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QFD Application Using Combined ANP-DEMATEL Approach for Improving Service Quality: A Case Study of Dental Clinic

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ABSTRACT

The Quality Function Deployment method (QFD) is one of the most effective tools of designing and improving quality being used in order to supply customer's requirements and enhancing his/her satisfaction. The main purpose of this research is to prioritize the identifiers of improving service quality of dental clinic using QFD approach and combined ANP and DEMATEL with fuzzy approach. Initially in this research, patients' demands were determined. Before ranking, the patients' demands were classified based on dimensions of SERVQUAL model, then they were ranked by the combined ANP and DEMATEL with fuzzy approach. Then, technical requirements were determined by nominal group technique. At last, the matrix of house of quality (HOQ) was completed that the most significant technical requirements include holding training courses, purchasing modern equipment, and recruiting skilled and committed personnel.

1. Introduction

Service quality has been recognized as one of the most important and essential issues and also one of the efficient tools to create competitive advantage and improving organizational performance (Shahin and Dabestani, 2010). Hoffman and Bateson have stated that developing a high level of

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service quality has resulted in customer satisfaction and loyalty; this has led to increase market share and profiting (Shahin and Samea, 2010). The quality means to produce a product or presenting services in such a way meeting customer requirements and satisfying them (Wolkin and Skotnicka, 2012). It is necessary to identify customer needs and transforming it into product design is very important to remain competitive in market (Tontini, 2003).

QFD is a systematic approach that leads to find customer's real requirements (Chen and Kom, 2008). QFD is based on the satisfaction of customers, translating their needs into measurable characteristics that meet their expectations. (Jose et al., 2013). QFD is regarded as a powerful customer-oriented design tool for developing new or improved products to achieve higher customer satisfaction by integrating various functions of an organization. (Nahma, 2013). One of the most functional tools used in QFD is house of quality (HOQ) which is used to determine coefficient of importance of customer's demands being one of the most significant aspects of HOQ. To determine these coefficients requires high accuracy. To use a method that may accurately specify these coefficients is of special importance (Azar and Shariati Rad, 2012). So far some research has been carried out concerning QFD function in the context of treatment and health. Rahimi et al. (2013) used QFD approach in order to supply customer's needs and to increase their satisfaction with the services of emergency ward of Shahid Faghihi hospital in Shiraz. By specifying 13 expectations and requirements of customer, they were weighted by Simple Additive Average Weighting (SAW). Then, 9 elements of service as pattern ingredients of service quality were prioritized at three improvement levels. The results showed that quality pattern resulting from the study may be a general guide to improve quality of emergency department. Comgoz et al. (2013) carried out a research to translate customer needs and expectations into the quality characteristics in a private healthcare setting in Istanbul (Turkey) through the QFD and SERVQUAL integrated approach. The most important finding of this research was that staff's behaviors and attitudes have the highest weight score. It does mean that when staff's behaviors and attitudes improve, there would be almost 25 percent improvement in the hospital. Gremyr and Raharjo (2013) conducted a research to improve QFD application in healthcare at a cardiovascular clinic. A time study at one clinic before and after the project within which the QFD was used showed that the time spent on prescription of medication has decreased by more than 20 percent. This has increased the time that doctors can spend with their patients.

The main purpose of this research is to prioritize the identifiers of improving service quality of dental clinic using QFD approach and combined ANP (Analytic Network Process) and DEMATEL (decision making trial and evaluation laboratory), approach. In fact, ranking and weighting of customer's demands are distinctive aspects of this research compared with other researches using QFD technique. Here after being recognized, customer's demands are classified by the approach of SERVQUAL (Service Quality) model and then the combined ANP and DEMATEL with fuzzy approach is utilized. Continuing this paper after describing QFD's concepts, the combined ANP-DEMATEL approach and SERVQUAL model, we present the main research model to prioritize identifiers of improving quality in dental clinic.

2. QFD

For product or service development, quality function deployment (QFD) is a useful approach to maximize customer satisfaction. (Ayag et al., 2013). QFD is a structured process and a related engineering set to make sure the voice of the customer (VOC) could be heard across designing phases (Yuan Hsu, 2010). The primary tool in QFD is HOQ, which is also known as product planning matrix or matrix diagram. It is a matrix of matrices consisting of the following six major building blocks, as shown in figure 1.

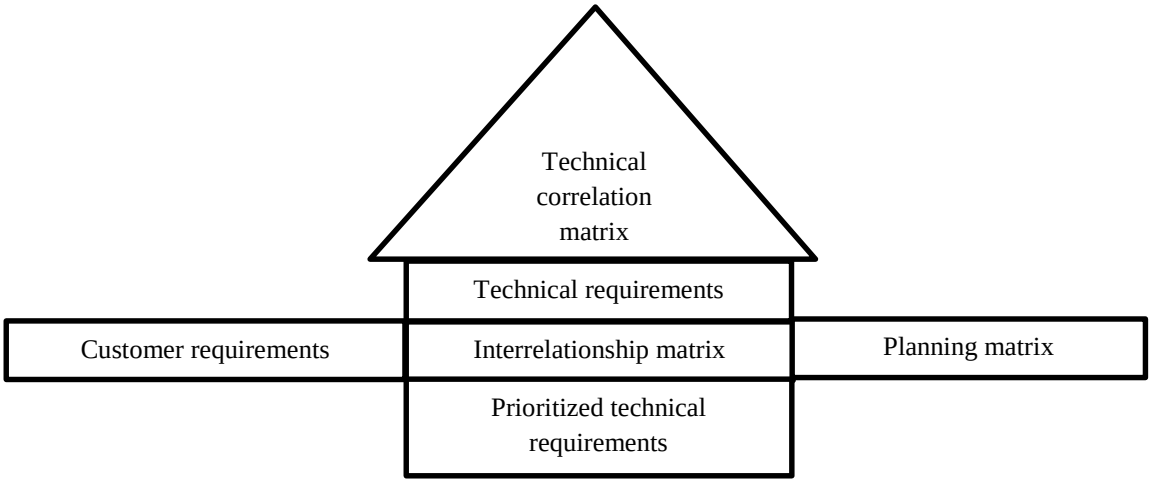

Figure 1 House of quality

a) Customer requirements (What's) – A structured list of the customers' requirements.
b) Technical requirements (How's) – A structured set of relevant and measureable product or service characteristics or design specifications.
c) Interrelationship matrix – Interrelationship between What's and How's is marked using symbols or numbers depending upon the contribution made by each customer's requirement and technical requirement.
d) Technical correlation matrix – A relationship between technical requirements is shown, which supports or impedes the product design. It is also known as a roof matrix.
e) Planning matrix – In this matrix, the customers' requirements are quantified and ranked in order of their importance.
f) Prioritized technical requirements – In this matrix, technical requirements are quantified and ranked in order of their importance (Chakraborty, 2013).

3. The combined approach of fuzzy ANP-DEMATEL

The combined approach of DEMATEL and ANP has been one of the combined techniques of decision making to measure and assess complicated systems (Shahbandarzadeh and Saeidi, 2013).

This model which is based on combining two methods: analytic network process (ANP) and DEMATEL in a fuzzy environment being able to resolve one of the problems and limitations of ANP method, namely surveying a huge number of pairwise comparisons to gain the importance of criteria having inner dependence, besides removing ambiguity and uncertainty from decision makers' linguistic assessments (Nakhaei kamal abadi and Bagheri, 2008). Implementing the combined ANP and DEMATEL with fuzzy approach would reduce computations volume and research complexity. Using fuzzy concepts also leads to implement linguistic terms in the form of spoken language and allowing experts to analyze research subject in a more accurate and proper way (Safaei ghadikalaei et al., 2013).

4. SERVQUAL

SERVQUAL model is one of the methods often used to evaluate service quality (Butt and De Run, 2011). Measuring tools were presented by Parasuraman et al. (1985) to measure service quality, reviewing and adapted in 1988, 1991, and again in 1994 (Sureshchandar,2004).This tool measures customer perceptions in five dimensions of service, namely: tangibles, reliability, responsiveness, assurance, and empathy . Tangibles dimension (physical space, environmental conditions and service delivery including facilities, equipment, personnel and communication channels), Reliability dimension(ability to serve secure and reliable forms of services), Responsiveness dimension (willingness to cooperate and assist the customer), Assurance dimension (competency of personnel for induction trust and confidence to customer), and Empathy (especially dealing with each customer according to their mood so that customers are convinced organization has understood them (Bahadori et al., 2011).

5. Methodology

This research is functional from the viewpoint of purpose and being case type - descriptive from the aspect of conducting method of research. In this research, statistical population is the monthly number of referrers to dental clinic during the month of August 2013. Based on the existent evidences and documents at the dental clinic, the average number of referrers to this clinic was determined about 950 people monthly. According to Morgan table, the sample size equals 274 people whom selected randomly. Interview and questionnaire were tools used to collect information. Cronbach's alpha was implemented to determine questionnaire reliability. The figure 2 shows the conceptual model of research.

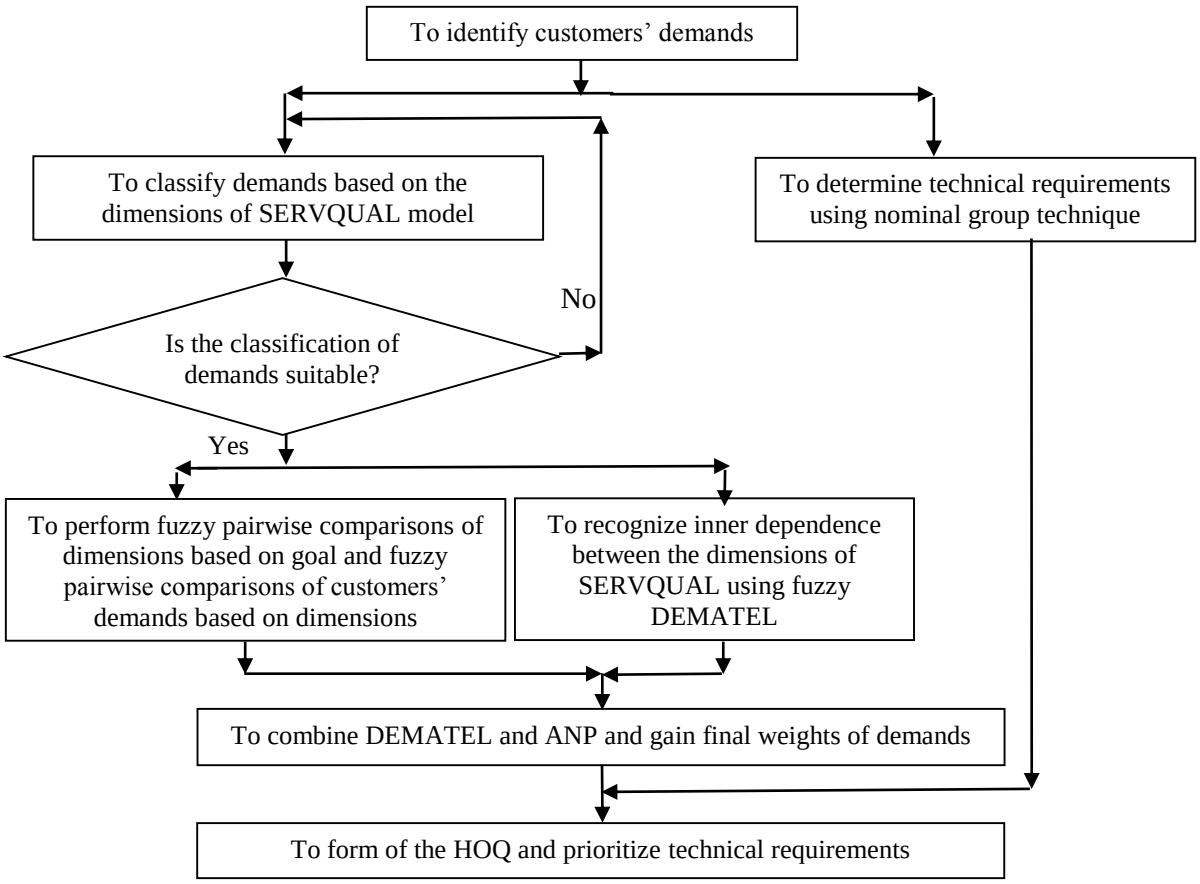

Figure 2 The conceptual model of research

In this study HOQ is used to prioritize the identifiers of improving service quality. For this, first customers' demands and expectations are determined. Then on one hand the technical requirements of customers' demands are determined. On the other hand the importance of customers' demands is determined using the combined ANP and DEMATEL with fuzzy approach. To use this model, first the customers' demands are classified according to the five main dimensions of SERVQUAL model. Then, inner dependence between main factors (dimensions) is specified by using DEMATEL model. Then, pairwise comparisons between criteria (customers' demands) are performed based the main dimensions and pairwise comparisons of main dimensions are performed based on research goal. Then, DEMATEL and ANP are combined to achieve the final weight of customers' demands. At last, specifying and weighting the customers' demands and determining their technical requirements, HOQ is formed in order to prioritize the technical requirements.

Stage1: Identifying customers' demands

Customers' demands are determined by library studies and interviewing customers and experts.

Stage2: Classification customers' demands based on SERVQUAL model

The customers' demands are classified based on SERVQUAL model based on five dimensions of this model (Tangibles, reliability, responsiveness, assurance, and empathy).

Stage3: Recognizing the relationships between the dimensions of SERVQUAL model

At this Stage, DEMATEL technique is used to recognize inner dependence between the dimensions of

SERVQUAL model and determine causal relations whose steps are as follow: (Zhou et al., 2011):

Step1) Generating the direct relation matrix:

The experts express their opinions about direct influence of every one of the main factors (dimensions of SERVQUAL) on each other by using linguistic variables of table 1. By converting linguistic estimations to fuzzy numbers, the direct relation $A = [a_{ij}]$, is gained that in it, A being non-negative matrix $n \times n$ and a_{ij} signifies a triangular fuzzy number indicating the direct influence of i factor on j factor. When i = j, matrix diametrical identifiers become zero (Zhou et al., 2011).

$$A = \begin{bmatrix} a_{11} & \dots & a_{1j} & \dots & a_{1n} \\ & & \vdots & & \\ a_{i1} & \dots & a_{ij} & \dots & a_{in} \\ & & \vdots & & \\ a_{n1} & \dots & a_{nj} & \dots & a_{nn} \end{bmatrix} \quad (1)$$

Table 1 Linguistic values and linguistic terms for DEMATEL method

Linguistic values	Linguistic terms
(0,0,0.25)	No influence
(0,025,0.5)	Very low influence
(0.25,0.5,0.75)	Low influence
(0.5,0.75,1)	High influence
(0.75,1,1)	Very high influence

Step2) Defuzzifying the direct relation matrix by CFCS method:

CFCS method is used to de-fuzzy the direct relation matrix presented by Tseng (2006). Suppose that$Z_{ij}^{k} = (l_{ij}, m_{ij}, r_{ij})$ is, where (1<k<K) is the fuzzy assessment that kth expert has presented about influence amount of i factor on j factor. Based on the CFCS method, de-fuzzy is performed in the following way:

$$xl_{ij}^{k} = \left(l_{ij}^{k} - \min_{1\le k\le K} l_{ij}^{k}\right)/\Delta_{min}^{max} \quad (2)$$

$$xm_{ij}^{k} = \left(m_{ij}^{k} - \min_{1\le k\le K} l_{ij}^{k}\right)/\Delta_{min}^{max} \quad (3)$$

$$xr_{ij}^{k} = \left(r_{ij}^{k} - \min_{1\le k\le K} l_{ij}^{k}\right)/\Delta_{min}^{max} \quad (4)$$

$$\Delta_{min}^{max} = \max r_{ij}^{k} - \min l_{ij}^{k} \quad (5)$$

$$xls_{ij}^{k} = xm_{ij}^{k}/(1 + xm_{ij}^{k} - xl_{ij}^{k}) \quad (6)$$

$$xrs_{ij}^{k} = xr_{ij}^{k}/(1 + xr_{ij}^{k} - xm_{ij}^{k}) \quad (7)$$

$$x_{ij}^{k} = \left[xls_{ij}^{k}\left(1 - xls_{ij}^{k}\right) + xrs_{ij}^{k}\, xrs_{ij}^{k}\right]/\left(1 + xrs_{ij}^{k} - xls_{ij}^{k}\right) \quad (8)$$

$$BNP_{ij}^{k} = \min l_{ij}^{k} + x_{ij}^{k}\, \Delta_{min}^{max} \quad (9)$$

$$BNP_{ij}^{k} = \min l_{ij}^{k} + x_{ij}^{k}\, \Delta_{min}^{max} \quad (10)$$

After defuzzifying, the direct relation matrix is performed which shows the influence of i factor on j factor.

Step3) Normalizing the direct relation matrix:

In this step, the direct relation matrix is normalized. The normalized matrix (matrix X) is obtained by the equation (11).

$$X = s \times A \quad (11)$$

$$s = \min\left[\frac{1}{\max_{i}\sum_{j=1}^{n}|a_{ij}|}, \frac{1}{\max_{j}\sum_{i=1}^{n}|a_{ij}|}\right] \quad (12)$$

Step4) Obtaining the total relation matrix:

The sum of unlimited traces from direct and indirect influences of elements on each other (accompanied with all possible feedbacks) is calculated in the form of a geometric progression based upon graph rules. The sum of this progression is total relation matrix T that i being an identity matrix n × n in it.

$$T = X + X^2 + \cdots + X^k = X\left(I + X + X^2 + \cdots + X^{k-1}\right)(I - X)(I - X)^{-1} = X\left(I - X^k\right)(I - X)^{-1}$$

Provided that

$$\lim_{k\to\infty} X^k = \left[0\right]_{n\times n}$$

Total relation matrix is obtained by the equation (13).

$$T = X(I - X)^{-1} \quad (13)$$

Where I is the identity matrix, which is also n× n matrix.

Step 5) Calculating the sum of rows and columns of the total relation matrix and identifying causal factors

$$r_i = \sum_{j=0}^{n} tij \quad (14)$$

$$c_j = \sum_{i=0}^{n} tij \quad (15)$$

By using the equation (14), the sum of ith row (ri) is obtained. By utilizing the equation (15), the sum of jth column (cj) is also obtained.

When i=j, ri+cj shows both the influence which factor i can have on other factors of system and also the influences of other factors of system on factor i. So, ri+cj show the significant degree of i factor in whole system, and ri-cj indeed shows the influence of i on system. If ri-cj is positive, then factor i is Affecting other factors which belongs to the cause group. Otherwise, if ri-cj is negative, then factor i is being influenced by other factors which belongs to the effect group.

Stage4: Performing fuzzy pairwise comparisons

At this Stage, fuzzy pairwise comparisons of the main factors (dimensions) based on goal and fuzzy pairwise comparisons of criteria (customers' demands) based on main factors (dimensions) are performed. Linguistic values and linguistic terms have been inserted in table 2 used to perform pairwise comparisons.

Table 2 Linguistic values and linguistic terms for pairwise comparison

Linguistic values	Linguistic terms
(1,1,1)	Exactly equal
(1,1,3)	So little preference
(1,3,5)	Somewhat important
(3,5,7)	More important
(5,7,9)	Very important
(7,9,9)	Absolutely important

To make group pairwise comparisons, the equation (16) is implemented to calculate composition of individuals' opinion and to obtain final tables of pairwise comparisons after gaining the table of fuzzy pairwise comparisons for every expert (Ataei, 2010):

$$Z_{ij}^{k} = \left(\sqrt[k]{L1 \times L2 \times \ldots \times Lk}, \sqrt[k]{m1 \times m2 \times \ldots \times mk}, \sqrt[k]{r1 \times r2 \times \ldots \times rk}\right) \quad (16)$$

To defuzzifying pairwise comparison tables, CFCS method is used by implementing the equations (2) to (10) considering the value of k=1. K is regarded to be equal to 1 because just one fuzzy

aggregated table becomes non- fuzzy. The final weight is obtained from the non-fuzzy final table and by the equation (17) (Hasan pour et al., 2012):

$$wi = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)1/n}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}\right)1/n} \qquad \text{i , j = 1 ,2 ,\& ,n} \qquad (17)$$

Stage5: Ranking of customers' demands and solving super matrix

At this step, the combined ANP and DEMATEL with fuzzy approach that are supposed to be multi-criteria decision making methods being used in order to prioritize and specify the importance of customers' demands. Since the existent factors in research model have interrelations and interactions with each other, DEMATEL is the best tool to measure the relations between them, and on the other hand ANP method used to determine final weight of each one of factors and their importance regarding relationship between them (Shah Bandar zadeh and Saeidi, 2013).

Super matrix is a composite matrix that each matrix of it including the set of relationships between and inside levels. Super matrix is used to analyze the interdependences among system's components (Shah Bandar zadeh and Saeidi, 2013). Forming and solving super matrix is performed in three steps:

Step1) To perform unweighted super matrix:

Goal is placed at the first level of network and main factors being at the second level having inner dependence and criteria (customers' demands) setting at the third level. In the super matrix W, W_{21} is relative weight of the main factors (dimensions) based on goal. W_{22} is inner weight among main factors. Matrix T as DEMATEL method output is considered to be W_{22} matrix after being normalized and W_{32} being criteria' weight based on main factors (dimensions).

$$\begin{array}{c} \\ \text{Goal(G)} \\ \text{W= dimension(D)} \\ \text{Criteria(C)} \end{array} \begin{array}{c} \begin{array}{ccc} \text{G} & \text{D} & \text{C} \end{array} \\ \begin{bmatrix} 0 & 0 & 0 \\ w_{21} & w_{22} & 0 \\ 0 & w_{32} & 0 \end{bmatrix} \end{array} \qquad (18)$$

Step2) To calculate weighted super matrix:

Weighted super matrix is a random matrix that sum of elements in each of its column equal 1. To normalize, values in each column dived by sum of existent elements in the respective column.

Step3) To calculate limit super matrix:

This matrix is obtained by converging weighted super matrix (Jaafar negad et al., 2011). To be converged, weighted super matrix reaches to the power of 2k+1 that k is an arbitrary large number (Lee et al., 2009). In this phase of research, Super Decision software was used to calculate limit super matrix and gaining demands' weights after obtaining unweighted and weighted super matrices.

Stage6: Determining technical requirements

The customers' demands are covered with technical requirements with the help of nominal group technique being a useful tool to reach general consensus (Karbasian and Raadpour, 2011).

Stage7: Formation of the HOQ

Specifying the customers' demands and determining their weights on the one hand and determining the technical requirements on the other hand, interrelationship matrix is constructed. This matrix basically shows the relationship between the customers' demands and technical requirements. In this HOQ, the relative importance of the customers' requirements can be judged based on a priority scale developed as 9- strong relationship, 3- median relationship and 1- weak relationship.

Once the HOQ is developed with the necessary data, the absolute and relative weights for each technical requirement calculated using the following equations (19) and (20):

$$W_j = \sum_{i=1}^{n} w_i \times R_{ij} \quad (19)$$

$$w'j = \frac{W_j}{\sum_{j=1}^{m} W_j} \quad (20)$$

Where Wj is the absolute weight of jth technical requirements. W′j is the relative weight of jth technical requirements. Wi is the weight of ith customers' requirements. Rij is the weight of relations between the ith customers' requirements and jth technical requirements. n is the number of customers' requirements and m is the number of technical requirements.

6. Case study and findings

This study is performed in a private dental clinic in Shiraz a city of Iran. To prioritize the technical requirements suitable with the customers' demands of this clinic, the following stages were performed.

6.1. Identification of customers' demands

First, customers' expectations and demands of dental clinic were determined by interviewing with the patients and experts and also library studies. Next, a questionnaire was prepared based on demands and after its validity confirmation by experts, distributed among customers and its reliability obtained by Cronbach's alpha equaling 0.873. The customers' demands are visible in table 3.

6.2. Ranking of customers' demands

At this step, the combined ANP and DEMATEL with fuzzy approach that are supposed to be multi-criteria decision making methods being used in order to prioritize of customers' demands. In order to use the above model, the patients' demands were classified based on the five dimensions of SERVQUAL model according to table 3.

Table 3 Classification of the patients' demands according to SERVQUAL model

The patients' demands	Symbol	The dimensions of SERVQUAL model
Staff's decent and tidy appearance	CR_1	Tangibles
Appropriate environment to wait for treatment	CR_2	
Modern equipment and medical instrument	CR_3	
To present all services of oral/dental hygiene	CR_4	Reliability
To observe hygiene /to control infection	CR_5	
To provide various services at announced times	CR_6	
To have access to staff if need be	CR_7	Responsiveness
To provide services immediately and quickly	CR_8	
To treat patient in a polite and friendly way by staff	CR_9	Assurance
Technical capability of dentist	CR_{10}	
Individual attention for each patient	CR_{11}	Empathy
Suitable work time of clinic	CR_{12}	

6.2.1. Recognition of relationships between the dimensions of SERVQUAL model

Total relation matrix T was obtained by DEMATEL method and with the help of experts from the equations (2) to (13) according to table 4.

Table 4 Total relation matrix T

	Tangibles	Reliability	Responsiveness	Assurance	Empathy
Tangibles	0.37	0.7	0.79	0.66	0.77
Reliability	0.59	0.6	0.93	0.65	0.98
Responsiveness	0.39	0.55	0.47	0.43	0.69
Assurance	0.54	0.84	0.92	0.5	1.04
Empathy	0.32	0.49	0.56	0.39	0.45

In order to identify causal relationship and also intensity of relation of every factor with other ones, the sum of columns and rows of total relation matrix T were calculated by using the equations (14) and (15) according to table 5.

Table 5 The sum of columns and rows of total relation matrix T

	r_i	c_j	$c_j + r_i$	$r_i - c_j$	Cause or effect
Tangibles	3.29	2.21	5.50	1.08	Cause
Reliability	3.75	3.19	6.94	0.56	Cause
Responsiveness	2.54	3.67	6.21	-1.13	Effect
Assurance	3.85	2.63	6.48	1.22	Cause
Empathy	2.21	3.93	6.14	-1.73	Effect

The figure 3 surveys also factors' cause and effect relationship regarding the importance of every factor. Considering the causal diagram, assurance, tangibles and reliability factors have been placed in the positive half of the vertical axis. They have, therefore, a high effect among responsiveness and empathy factors. Responsiveness and empathy factors being in the negative half of the vertical axis show a high influence by other factors. Placing in the lowest part of the diagram, empathy factor is the utmost influenced by other factors. Of course it should be considered that all factors have a positive value on the horizontal axis, which means they interact severely with the other factors and change in every factor causing changes in other ones.

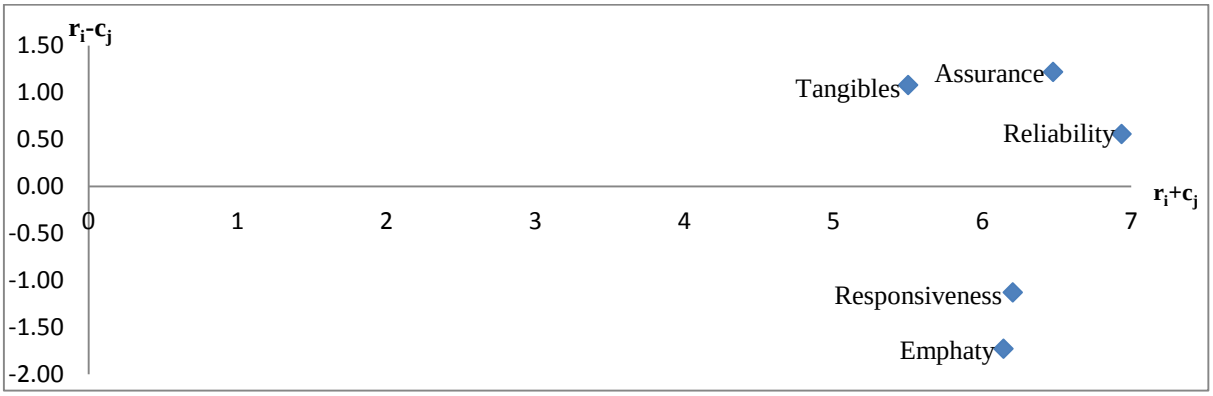

Figure 3 Causal diagram

6.2.2. Forming and solving super matrix

Unweighted super matrix is gained by matrix T (W22), matrix of pairwise comparison dimensions based on research goal (W21) and matrix of pairwise comparison of patients' demands based on dimensions (W32). Then this matrix is normalized in order to obtain weighted super matrix. In this phase of research, Super Decision software was used to calculate limit super matrix and gaining demands' weights after obtaining unweighted and weighted super matrices which the results being visible in table 7.

6.3. Determining technical requirements

By the nominal group technique, experts determine twenty technical requirements suitable with the patients' demands which can be seen in table 6.

Table 6 Technical requirements

technical requirements	Symbol
Specialized uniform for every job	TR1
To devote suitable space to children	TR2
To show instructional films and posters	TR3
To install cooling and heating systems	TR4
To set suitable seats	TR5
To purchase modern equipment and medical instrument	TR6
To initiate treatment various wards	TR7
To use dentists with required proficiencies of clinic	TR8
To utilize sterile system in every shift	TR9
To use disinfection for floors and surfaces at the right time	TR10
To file dossiers and records of patients	TR11
To set schedule clinic and work time of personnel	TR12
To change the arrival distribution of referrers	TR13
To hold training courses	TR14
To recruit skilled and committed personnel	TR15
To develop suitable valuation system for personnel	TR16
To use stimulating factors to improve personnel's performance	TR17
To give necessary explanations about the process of treatment to patients	TR18
The free pursuit of treatment	TR19
Offering services on holidays	TR20

6.4. Formation of the HOQ

Identification the patients' demands and determining their weights on the one hand and determining technical requirements on the other hand, the HOQ was formed. Following this, experts' opinions were implemented to complete interrelationship matrix and technical requirements were prioritized by using the equations (19) and (20). The table 7 shows the HOQ.

Table 7 The HOQ for the case of dental clinic

Technical Requirements / Customers' Requirements	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TR10	TR11	TR12	TR13	TR14	TR15	TR16	TR17	TR18	TR19	TR20	The Weights of Customers' Requirements
CR1	9														3						0.02
CR2		9	3	9	3					3											0.05
CR3						9															0.15
CR4							9	9				3			3						0.05
CR5						9			9	9				3							0.2
CR6											3	9	9								0.03
CR7												3		1	3	1	9				0.06
CR8												9	3	1	3	1	9			3	0.07
CR9														9	9	9	9				0.05
CR10								9						9	9	3	3		3		0.22
CR11		3																9	9		0.08
CR12												9								3	0.02
Absolute Weight of Technical Requirements	0.177	0.696	0.152	0.457	0.152	3.105	0.410	2.434	1.79	1.943	0.088	1.434	0.487	3.376	3.087	1.28	2.327	0.716	1.391	0.228	
Relative Weight of Technical Requirements	0.007	0.027	0.006	0.018	0.006	0.12	0.016	0.094	0.069	0.075	0.003	0.056	0.019	0.131	0.12	0.05	0.090	0.028	0.054	0.011	

7. Discussion and Conclusion

Considering the fact that the main purpose of this research is to prioritize the identifiers of improving service quality of dental clinic using QFD approach and combined ANP-DEMATEL model, 12 demands of the patients were initially determined to specify the patient's demands through interviewing patients and experts and library studies. Dorriz et al. (2010) took also into consideration services expenses, student and staff's behavior, reception process and health observation in order to survey the rate of patients' satisfaction with the offered services at the dental college of Tehran medical sciences university as the identifiers under examination. In order to survey the rate of patients' satisfaction with the offered services at Shiraz dentistry college, Ghopanchi et al. (2009) gave also full consideration to health observation, the condition of signposts, contact style of staff and students, and the skills of students. After identifying the patients' demands, the customers' requirements were classified based on the five dimensions of SERVQUAL model. Next, internal relations between dimensions were specified by using DEMATEL model. Considering the diagram of figure 3, it appeared that reliability, assurance, and tangibles factors influence empathy and responsiveness factors. Among influencing factors, Reliability has had the utmost interaction with other factors and consequently having the highest importance. In the next step, fuzzy pairwise comparisons of the dimensions based on goal and fuzzy pairwise comparisons of customers' demands based on dimensions were performed. Then, the demands' weights were determined by combining DEMATEL method and ANP and solving super matrix; the importance of customers' requirements (CR) is observed as following:

$CR_{10}> CR_5> CR_3> CR_{11}> CR_8> CR_7> CR_9> CR_2> CR_4> CR_6> CR_{12}> CR_1$

Based on the obtained results, technical capability of dentists, control infection and health observation and use modern equipment and medical instrument were recognized as the most important customers' requirements. In a research conducted by Esa et al. (2006) in Malaysia, dentist contact is of the most significant factors of satisfaction. Examining oral/dental patients in a research carried out by Klingenberg et al. (2008), health observation gained the high rank. In studying Gilan dentistry college health observation has been introduced as one of the important factors affecting satisfaction (Hashim, 2005). Examining dental patients' expectations in Greece, Kardis et al. (2001) introduced sterilization observation as the highest preference from the viewpoint of patients.

At next stage, technical requirements were determined by nominal group technique .At last, the HOQ was formed with the necessary data and the absolute and relative weights of technical requirements were calculated. The importance of technical requirements (TR) is observed as following:

$TR_{14}>TR_6>TR_{15}>TR_8>TR_{17}>TR_{10}>TR_9>TR_{12}>TR_{19}>TR_{16}>TR_{18}>TR_2>TR_{13}>TR_4>TR_7>TR_{20}>TR_1>TR_3> TR_5>TR_{11}$

Among the technical requirements, holding training courses, purchasing modern equipment and medical instrument and recruiting skilled and committed personnel were recognized as the most

significant ones, which the dental clinic management by prioritizing these requirements can highly improve the service quality presented to customers.

7.1. Managerial application

1- By separating children's waiting room from adults' and providing entertainment such as pictures and plays relating dentistry especially made for children, children may have a better communication with treatment.

2- To place staff with a high thrill intellect and capable of understanding patients' needs in some queues like reception part in order to offer services as soon as possible and considering characteristics of each patient.

3- Using simulation and implementing it in queuing theory in order to planning and determining distribution of patient's arrival via reception process.

7.2. Research limitation

1- To reduce expenses was one of the important demands of people referring to the dental clinic. Since rates were determined by tariffs of medical profession system, the dental clinic management had no solution to reduce it.

2- The research findings are limited to a short period of time and a long time may affect the studied variables in this research and causing some changes in results.

7.3. Future studies

1- The integration of QFD by clustering method: it is probable that various groups of customers have a set of different needs. Under these conditions, we may cluster customers and perform a separate the HOQ for every group of customers.

2- To specify QFD effect in improving the level of satisfaction of customer, the level of satisfaction of customers one may measure the level of customers' satisfaction before and after implementing QFD by SERVQUAL tool and comparing the obtained results with each other.

3- To utilize this model at other dental clinics and service industries and comparing the obtained results with the results of this research.

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