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Research Article

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Improving the Quality of Hospital Services Using the QFD Approach and Integration With Kano Analysis Under Budget Constraint

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Abstract

Background and Objectives: One of the main concerns of hospital managers is their ability in improving their organization's performance. The use of quality management and decision-making techniques facilitates managers to achieve this goal. In this research, the corrective activities to increase the quality of hospital services are determined and selected using an integration of the quality function deployment (QFD) method with the kano analysis and Knapsack Problem Mathematical Model (KPMM). This approach is implemented in a private hospital in Iran.

Methods: First, the customers' wants are identified. The corrective activities are then identified to meet these wants, and the relationship between each corrective activity and each want is determined. Next, the types of the wants are identified based on the kano analysis, and their weights are determined using their degree of importance and type. Then, the final weight of each corrective activities is obtained based on the wants' weights and the relationship matrix. Finally, KPMM is used to select the optimum list of corrective activities under budget constraint.

Findings: This study identifies 30 customers' wants among them "Professional and experienced doctors and nurses" and " Healthy and sufficient consumables" obtained the highest weights. Results show that there are 2 "Attractive" customer wants, 15 "One-dimensional" customer wants and 13 "Must-be" customers' wants. Finally, 30 corrective activities were identified which are placed at house of quality. The corrective activities "Training of physicians and nurses" and "Increasing staff sense of responsibility" obtained the highest weights.

Conclusions: Utilizing the kano analysis for determining the weight of customers' wants in the house of quality approach causes the organization's strategies taken in to account in prioritizing corrective activities. Moreover, KPMM leads to an optimum selection of corrective activities.

Keywords: Hospital, House of quality, Kano analysis, Functional expansion

Background and objectives

Healthcare is a crucial issue in every society, which has become increasingly important in recent years as living standards have changed and the need for better healthcare to improve the lifestyle is felt.[1] In recent years, a variety of research studies have been constructed in the field of healthcare performance evaluation,[2-7] optimization[8-10] and quality enhancement.[11,12] Hospitals not only should provide health care services but also address the issues of increasing customer satisfaction.[13] Improving hospital services based on customers' wants results in customer satisfaction.[14]

There are various customer-oriented tools for managers to evaluate services and improve their services, such as quality function deployment (QFD),[12] Kano's model,[11] multi-criteria decision making,[15-17] etc. In this study, QFD is used to identify and prioritize the implementation of corrective activities to meet the customers' wants. Moreover, the kano analysis is used to identify the types of customers' wants and determine their weight. For better understanding, the proposed approach is applied to a private hospital in Iran. In this research, in addition to the patients' requests, the needs of the patients' companions have also been considered. Therefore, in the rest of the paper, the word customer is used to consider both patient and companions of the patients.

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This study integrates the QFD approach with the Kano analysis and Knapsack Problem Mathematical Model (KPMM) to improve the quality of hospital services under budget constraint.

Kano developed a model for classifying product or service features based on how they are able to meet the customer's needs.[18]

These wants are divided into 5 sections:

1) The must-be wants: these are the requirements that the customers expect and are taken for granted. When done well, customers will only be neutral, but when done poorly, customers will be very dissatisfied.

2) One-dimensional wants: these attributes result in satisfaction when fulfilled, and dissatisfaction when not fulfilled.

3) Attractive wants: these attributes provide satisfaction when fully achieved, but do not cause dissatisfaction when not fulfilled.

4) Indifferent wants: these attributes refer to aspects that are neither good nor bad, and they result in neither satisfaction nor dissatisfaction.

5) Reverse wants: These attributes refer to a high degree of achievement resulting in dissatisfaction and to the fact that not all customers are alike.[19] Figure 1 shows how customers' wants in the kano analysis are segmented.

Some researchers have used Kano analysis to improve service quality. Materla et al[11] developed Kano analysis to identify a wide range of complex patient needs or convey its potential usefulness in the continuous improvement of the healthcare sector. Wang and Fong[12] presented a fuzzy Kano analysis to identify customers' perceptions and increase their satisfaction from the airline services. Behdioğlu et al[20] evaluated services quality in a physiotherapy and rehabilitation hospital in Turkey. Using the Kano analysis, Zobnina and Rozhkov[21] provided a model for customer satisfaction with existing hotels in Europe. Ali et al[22] Presented an approach to identify and compare the level of patients' expectations of healthcare and their perceived using the SERVQUAL method. Farokhnia and Beheshtinia[23] developed a three-dimensional house of quality model to enhance the service quality in an airline and an airport in Iran. Cetinkaya et al[24] presented a university curriculum with the help of QFD. Wood et al[25] developed a method for identifying factors (customers' concerns) which affect the quality of the green hospital.

The QFD is a comprehensive quality system that aims to translate customers' wants into corrective activities.[26] The main part of QFD is the house of quality (HOQ) matrix, which consists of two main components: WHATs and HOWs. WHATs are data that identify the customers' wants and HOWs are data that provide solutions for them, named corrective activities. When using QFD, the essential factor is to define and understand WHATs (customers' wants) and HOWs (corrective activities).

Figure 2 shows an HOQ, in which the numbered parts are: (1) the identified customers' wants; (2) the identified corrective activities to meet the customers' wants; (3) calculations related to the weights of the customers' wants; (4) the relationship between the customers' wants and the corrective activities, and (5) the prioritization of the corrective activities.

Some researchers integrated QFD with other techniques to obtain more accurate results. Fauziah et al[27] carried out a research on integrating QFD and SERVQUAL for using in a hospital pharmacy. Raziei et al[28] developed an integrated model by QFD, SERVQUAL and group decision making to improve the service quality in hospitals. Wibawa et al[29] Introduced an approach by integrating SERVQUAL and Kano with QFD to improve the hospital information system in a private hospital. Gao and Zhang[30] introduced hidden costs of quality resulting from patient dissatisfaction and used the QFD and SERVQUAL methods to calculate these costs. Camgöz-Akdağ et al[31] improved service quality in the healthcare industry by integrating QFD

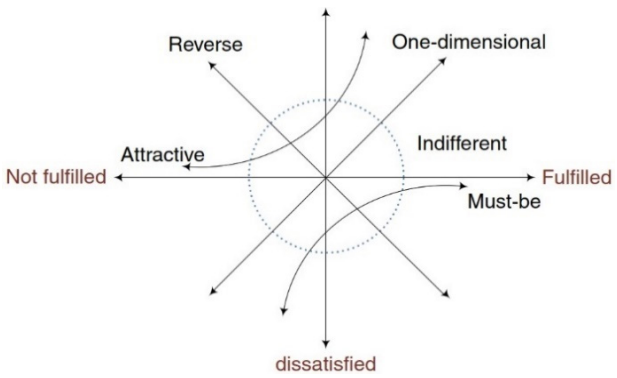

Figure 1. Kano Model.

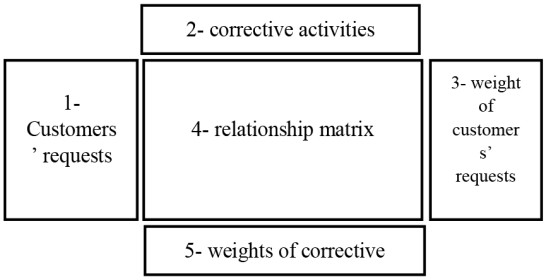

Figure 2. House of Quality.

with SERVQUAL analysis. Osorio-Gómez and Manotas-Duque[32] presented a multi-criteria model using fuzzy QFD and TOPSIS for maritime transportation.

On the other hand, the knapsack problem is a problem in combinatorial optimization: Given a set of items, each with a weight and a value, determine the number of each item to include in a collection so that the total weight is less than or equal to a given limit and the total value is as large as possible.

Some studies have investigated the integration of QFD and the Kano analysis simultaneously. Garibay et al[33] presented a combination of the Kano analysis and QFD as a useful tool for evaluating the quality of digital library service at a Mexican university. Kuo et al[34] examined the integration of the Kano analysis and the QFD method to improve hotel services. Vaziri and Beheshtinia[35] integrated QFD, SERVQUAL and the kano analysis in the field of life insurance services. Baki et al[36] developed a model to improve logistics services quality using the QFD approach and its integration with SERVQUAL and the kano analysis. Beheshtinia and Farzaneh Azad[37] provided a model to improve the quality of hotel services by integrating QFD with the Kano analysis and the SERVQUAL analysis. Moreover, some researches use combination of QFD and kano analysis in healthcare systems and hospital services.[29,38-44]

As seen in the literature, applying some techniques such as MCDM, SWOT, QFD, etc in various case studies may lead to new findings and it could be said that there is a contribution in applying the same technique in various organizations in the mentioned scopes. For example, implementing QFD in various organizations may lead to new customers' wants or new technical requirements. Table 1 depicts the previous papers categorized based on the tools used in the studies and their case studies. Review of previous studies in the literature shows that no study in the literature integrates QFD, kano analysis and KPMM in the hospital services.

The research contributions are as follows:

- Integration of QFD, Kano analysis and KPMM in the hospital services
- Applying the proposed approach in a hospital in

Table 1. The Categorization of Previous Studies

Researcher	Case Study	Kano	QFD	Hospital Services	KPMM
Cetinkaya et al (2019)	Educational services		✓		
Fauziah et al (2019)	Pharmaceutical services		✓		
Materla et al (2019)	Hospital services	✓		✓	
Osorio-Gómez and Manotas-Duque (2019)	Supply chain and logistics		✓		
Farokhnia and Beheshtinia (2018)	Airline and Airport services		✓		
Raziei et al (2018)	Hospital services		✓	✓	
Zobnina and Rozhkov (2018)	Hotel and tourism	✓			
Beheshtinia and Farzaneh Azad (2017)	Hotel and tourism	✓	✓		
Vaziri and Beheshtinia (2016)	Insurance services	✓	✓		
Wang and Fong (2016)	Airline services	✓			
Kuo et al (2016)	Hotel and tourism	✓	✓		
Wood et al (2016)	Green hospital design		✓		
Gao and Zhang (2016)	Healthcare services		✓		
Wibawa et al (2016)	Hospital Information system	✓	✓		
Yeh and Chen (2014)	Healthcare services	✓	✓		
Camgöz-Akdağ et al (2013)	Hospital services		✓	✓	
Gupta and Srivastava (2011)	Healthcare services	✓	✓		
Nordin and Che Razak (2010)	Healthcare services	✓	✓		
Garibay et al (2010)	Digital library services	✓			
Yeh (2010)	Hospital services	✓	✓	✓	
Baki et al (2009)	Logistics services	✓	✓		
Chiou and Cheng (2008)	Healthcare services	✓	✓		
Mustafa (2002)	Hospital services	✓	✓	✓	
Our study	Hospital services	✓	✓	✓	✓

Tehran, Iran and identifying a new

Methods

Research Questions

In this study, the main research question is as follow:

What is the optimum set of corrective activities to enhance quality of hospital services under budget constraint?

Research sub-questions are as follows:

What are the hospital customers' wants?

What is the type of customers' wants based on the kano analysis?

What are the importance degrees of customers' wants?

What are the weights of customers' wants?

What are the corrective activities required to satisfy the identified customers' wants?

What is the relationship between the corrective activities and the customers' wants?

How much is the estimated cost of implementing each identified corrective activity?

Data Gathering

Four types of questionnaires are used in this study. The first questionnaire is based on the Kano analysis to determine the type of the customers' wants. The questionnaire consists of two positive and negative questions about considering or ignoring each want in the services provided by the hospital.

The second questionnaire identifies the customers' wants' importance degree. The respondents of both questionnaires used a 5-point Likert scale (Table 2) to answer the questions. As shown in Table 2, scores 1 to 5 (from least significant to most significant) are assigned to the importance degree of requirements from the clients' point of view. Finally, according to the scores collected from clients, the mean of importance scores is calculated for each need.

The third questionnaire is used to determine the relationship between the customers' wants and corrective activities, in which the respondents' options are presented in Table 3.Table 3 shows the type and numerical value of the relationship between needs and corrective activities.

The fourth questionnaire is used to identify the cost of implementing each corrective activity by experts.

According to Cochran's formula, assuming a 5% error, 385 questionnaires are distributed in the hospital in each case over a five-month period. The third and fourth questionnaires are completed by eight experts. Because the used questionnaires are standard, their validity have been confirmed.[35] The reliability of the questionnaire was confirmed by Cronbach alpha test.

Research Steps

This study presents a QFD approach and integrates it with the kano analysis and KPMM to improve the quality of hospital services under budget constraint. The research steps are described below. Figure 3 shows an overview of the research steps.

Step 1: Identify the customers' wants

These wants are identified by the experts' opinions, the literature review, and interviews with the customers

Step 2 Identify the corrective activities required to satisfy the customers' wants

Step 3: Determine the relationship matrix

Each corrective activity is related to at least one of the customer wants. The HOQ relationship matrix is used to illustrate and simplify these relationships. The customers' wants and corrective activities are placed in the rows and columns of the HOQ matrix, respectively. The arrays in this matrix are the values of the relationship matrix in accordance with Table 2.

Step 4: Identify the importance of customers' wants

The second questionnaire helps to identify the importance degree of the customers' wants. The greater the importance degree of a want, the more attention managers should pay to that want.

Step 5: Calculate the type of the wants based on the Kano analysis

In this step, the customers' wants are divided into five categories of must-be, one-dimensional, attractive, indifferent, and reverse wants using the second questionnaire.

Step 6: Calculate the weight of the customers' wants

To calculate the final weight of each customer's want, the values of its importance degree is multiplied by its type. The related values to the type of wants are

Table 2. Linguistic Variables of the First and Second Questionnaires and the Related Scores

Importance Degree Questionnaires	Relate Score
Very Low	1
Low	2
Medium	3
High	4
Very High	5

Table 3. Symbols and Scores for the Relationship Matrix

Type of Relationship	Notation	Relate Score
Strong	•	9
Moderate	○	5
Weak	Δ	1
No relationship	Blank	0

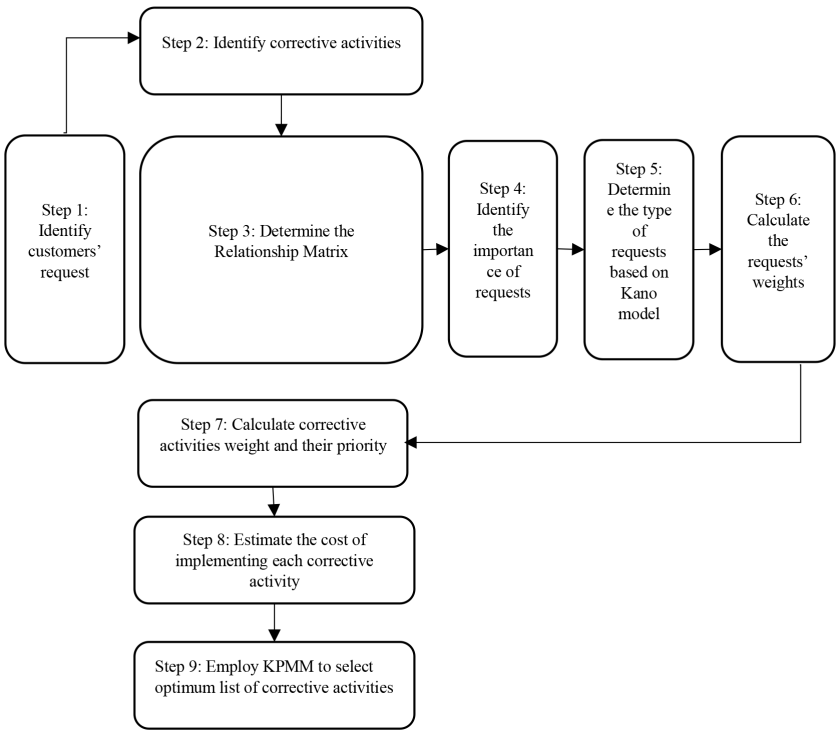

Figure 3. Overview of the research steps

determined according to the organization's strategies. If the organization's strategy is to retain current customers, a higher value should be allocated to the basic wants. However, if the organization's strategy is to attract new customers, a higher value should be assigned to the attractive wants.

$$AW_i = k_i \times I_i \quad (1)$$

$$RW_i = AW_i / \sum_{i=1}^{n} AW_i \quad (2)$$

In this formula, K_i is the value related to the type of want *i* according to the kano analysis and I_i is the importance degree of want *i*. Finally, AW_i and RW_i are the absolute and relative weights of want *i*.

Step 7: Calculate the corrective activities' weights and their priority

The corrective activities do not have the same importance. Some corrective activities require more attention than others. The corrective activities' weights are calculated using the following equation:

$$AEW_j = \sum_{i=1}^{n} d_{ij} \times AW_i \quad (3)$$

$$REW_j = AEW_j / \sum_{j=1}^{m} AEW_j \quad (4)$$

where AEW_j is the absolute weight of corrective activity *j*, d_{ij} is the value of the relationship between want *i* and corrective activity *j*, and REW_j is the relative weight of corrective activity *j*. A higher value for the weight of a corrective activity indicates its higher importance and higher priority for being implemented by the managers.

Step 8: Estimate the cost of implementing each corrective activity

Step 9: Employ KPMM to select optimum list of corrective activities

To select the optimum list of corrective activities, the KPMM is employed as follows:

$$\text{Max } Z = \sum_{j=1}^{m} REW_j \times X_j$$

$$\text{St:} \quad \sum_{j=1}^{m} C_j \times X_j \le B \quad (5)$$

$$X_i \in \{0,1\} \qquad i = 1, 2, \ldots, n.$$

Where *B* is the total budget and *Xj* is the decision variable in which it is 1 if corrective activity *j* in selected and vice versa. REW_j and *Cj* are the weight of j^{th} activity and its estimated cost, respectively.

Results

To illustrate the performance of the proposed approach, it was applied to a private hospital located in Tehran,

Iran. The results of implementing the research steps are presented in this section.

Identifying the Customers' Wants

In the first step, the customers' wants are identified. In addition to the medical wants, the mental condition and other customer related services are considered. Finally, 30 wants were identified, as shown in Figure 4.

Identifying the Corrective Activities

The hospital performance can be improved systematically by implementing corrective activities considering the priority given. At this stage, 30 corrective activities were identified to satisfy the customers' wants, as shown in Figure 4.

Determining the Relationship Matrix

In this step, using the third questionnaire, the relationship of each corrective activity, and each customer want is determined according to Figure 4.

Identifying the Importance of the Customers' Wants

The importance degrees of the wants obtained by the second questionnaire are shown in Table 4. As determined in Table 4, the clients' wants of R_{24}, R_{14} and R_{26} are of the highest importance degree.

Determine the Type of The Wants Based on the Kano Analysis

The results of this step are shown in Table 4. The "Must-be," "one-dimensional," and "attractive" wants are represented by the symbols M, O, A, respectively. The weight assigned to each type of want may be different from another, based on the organization's strategy. If the organization's strategy is to preserve the current situation, the focus is on "Must-be" want. Therefore, the wants of this type are given higher weights. On the other hand, if the strategy of the organization is to attract new customers, the "attractive" wants are given higher weight. For this purpose, according to the opinions of hospital managers, the assigned weight to " Must-be," "one-dimensional," and "attractive" want are 5, 3, and 1, respectively. Table 4 shows that there are 2 "Attractive" clients' wants, 15 "One-dimensional" clients' wants and 13 "Must-be" clients' wants.

Calculating the Weight of the Customers' Wants

Table 4 shows the final weights of the customers' wants in which R_{26}, R_{25} and R_{16} have the highest weights.

Calculating the Weight and Prioritization of the Corrective Activities

In this step, the weights of the corrective activities are

Customers' requests		A1 Consulting and educating clients and patients	A2 Creating an accurate information system	A3 Increase staff sense of responsibility	A4 Use alarms to declare a patient's health status	A5 Strengthen laboratories	A6 Increase patient appointment time	A7 Timely remedy deficiencies	A8 Use of safety equipment to transport of patients	A9 Create enough space for traffic	A10 Prepare descriptions for devices and equipment	A11 Providing comfortable and clean patients' clothes	A12 Training of physicians and nurses	A13 Use of modern construction equipment	A14 Perform a timely and proper examination	A15 Providing entertaining equipment for patrons	A16 Reinforcement of reception system	A17 Provision of comfort facilities for clients	A18 Hiring experienced surgeons, specialists and nurses	A19 Providing modern medical equipment	A20 Balancing between the number of patients and staff	A21 Improve environmental conditions	A22 Periodic replacement of medical equipment	A23 Use color labels for equipments	A24 Use signage and warning signs	A25 Increasing the variety and quality of foods	A26 Training the hospital cleaning crews	A27 Improve facilities and mechanize cleance equipment	A28 Establish personalize facilities for patients	A29 Increasing managers' knowledge	A30 Get advice from medical equipment experts
Friendly environment	R1	○		○			○					●	○			●		●	Δ			●		●						●		Δ
Pharmacy with enough variety and drugs	R2			○				●					○																		○	
Proper parking with easy access	R3													○			○	●							●						○	
High capacity waiting rooms	R4		●	○						●			○				●		Δ		●	○			●						○	
Proper care after surgery	R5			○	●	●		○	○				●		●				●	○	○		Δ								Δ	
Taking care of patients	R6	○		○	○			○					●		●				○		Δ											
Fast and safe patient transfer	R7		○	○					●	●			●	●						●		○	○									○
Adequate beds	R8		●	Δ				○					○	●			●	○		●	○	Δ	○										
Appropriate assistance to patients	R9	●		●									●						Δ		○											
Suitable size and tidy environment	R10									●				●						Δ												
Safe devices and equipment	R11	●							●		●									●				○	●							○
The presence of a relaxing environment	R12		Δ						Δ	○			○	●		Δ		Δ		Δ		●			●			●				
Provide patient health information to fellows at any time	R13		●	●									●		Δ				●		○											
Enough manpower	R14																				●									●		
Healthy food and variety	R15																	○								●				Δ		
Environmental cleanliness	R16			Δ									○	○								○			○		●	●				
Proper behavior of the staff	R17	●		○									●						○													
Adequate and modern medical equipment	R18												○							●		●									●	●
Timely and appropriate treatment	R19			○		●		●					●		●				●	●	○		Δ									○
Proper guidance for clients	R20	●	●	○									●				○		Δ		○				●							
Considering a special environment for children	R21	●		○		●							○			●		●	Δ			●		●		●				Δ		Δ
Low waiting time for surgery	R22		Δ	○		●			Δ				●		○		●		●	●	●										○	
Pay attention to client stress	R23	●		○			●						○			○		Δ	●	○				●								
Special attention to specific patients	R24			○	●								○		○					Δ												
Healthy and sufficient consumables	R25		●	Δ				●					○						○			○										
Professional and experienced doctors and nurses	R26												●						●		●										○	
Provide sufficient information centers	R27	●	●	●							○		●						Δ						●							
The nice interior design	R28								○	Δ	●		○		●		●					●		●	Δ	Δ	●		●			
Good buffet with full and varied menu	R29							○					○		○		●									●				○		
Elevator and construction equipment failure reduction	R30		○					●					●																			

FIgure 4. House of Quality.

Table 4. The Wants' Importance Degree, Type, and Weight

Client Request	Importance Degree	Request Type	Kano Weight	Absolute Weight	Relative Weight
R_1	3.982	O	3	11.945	0.024
R_2	4.252	M	5	21.26	0.044
R_3	4.281	M	5	21.403	0.044
R_4	4.174	M	5	20.87	0.043
R_5	4.351	M	5	21.753	0.045
R_6	4.501	O	3	13.504	0.028
R_7	4.317	O	3	12.951	0.027
R_8	4.153	O	3	12.46	0.026
R_9	4.205	O	3	12.616	0.026
R_{10}	4.475	M	5	22.377	0.046
R_{11}	4.499	M	5	22.494	0.046
R_{12}	4.41	O	3	13.231	0.027
R_{13}	4.362	O	3	13.085	0.027
R_{14}	4.566	O	3	13.699	0.028
R_{15}	4.083	O	3	12.249	0.025
R_{16}	4.514	M	5	22.571	0.046
R_{17}	4.39	M	5	21.948	0.045
R_{18}	4.353	O	3	13.06	0.027
R_{19}	4.514	O	3	13.543	0.028
R_{20}	4.34	M	5	21.701	0.044
R_{21}	4.322	A	1	4.322	0.009
R_{22}	4.47	O	3	13.41	0.027
R_{23}	4.249	O	3	12.748	0.026
R_{24}	4.605	O	3	13.816	0.028
R_{25}	4.532	M	5	22.662	0.046
R_{26}	4.54	M	5	22.701	0.046
R_{27}	4.275	M	5	21.377	0.044
R_{28}	4.309	O	3	12.927	0.026
R_{29}	4.184	A	1	4.184	0.009
R_{30}	4.306	M	5	21.532	0.044

calculated based on the equations (3) and (4). Table 5 shows the absolute weight, relative weight, and the corrective activities ranks that A_{12} and A_3 have the highest weight and A_{11} and A_6 have the lowest weight.

Estimating the Cost of Implementing Each Corrective Activity

In this step the cost of implementing each corrective activity is estimated using the fourth questionnaire. The results are shown in Table 5.

Employ KPMM to Select Optimum List of Corrective Activities

In this step the optimum list of corrective activities is obtained under various values of budget using KPMM. If the assigned budget is equal to sum of the corrective activities costs, all corrective activities are selected. But if the assigned budget is lower than sum of the corrective activities costs some corrective activities will not be selected. Table 6 shows the list of optimum corrective activities under various assigned budgets.

Discussion

Some advantages of the proposed approach are as follows:

- Considering the type of need and its importance degree in determining the weight of customers' wants, simultaneously to improve hospital services quality.
- Applying the organizations strategies in determining the weight of customers' wants and subsequently in the weight of corrective activities as mentioned previously.
- Selecting the optimum set of corrective activities under budget constraint.

Table 5. Weight, Rank and Cost of the Corrective Activities

Rank	Corrective Activity	Absolute Weight	Relative Weight	Estimated Cost (US Dollar)
1	A_{12}	2807.789	0.118	52000
2	A_{3}	1627.345	0.068	9000
3	A_{18}	1446.789	0.061	69000
4	A_{20}	1360.043	0.057	169000
5	A_{24}	1307.612	0.055	1000
6	A_{2}	1248.642	0.053	17000
7	A_{19}	1213.092	0.051	169000
8	A_{1}	1163.356	0.049	17000
9	A_{13}	1141.904	0.048	169000
10	A_{7}	1067.338	0.045	9000
11	A_{29}	923.9935	0.039	17000
12	A_{14}	771.192	0.032	17000
13	A_{16}	729.498	0.031	17000
14	A_{21}	688.6482	0.029	9000
15	A_{9}	686.627	0.029	52000
16	A_{22}	613.8711	0.026	169000
17	A_{5}	607.5665	0.026	85000
18	A_{17}	589.0441	0.025	34000
19	A_{8}	475.7866	0.02	33000
20	A_{4}	475.1257	0.02	32000
21	A_{30}	421.4588	0.018	1000
22	A_{27}	404.2391	0/017	69000
23	A_{10}	325.7928	0/014	1000
24	A_{26}	322.9543	0.014	17000
25	A_{23}	311.1328	0.013	1000
26	A_{15}	301.714	0.013	17000
27	A_{25}	223.3374	0.009	17000
28	A_{6}	177.7658	0.007	9000
29	A_{28}	170.1846	0.007	53000
30	A_{11}	153.3022	0.006	17000

If original QFD approach such as the exerted QFD in[24,25,32] is applied, the client wants of “Special attention to specific patients”, “Enough manpower”, and “Professional and experienced doctors and nurses” obtain the highest weight because they have the highest importance degree. But, in this research the client wants of “Professional and experienced doctors and nurses”, “Healthy and sufficient consumables”, and “Environmental cleanliness” obtained the highest weights among all wants. It is because the type of these client wants are “Must-be” and their importance degrees are multiplied by a high coefficient. Although, Special attention to specific patients” and “Enough manpower” have the highest importance degree but their type is “One-dimensional” and their importance degrees are multiplied by a lower coefficient. The results of the exerted approach are flexible and by changing the strategies of the organization, the Kano weights and the clients’ wants’ weights will accordingly be changed.

Using the Kano analysis for obtaining the weights of the customers’ wants allowed for the organization’s strategies to be considered in determining the priority of the corrective activities. According to the organization’s strategy, the weight assigned to each type of wants may be different from another. On the other hand, using KPMM leads to selection of optimum set of corrective activities under budget constraint.

Conclusion

Like other service organizations, hospitals provide services to their customers and seek customer satisfaction. This research aimed to improve hospital services quality through QFD and its integration with the Kano analysis and KPMM. For this purpose, at first, the customer’s wants were identified, and the corrective activities required to satisfy them were obtained. Consequently, the relationship between each customer want and each corrective activity was determined. Then, each customer want’s importance degree and type were determined based on the Kano analysis. Subsequently, the weight of each clients’ wants

Table 6. List of Optimum Corrective Activities Under Various Budgets

Selected Corrective Activities	Assigned Budget (US Dollar)
All activities	1348000
All activities except A22, A27 and A28	0.8×1348000=1078400
All activities except A5, A13, A22, A27 and A28	0.6×1348000=808800
All activities except A11, A13, A19, A20, A22, A27 and A28	0.4×1348000=539200
All activities except A4, A5, A8, A9, A11, A13, A15 A17 A19, A20 A22, A25, A27 and A28	0.2×1348000= 269600
No activity	0

and corrective activity was calculated. Finally, the cost of implementing each corrective activity is estimated and the set of optimum corrective activities under budget constraint is determined using KPMM.

It is suggested that hospital managers consider the proposed list of clients' wants and corrective activities to have better insight about their customers. The priority and the weight of corrective activities are related to weight of clients' wants. Therefore, any change in the weight of clients' wants, change the priority of clients' wants. It is suggested to managers using the proposed approach and deals their strategies by assigning scores to type of clients' wants. Moreover, it is suggested that managers use KPMM to determine the optimum set of corrective activities under budget constraint.

Using the proposed approach in other service organizations such as banks, hotels and training centers may be the scope for future research. Adding other techniques such as MCDM techniques,[45] data envelopment analysis[46-49] or supply chain aspects[50-54] to the approach could be another scope for future studies. Employing fuzzy methods in determining the weight of the corrective activities may also be considered in future research.

Abbreviations

(QFD): Quality function deployment; (HOQ): House of quality; (MCDM): Multi-criteria decision making; Knapsack Problem Mathematical Model (KPMM).

Competing Interests

The authors declare no competing interest.

Authors' Contributions

MAB conceived of the presented idea. AM developed the theory and performed the computations. MK wrote the paper.

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