EVIDENTIAL REASONING-BASED QFD TO IMPROVE SERVICE QUALITY OF DIAGNOSTIC RADIOLOGY UNDER UNCERTAINTY

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Abstract

Lately, the issue of customer satisfaction accomplishing on the basis of enhancing the service quality has been broadly tested. To accomplish this objective, one of all around organized strategy is Quality Function Deployment (QFD). QFD is a way to deal with characterizing customer needs and make an interpretation of them into pertinent service or engineering characteristics and regularly incorporates a gathering of cross-functional team members from marketing, design, quality, finance and production and a team of customers. The QFD team is in charge of surveying the connections between service or engineering characteristics and customer needs and the interrelationships amongst them to prioritize and evaluate service or engineering characteristics. In the basic QFD, crisp values are utilized to decide connections between customer needs and service characteristics, however the specified technique are not suitable to address the subject of uncertainty since in most cases QFD team express their opinions with uncertainty and in this way, bringing about unseemly usage of QFD. In this paper, a QFD method is applied based on evidential reasoning approach to improve service of radiation protection in diagnostic radiology. This method is able to consider and handle uncertainties by utilizing belief structure and then aggregating them to prioritize service characteristics according to the health care requirements of the patients.

Keywords: Quality Function Deployment, Radiation safety management, Healthcare management, Team decision making, Uncertainty modelling; Evidential reasoning, Preference programming.

1. Introduction

Today, customer loyalty assumes a critical part in aggressive business environment. With respect to the issue of customer loyalty, the importance of quality is one of the key criteria. Numerous strategies and procedures, for example, Failure Mode and Effect Analysis (FMEA), Statistical Process Control (SPC) and Measurement System Analysis (MSA), Suivi Qualite Par le Fournisseur Exterieur (SQFE) and so on have been used to gauge and review the quality of an item. Quality can be characterized as addressing customer needs in an item and giving predominant worth. This attention on fulfilling the customer needs, lays accentuation on methods, for example, Quality Function Deployment (QFD), to comprehend those necessities and arrangement an item to create predominant worth.

Quality Function Deployment is an efficient methodology for guaranteeing that customers' voices are sent in the item arranging and outline stages. The voice of the customer is caught in an assortment of courses, for example, direct discourse or meetings, overviews, centre gatherings, customer particulars, perceptions, guarantees information and etc. by the promoting division and regarded as an arrangement of customer needs. Various engineering or service requirements that influence customer needs are additionally recognized to augment customer loyalty. The primary suspicion of basic QFD technique is that connections between customer needs and service or engineering characteristics depend on exact values.

With today's high uncertainty seen in the businesses, it is extremely justifiable that QFD strategy is adjusted for uncertain environment. Consequently, the techniques for organizing service of engineering characteristics under uncertainty with respect to fuzzy set hypothesis have been generally researched. For instance, Kim et al. [5] investigated a fuzzy multicriteria modeling approach to QFD planning in which fuzzy linear regression with symmetric triangular fuzzy numbers is used to estimate the functional relationships between customer needs and engineering characteristics as well as among DRs. Ko and Chen [6] proposed a fuzzy QFD on the basis of fuzzy linear programming to determine fulfillment levels of engineering characteristics and design requirements to maximize customer satisfaction considering company’s sources, technical difficulties and market competition constraint.

Chen and Ko [7] proposed a combination of fuzzy nonlinear programming and Kano's model to determine performance levels of design requirements wherein design requirements are categorized in three groups of exciting, functional and basic. Kwong and Bai [8] proposed a QFD method wherein the weight of customer needs is obtained by fuzzy analytical hierarchy process (FAHP). Buyukozkan et al. [9] applied fuzzy analytical network process (FANP) to determine engineering characteristics weights in which the results are more precise and therefore more useful and helpful for companies. Wang [10] proposed a fuzzy group decision making approach for prioritizing design requirements under uncertainty wherein both the group decision behaviors of customers and QFD team members are taken into account. Likewise the fuzzy QFD techniques for uncertain environment have been used and connected in an extensive variety of cases in different businesses (see for occurrence, Su and Lin [11], Rahman and Qureshi [12], Celik et al. [13], Vindoh and Chintah [14], Yeh et al. [15], Ding [16], Kannan [17] and Ayag [18]). Be that as it may, the fuzzy logic based methodologies cannot be applied for the uncertainty such as incomplete, imprecise and missing information data, since the majority of the said circumstances have been happened while people express their judgments. At the point when confronting these extreme choices, ER methodology can be awesomely settle on choice more exact based the mentioned data.

ER approach has been created by Yang et al. [19] for multiple attribute decision analysis (MADA) under uncertainty (Huyneh et al. [20]; Yang and Xu [21]). The methodology is created on the premise of choice hypothesis and Dempster-Shafer theory of evidence (Dempster [22], Dempster [23] and Shafer [24]). Button et al. [26] proposed a QFD model in view of ER methodology for consolidating different types of data such as incomplete, imprecise and missing information data got from a gathering of customers and QFD team members keeping in mind the end goal to organize plan requirements. In this paper, an evidential reasoning-based QFD method is implemented to incorporate incomplete, imprecise and missing information data to improve service of radiation protection in diagnostic radiology. This method is able to consider and handle uncertainties by utilizing belief structure and then aggregating them to prioritize service characteristics according to the health care requirements of the patients.

2. What is QFD?

QFD begins with the identification of customer needs and their mapping into relevant service characteristics. The relationship between customer needs, and service characteristics in QFD are represented in the matrix form, which is also called the house of quality (HOQ), as shown in Fig1. The matrix has two dimensions, i.e., customer needs and service characteristics. A triangular-shaped matrix placed over the service characteristics corresponds to the correlations between them. In the Fig1, R_{ij} denotes the score of relationship between the *i*th customer needs, and the *j*th service characteristics, w_i are the relative weights of the customer needs with $\sum_{i=1}^{m} w_i = 1$ and $w_i > 0$ for $i = 1, \dots, m$, and r_{jn} is the correlation score for the *j*th and *n*th service characteristics. We assume that the importance degrees of customer needs and relationship matrix between customer needs and service characteristics be one of the grades which are listed in Table1.

In the basic QFD, crisp values are used to determine relationships between customer needs and service characteristics, and the relative weights of customer needs, but the mentioned method are not suitable to address the subject of uncertainty, since in our case QFD team express their opinions with uncertainties like imprecise, incomplete and interval data and therefore resulting in inconvenient implementation of QFD. In this study, ER-based QFD approach is used in order to handle the mentioned uncertainties which are commonly observed in our case while QFD team members state about their judgments.

3. Methodology

3.1. Modeling the relationship matrix between customer wants and possible improvements

The relationships between the *i*th customer needs and the *j*th service characteristics shown by R_{ji} $(i = 1, \dots, m$ and $j = 1, \dots, n)$ is evaluated by team members' opinions with using belief structures. Each belief structure may be complete or incomplete, precise or imprecise. In this study, it is assumed that M team members and they express their opinions with mentioned uncertainties.

Suppose that $\{(H_{pq} \ \ ,\beta_{pq}),\ p = 0,\dots,N; q = p,\dots,N\}$ be the totalized belief structure provided by team members on the assessment of relationship R_{ji}, where H_{pp} for $p = 0$ to N are the crisp ratings defined for relationship assessment, H_{pq} for $p = 0,\dots,N$ and $q = p+1,\dots, N$ are intervals between H_{pp} and H_{qq}, and $\beta_{pq}^{(l)}$are the belief degrees to which the relationship R_{ji} is assessed to interval rating H_{pq}. For the grades defined in Table 1, we have six crisp grade which are 0, 1, 3, 5, 7, 9, and fifteen possible intervals that are 0-1, 0-3, 0-5, 0-7, 0-9, 1-3, 1-5, 1-7, 1-9,3-5, 3-7, 3-9, 5-7, 5-9 and 7-9. The matrix below shows the all possible relationship which can be existed between customer needs and service characteristics.

$$H=\begin{Bmatrix} H_{00} & H_{01} & H_{02} & H_{03} & H_{04} & H_{05} \\ & H_{11} & H_{12} & H_{13} & H_{14} & H_{15} \\ & & H_{22} & H_{23} & H_{24} & H_{25} \\ & & & H_{33} & H_{34} & H_{35} \\ & & & & H_{44} & H_{45} \\ & & & & & H_{55} \end{Bmatrix} = \begin{Bmatrix} 0 & 0-1 & 0-3 & 0-5 & 0-7 & 0-9 \\ & 1 & 1-3 & 1-5 & 1-7 & 1-9 \\ & & 3 & 3-5 & 3-7 & 3-9 \\ & & & 5 & 5-7 & 5-9 \\ & & & & 7 & 7-9 \\ & & & & & 9 \end{Bmatrix}$$

3.2. Aggregating the belief relationship matrix for possible improvement

After computing belief structures for all relationships, R_{ji}, they should be aggregated for each service characteristic. Since it is assumed that the overall assessment of relationships are on the basis of belief structure with interval and incomplete data, hence a method based on Dempster-Shafer theory of evidence for aggregating the customer wants is utilized. Let consider $R_{ji_1} = \{(Hpq\ ,\beta_{pq}(R_{ji_1})), p = 0,\dots,N ; q = p,\dots,N\}$ and $R_{ji_2} = \{(Hpq\ ,\beta_{pq}(R_{ji_2})), p = 0,\dots,N ; q = p,\dots,N\}$ be two belief structures showing the relationships between the customer needs i_1 and i_2 related to a service characteristic and $w_{i_1}$and w_{i_2} be the normalized weights for customer needs i_1 and i_2 . Hence, the belief structures are converted into basic probability masses as given below.

$$m_{pq} = w_{i_1}\beta_{pq}(R_{ji_1}), p = 0,\dots,N; q = p,\dots,N, \quad (14)$$

$$m_H = 1 - \sum_{p=0}^{N}\sum_{q=p}^{N} w_{i_1}\,\beta_{pq}(R_{ji_1}) = 1 - w_{i_1}\sum_{p=0}^{N}\sum_{q=p}^{N}\beta_{pq}\,(R_{ji_1}) = 1 - w_{i_1}\ , \quad (15)$$

$$n_{pq} = w_{i_2}\beta_{pq}(R_{ji_2}), p = 0,\dots,N; q = p,\dots,N, \quad (16)$$

$$n_H = 1 - \sum_{p=0}^{N}\sum_{q=p}^{N} w_{i_2}\beta_{pq}(R_{ji_2}) = 1 - w_{i_2}. \quad (17)$$

Based on Dempster-Shafer theory of evidence, the above probability masses are combined to produce a set of joint probability masses which are obtained by the following equations:

$$C_{pq} = \frac{1}{1-K}\left[\sum_{s=0}^{p}\sum_{t=q}^{N}\left(m_{st}n_{pq} + m_{pq}n_{st}\right) + \sum_{s=0}^{p-1}\sum_{t=q+1}^{N}\left(m_{sq}n_{pt} + m_{pt}n_{sq}\right)\right] + \frac{1}{1-K}\left[m_H n_{pq} + m_{pq}n_H - m_{pq}n_{pq}\right], p = 0, \dots, N; q = p, \dots, N \tag{18}$$

$$K = \sum_{p=0}^{N}\sum_{q=p}^{N}\sum_{s=0}^{p-1}\sum_{t=s}^{p-1}\left(m_{st}n_{pq} + m_{pq}n_{st}\right) \tag{19}$$

$$C_H = \frac{m_H n_H}{1-K} \tag{20}$$

The above results can be viewed as a new piece of evidence, which is further combined with the probability masses of $R_{ji_3} = \left\{\left(H_{pq}, \beta_{pq}\left(R_{ji_3}\right)\right), p = 0, \dots, N; q = p, \dots, N\right\}$

$$u_{pq} = w_{i_3}\beta_{pq}\left(R_{ji_3}\right), p = 0, \dots, N; q = p, \dots, N \tag{21}$$

$$u_H = 1 - \sum_{p=0}^{N}\sum_{q=p}^{N} w_{i_3}\,\beta_{pq}\left(R_{ji_3}\right) = 1 - w_{i_3}\sum_{p=0}^{N}\sum_{q=p}^{N}\beta_{pq}\left(R_{ji_3}\right) = 1 - w_{i_3}\ , \tag{22}$$

The combined results can be written as follows.

$$C'_{pq} = \frac{1}{1-K}\left[\sum_{s=0}^{p}\sum_{t=q}^{N}\left(c_{st}u_{pq} + c_{pq}u_{st}\right) + \sum_{s=0}^{p-1}\sum_{t=q+1}^{N}\left(c_{sq}u_{pt} + c_{pt}u_{sq}\right)\right] + \frac{1}{1-K}\left[c_H u_{pq} + c_{pq}u_H - c_{pq}u_{pq}\right], p = 0, \dots, N; q = p, \dots, N \tag{23}$$

$$K = \sum_{p=0}^{N}\sum_{q=p}^{N}\sum_{s=0}^{p-1}\sum_{t=s}^{p-1}\left(c_{st}u_{pq} + c_{pq}u_{st}\right) \tag{24}$$

$$C'_{pq} = \frac{c_H u_H}{1-K} \tag{25}$$

Next, the mentioned procedure continues once all pieces of evidence combined. Let $X_{pq}(\ p\ = 0, \dots, N; q\ = p, \dots, N\ )$ and X_H be the final combined probability masses. Then the overall assessment for PI_j will be $\{(H_{pq}\ , \delta_{pq}\ ), p =\ 0, \dots\ , N; q =\ p, \dots\ , N\}$, which is an aggregated belief structure and δ_{pq} are computed by:

$$\delta_{pq} = \frac{X_{pq}}{1 - X_H}, p = 0, \dots, N; q = p, \dots, N. \tag{26}$$

3.5 Obtaining overall assessment interval for service characteristics

In this paper, it is considered that customer needs' weights to be imprecise and uncertain. In this situation, the weights of customer wants act as decision variables so as to optimize the lower and upper limit of overall assessment for each service characteristics. The lower and upper bound of overall assessment is computed by solving the following pair of mathematical programming models:

$$min\, E^L(S) = \sum_{p=0}^{N}\sum_{q=p}^{N} \delta_{pq} H_p$$

Subject to.

$$W_i^L \leq W_i \leq W_i^U, i = 1, \dots, m\,,$$
$$\sum_{i=1}^{m} W_i = 1 \tag{27}$$

And

$$max\, E^U(S) = \sum_{p=0}^{N}\sum_{q=p}^{N} \delta_{pq} H_q$$

Subject to.

$$W_i^L \leq W_i \leq W_i^U, i = 1, \dots, m\,,$$
$$\sum_{i=1}^{m} W_i = 1 \tag{28}$$

It is obvious that if the customer wants weights are precise and crisp values, hence, there is no need to solve the above models and maximum and minimum overall assessment is obtained as follows.

$$E(S) = \sum_{p=0}^{N}\sum_{q=p}^{N} \delta_{pq} H_{pq} = \left[\sum_{p=0}^{N}\sum_{q=p}^{N} \delta_{pq} H_p\,, \sum_{p=0}^{N}\sum_{q=p}^{N} \delta_{pq} H_q\right] \tag{29}$$

For each Service characteristic, an interval is obtained due to uncertainty observed in customer and decision making team judgments, which are non-normalized and can be normalized as follows.

$$E(S_j) = \left[\frac{E^L(S_j)}{E^L(S_j) + \sum_{i\neq j} E^U(S_j)}, \frac{E^U(S_j)}{E^U(S_j) + \sum_{i\neq j} E^L(S_j)}\right],\ \ j = 1, \dots, n \tag{30}$$

Where $E^L(S_j)$ and $E^U(S_j)$ are the lower and upper bounds of $E(S_j)$.

Once the normalized overall assessments are obtained, they can be used in order to prioritize possible improvements. There are two methods can be used to prioritize service characteristics, one with comparing the average value of each interval rating which is not complete appropriate ranking and another with calculating equation below for each pair of interval and ranking probably overall assessment.

$$P(a > b) = \frac{\max(0, a_2 - b_1) - \max(0, a_1 - b_2)}{(a_2 - a_1) + (b_2 - b_1)} \tag{31}$$

Where a= $[a_1, a_2]$ and b= $[b_1,b_2]$ are two positive interval numbers.

4. Case study

This case study has been carried out from June to August 2015 in Tehran Clinic. As mentioned previously, in the case investigated, the QFD team members express their subjective judgments including imprecise, interval and incomplete data. Thus, we implement ER-based QFD in the company to prioritize service characteristics more precisely. Based on QFD team members and customers assurance, responsiveness, reliability and empathy are the four identified important customer needs which are shown in Table 2. The weights of customer needs which are interval are also listed in the same table. Responsibilities, justification, optimization, clinical audit, expert advice, equipment and training are the six engineering characteristics. The importance degrees of the four customer needs are obtained and analyzed by qualified customers are totalized and shown in Table 3. Based on QFD team members, totalized probabilistic opinions are shown In Table 4 and final ranking of service characteristics are listed in Table 5.

Conclusion

This paper deals with the extension of QFD under uncertainty including imprecise, incomplete and interval data. It is assumed that the relationships between customer needs and service characteristics as well as weights of customer wants are under mentioned uncertainties. The paper aims to help decision makers to incorporate the mentioned uncertainties into a priority problem and choose the best decision. The criteria for an alternative are combined based on Dempster-Shafer rule of combination and evidential reasoning algorithm. The model is applied in a numerical example with four criteria (i.e. customer needs) and seven characteristics Since the weights are interval, two nonlinear models are obtained and solved in order to find overall assessment interval for each alternative. Finally the service characteristics are ranked with their average overall assessment.

Reference

[1] Hauser J R, Clausing D, The house of quality, Harvard Business Review, 1988, 66: 63-73

[2] Etray T, Simulation approach in comparison of a pull system in a cell production system with a push system in a conventional production system according to flexible cost: A case study, International Journal of Production Economics, 1998, 57:145-155

[3] Hsiao S W, Concurrent design method for developing a new product. International Journal of Industrial Ergonomics, 2002, 29: 41-55

[4] Cohen L, Quality Function Deployment, how to make QFD work for you, Addition-Wesley, Reading, MA,1995

[5] Kim KJ, Moskowitz H, Dhingra A, Evans G, Fuzzy multi-criteria models for Quality Function Deployment, European Journal of Operational reseach, 2000, 121: 504-518.

[6] Ko WC, Chen LH, An approach of new product planning using Quality Function Deployment and fuzzy linear programming model, International Journal of Production Research, 2014, 52: 1728-1743

[7] Chen LH , Ko WC, A fuzzy nonlinear model for Quality Function Deployment considering kano's concept, Mathematical and Computer Modeling, 2008, 48: 581-598

[8] Kwong CK, Bai H, A fuzzy AHP approach to the determination of importance weights of customer requirements in Quality Function Deployment, Journal of Intelligent Manufacturing, 2002, 13: 367-377

[9] Buyukozkan G, Ertay T, Kahraman C, Ruan D, Determining the importance weights for design requirements in the house of quality using the fuzzy analytic network approach, International journal of Intelligent Systems, 2004, 19:443-461.

[10] Wang YM, A fuzzy-normalization-based team decision-making approach for prioritizing engineering design requirements in QFD under uncertainty, International Journal of Production Research, 2012, 50: 6963-6977

[11] Su CT, Lin CS, A case study on the application of Fuzzy QFD in TRIZ for service quality improvement, Quality and Quantity, 2008, 42: 563-578.

[12] Rahman Z, Qureshi MN, Developing new services using fuzzy QFD: a LIFENET case study, International Journal of Healthcare Quality Assurance, 2008, 21: 638-658

[13] Celik M, Cebi S, Kahraman C, Deha I, An integrated fuzzy QFD model proposal on routing of shipping investment decisions in crude oil tanker market, Expert Systems with Applications, 2009, 36: 6227-6235

[14] Vindoh S, Chintha SK, Application of fuzzy QFD for enabling agility in a manufacturing organization: A case study, The TQM Journal,2011, 23: 343-357.

[15] Yeh CH, Haung JCY, Yu CK, Integration of four-phase QFD and TRIZ in product R&D: a notebook case study, Research in Engineering Design, 2011, 22: 125-141

[16] Ding JF, Applying fuzzy Quality Function Deployment (QFD) to identify solutions of service delivery system for port of Kaohsiung, Quality and Quantity, 2009, 43:553-570.

[17] Kannan G, Implementation of fuzzy Quality Function Deployment in an automobile component to improve the quality charactristics, Quality Engineering, 2008, 20:321-333

[18] Ayağ Z, Samanlioglu F, Büyüközkan G, A fuzzy QFD approach to determine supply chain management strategies in the dairy industry, Journal of Intelligent Manufacturing, 2013, 24: 1111-1122

[19] Yang JB, Singh MG, An evidential reasoning approach for multiple attribute decision making with uncertainty, IEEE Transactions on Systems, Man and Cybernetics,1994, 24: 1-18

[20] Huyneh V N, Nakamori Y, Ho T B, Murai T, Multiple attribute decision making under uncertainty: the evidential reasoning approach revisited, IEEE Transaction on Systems, Man, and Cybernetics, Part A: Systems and Humans, 2006, 36: 804-822

[21] Yang J B, Xu D L, On the evidential reasoning algorithm for multiple attribute decision analysis under uncertainty, IEEE Transactions on Systems, Man and Cybernetics, Part A: systems and Humans, 2002, 32: 289-304

[22] Dempster, A P. (1967). Upper and lower probabilities induced by a multiqualityd mapping. Annals of Mathematical Statistics, 38(2), 325–339.

[23] Dempster, A P. (1968), A generalization of Bayesian inference (with discussion), Journal of Royal Statistical Society, Series B, 30, 208-247

[24] Shafer G, (1976), A mathematical theory of evidence, Princeton: Princeton University Press.

[25] Wang YM, Yang JB, Xu DL, Chin KS, the evidential reasoning approach for multiple attribute decision analysis using interval belief degress, European Journal of Operational Research, 2006 ,175:35-66

[26] Chin KS, Wang YM, Yang JB, Poon KG, An evidential reasoning based approach for Quality Function Deployment under uncertainty, Expert System with Applications, 2009, 36: 5684-5694

[27] Akao Y, Quality Function Deployment QFD, Integrating customer requirements into product design. Productivity Press, Cambridge 1990.

Fig1. The house of quality in QFD

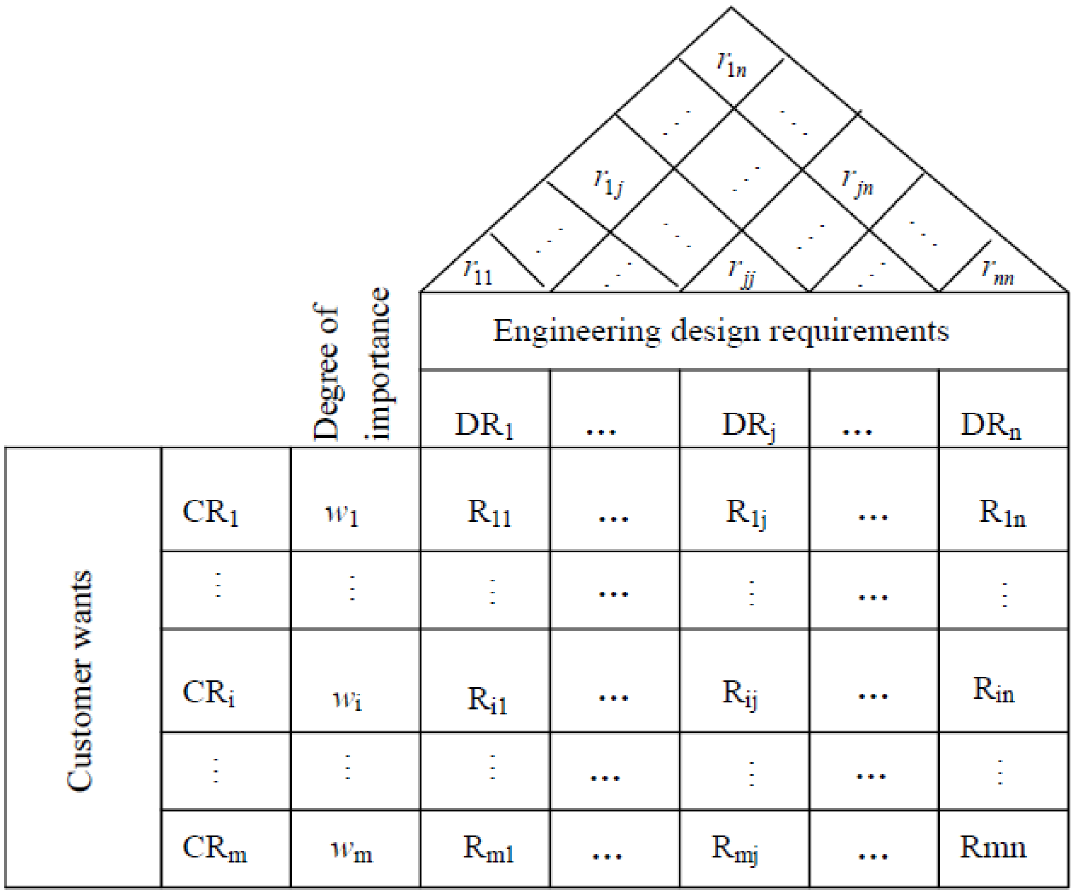

Table 1. Grades assumed for importance degree of customer wants and relationship between customer wants and possible improvements

Grade	Importance degree	Relationship matrix
9	Extremely important	Very strong relationship
7	Very important	Strong relationship
5	Moderately important	Moderate relationship
3	Weakly important	Weak relationship
1	Very weakly important	Very weak relationship
0	Not important	No relationship

Table 2: Customer needs

Assurance $0.35 \leq w_1 \leq 0.43$	Friendly and courteous doctors/staff Doctors should possess a wide spectrum of knowledge Patients should be treated with dignity and respect Explain thoroughly medical condition to patients
Responsiveness $0.12 \leq w_2 \leq 0.16$	Patients should be given prompt service Responsive doctors/staff Attitude of doctors/staff should instil confidence in patients Waiting time of not more than 1 h
Reliability $0.25 \leq w_3 \leq 0.30$	Services should be provided at appointed time Services should be carried out right the first time Doctors and staff should be professional and competent Consistency of any charges.
Empathy $0.20 \leq w_4 \leq 0.23$	Obtain feedback from patients 24 h service availability Doctors/staff should have the patient's best interest at heart Doctors/staff should understand the specific needs of patients.

Table 3. Service characteristics

Responsibilities	QA Dose audit/DRL Referrer Practitioner Operator Written protocols/procedures (guidance) Referral criteria Professional development Exposure much greater than expected Appropriate reviews (techniques)
Justification	Authorisation of exposure Net benefit Detriment Risk/benefit Previous clinical data
Optimization	As Low As Reasonably Achievable (ALARA) Intended diagnostic purpose Pregnant patient Clinical outcome recorded
Clinical audit	Clinical audit
Expert advice	Medical physics expert
Equipment	Inventory of equipment Equipment selection
Training	Adequately trained

Table 4. Relationship matrix

	Responsibilities	Justification	Optimizations	Clinical Audit	Expert Advice	Equipment	Training
Assurance	1: 0.25 3: 0.75	3: 1	3: 0.95 9: 0.05	1: 0.5 1-9: 0.1 3: 0.4	1: 0.4 3: 0.6	1: 1	1-9: 0.2 3: 0.8
Responsiveness	0-9: 0.05 1: 0.95	0-9: 0.05 1: 0.8 1-3: 0.15	1: 1	1: 1	0: 0.5 0-1: 0.25 1: 0.25	1: 1	1: 0.5 1-3: 0.5
Reliability	3: 0.5 3-5: 0.5	0-9: 0.05 1: 0.1 3: 0.85	3: 1	1: 0.1 1-3: 0.4 3: 0.5	0-9: 0.1 1: 0.9	1: 0.4 3: 0.5 5: 0.1	3: 1
Empathy	5: 0.7 7: 0.3	3: 0.2 5: 0.8	1: 0.6 3: 0.4	0	1: 1	3: 0.4 5: 0.6	3: 0.4 5: 0.6

Table 5. Final ranking of service characteristics

	MIN $\mathbf{E}^{l}{}_{j}$	MAX $\mathbf{E}^{l}{}_{j}$	Average value	Ranking order
Responsibilities	3.46	2.96	3.21	2
Justification	2.33	2.90	2.61	4
Optimization	2.79	2.79	2.79	3
Clinical audit	0.91	1.41	2.32	5
Expert advice	0.88	1.32	2.20	6
Equipment	2.00	2.00	2.00	7
Training	2.93	3.54	3.23	1