study demonstrates that optimization techniques and digital technology applications (such as RFID and QR-based traceability) can play a significant role in ensuring effective cleaning and hygiene processes. Overall, the findings reveal that cleaning services in healthcare institutions are not merely a supporting activity but a strategic process that directly impacts service quality and patient safety. In this context, QFD-based approaches provide healthcare institutions with both a competitive advantage and a viable roadmap for digital transformation. It is thought that applying QFD to health professionals representing internal customers in health institutions will increase the quality standards of health institutions and ensure both internal and external customer satisfaction.

Although QFD has several advantages, it also has some drawbacks in health institutions during the implementation stage. One of the few disadvantages experienced during the use of quality function deployment in health institutions is that it calls for personnel who are conversant with the application of interdisciplinary knowledge. Future research could cover the integration of digital solutions to improve the effectiveness of different operational activities in health institutions with QFD.

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