An Integrated Approach for the Evaluation of Sustainability and Patient Satisfaction in Hospitals: A Case of Turkey

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Abstract. Improving quality is a very important issue in hospitals. Measuring quality is directly proportional to measuring sustainability criteria. Customer satisfaction is seemingly correlated with the factors which affect sustainability evaluation. Besides, the evaluation sustainability and satisfaction consist of different kinds of uncertainties. In this case, Quality Function Deployment (QFD) is very useful tool to evaluate customer satisfaction integrated with the fact that the weights of QFD are calculated by the method of Analytic Hierarchy Process (AHP). In this study, we propose an integrated approach for the evaluation of sustainability in Turkish Hospitals by using Quality Function Deployment and Analytic Hierarchy Process in order to assess patient satisfaction by considering the most important criterium in hospitals. This study enlightens the relations between patient satisfaction in hospitals and sustainability assessments in the same place.

Keywords: QFD · Quality management · Healthcare · AHP

1 Introduction

Sustainability is now being considered as a very important topic. As energy resources are continuing to decrease, every part of world seeks to develop their sustainability qualifications in sense of water, energy and any kind of energies. Furthermore, by keeping their sustainability qualification high, they need to try their customers to be satisfied. In this case, hospitals are taken into consideration as a type of establishments which are very important for the next generations. Hospitals are supposed to be eco-friendly buildings and establishments.

While developing the sustainability factors in a hospital, meeting customer satisfaction and focusing on patient needs are equally important because in aspect of customer satisfaction, some qualifications of sustainability can be related to customer needs. In Turkey, in this case, as a developing country, sustainability gains importance thanks to the awareness of renewable energy as well customer satisfaction in hospitals are considered while designing a hospital. Even if many of hospitals are opened in Turkey, it is not certain that patient satisfaction in hospitals are interrelated with sustainability qualifications.

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Total Quality Management can be defined as continuous improvement. In hospitals, patient satisfaction can be a part and measure of quality management. Total Quality Management can be also provided by using sustainability tools. Patient satisfaction in a hospital can then be related to some qualifications of green buildings.

In this study, there are five main parts which consist of introduction, literature review, methodology, application and finally results and conclusion. In the introduction part of this study, it is tried to explain the aim and the scope of the study. In the literature review part, the previous studies about sustainability, quality management, quality function deployment (QFD) and Analytic Hierarchy Process (AHP) is tried to be investigated. In methodology part, Analytic Hierarchy process and QFD are explained systematically while in application part, the weights of QFD are calculated by using AHP and QFD approach correlated with sustainability qualifications in general and patient satisfaction in the hospitals of Turkey. Finally, the results of QFD and AHP integrated approach considering sustainability qualifications and patient satisfaction results are discussed.

2 Literature Review

2.1 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) provides weight comparisons between different criteria according to experts' opinion. These weights are given within a scale which compare pairs relatively. If one attribute dominates one another, then the appropriate evaluation is given according to the scale. After the selection of a criteria it is important to measure inconsistency if exists (Saaty 2008). AHP helps to solve complex problems which include multiple criteria to give a decision between them. The first step is to draw a hierarchical table that decompose decision criteria. These sub-criteria are compared pairwise to give different levels of importance (Kurttila et al. 2000).

It is possible to combine different methods such as fuzzy approach, linear programming, and quality function deployment and so on, with AHP. This possibility leads with more accurate and detailed results and a better way to reach the aim. AHP also gives chance to evaluate both qualitative and quantitative data according to its numerical scale. If compared attributes are equal than it will be "1", if one another is more important than it will be "1/9" or "9" according to the related one. Basic steps of AHP are:

1. Problem definition
2. Giving more detailed definitions according to the objective
3. The effective criteria identification
4. Drawing hierarchical tree for criteria, sub-criteria and alternatives
5. Making pairwise comparisons which is calculated by $n(n-1)/2$, where n is the element amount. The diagonal elements are 1 and the others are compared each other according to the importance.

6. Finding maximum Eigen value, CI (consistency index), CR (consistency ratio) and normalized values
7. Taking the decision if these values are at the satisfactory level (Vaidya and Kumar 2006) (Fig. 1).

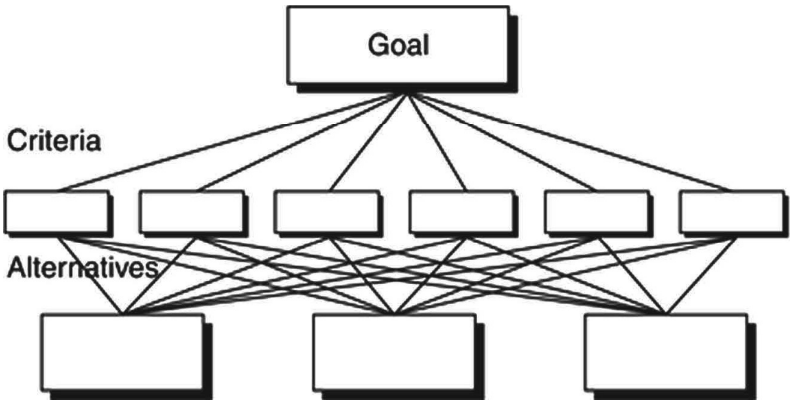

Fig. 1. Analytic hierarchy scheme (Saaty 2013)

2.2 Quality Function Deployment

The most important thing at product and service design is to meet customer requirements. With suitable ergonomic principles and meeting customer needs, high quality of good or service can be reached. In terms of quality, more efficient methods are developed to simplify product and process improvement. These techniques are used in different areas to get benefit from not only quality issues but also ergonomics. Quality Function Deployment (QFD) helps to convert customer requirements to technical properties of the product/service to be developed. These customer needs mostly come out of basic ergonomic principles. Figure 2 shows "House of Quality (HoQ)" which is the matrix for QFD analysis (Bergquist and Abeysekera 1996).

QFD steps can be summarized as follows:

1. Product Planning
2. Product Design
3. Process Planning
4. Process Control (Bouchereau and Rowlands 2000)

Within the first step of QFD, product planning may be done via HoQ that consists of customer requirements. HoQ provides both converting these needs to technical properties and benchmarking between other providers. At last, different weights give a result to prioritize these properties to be focused.

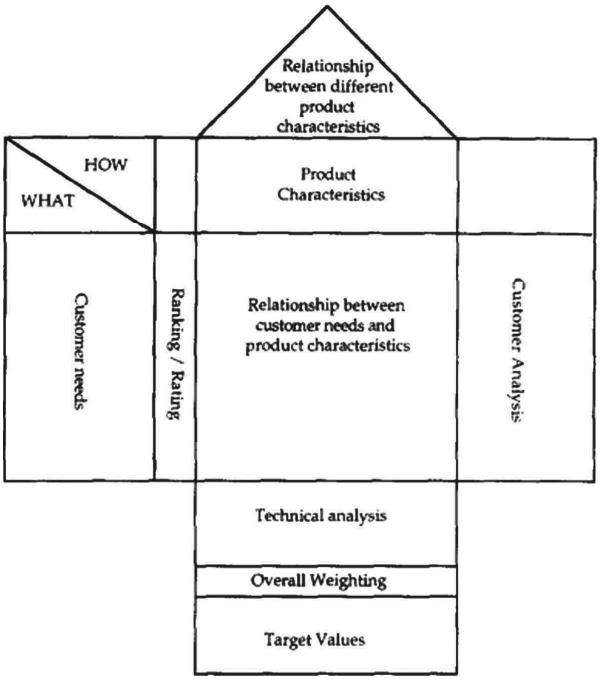

Fig. 2. House of quality (Bergquist and Abeysekera 1996)

2.3 AHP and QFD Integration

There are different examples at the literature that uses AHP and QFD together. Armacost et al. studied about construction industry at United States. There were lack of modernization at the building sites. A development was needed to reach minimum energy consumption and so on. To build a proper wall panel, this study used QFD to define the customer requirements clearly. They also integrated AHP to be able to prioritize customer needs to make decision making (1994). Hua et al. studied about marketing, using Kotler's model for strategic orientation. They used QFD and AHP together to make strategic decision while benchmarking for different types of adoptions (1994).

Bhattacharya et al. studied robot selection with a integrated QFD-AHP model. There are different factors that should be considered while selecting a robot for a specific work. This integrated model leads economic point of view while converting customer requirements into specifications. For this study, seven factors were considered to evaluate different needs (2005). Dai and Blackhurst studied combination of AHP and QFD for supplier selection. There are three different aspects, economic, social and environmental, for meeting sustainability criteria. To compare different suppliers in terms of sustainability there are different tools. In this study QFD was used to define stakeholders' needs and AHP was used for the assessment of different suppliers (2012). Chadawada et al. studied location selection both using QFD and AHP. This combined model allows considering several factors and selecting location from different alternatives (2015).

3 Methodology

3.1 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP), which is a very useful tool in decision making and prioritization, has been developed by Saaty in 1980 and uses pairwise comparison in order to reduce complexity in complex decisions (Wind and Saaty 1980). Furthermore, AHP simply consists of three main steps which includes

1. Calculation of the criteria vectors' weights
2. Calculation of the A matrix which shows the optional scores
3. Rankings the options according to the A matrix.

The calculation of the criteria vectors' weights is the most important part compared to other steps. The comparison matrix is called as A matrix whose a_{jk} shows the importance of the *j*th criterion relative to the *k*th criterion (Saaty 1980). Table 1 shows the relative importance scores.

Table 1. The relative scores based on a_{jk} values (Saaty 1980)

Value of a_{jk}	Interpretation
1	j and k are equally important
3	j is slightly more important than k
5	j is more important than k
7	j is strongly more important than k
9	j is absolutely more important than k

After building *A* matrix, it is possible to construct normalized A matrix by using (1)

$$\overline{a_{jk}} = \frac{a_{jk}}{\sum_{i=1}^{m} a_{lk}} \tag{1}$$

Where $\overline{a_{jk}}$ values are the entities of normalized A matrix. For criteria weighting vector, it is possible to say that the final step is to calculate w's by using (2)

$$w_j = \frac{\sum_{l=1}^{m} \overline{a_{jl}}}{m} \tag{2}$$

According to Saaty, the matrix B, whose entity b_{ih} shows the comparison of ith criterion compared to hth criterion based on jth criterion, should then be calculated as seen in (3). In this case,

$$b_{ih} b_{hi} = 1. \tag{3}$$

Last but not least, in B matrix, sum of each column should be divided by average of this column in order to have S matrix.

The scores v can be found as

$$v = S \cdot w$$

3.2 Quality Function Deployment

The QFD methodology mainly focuses on customers' needs and obligations in order to evaluate their satisfaction levels. A brief QFD methodology is shown in the Fig. 3.

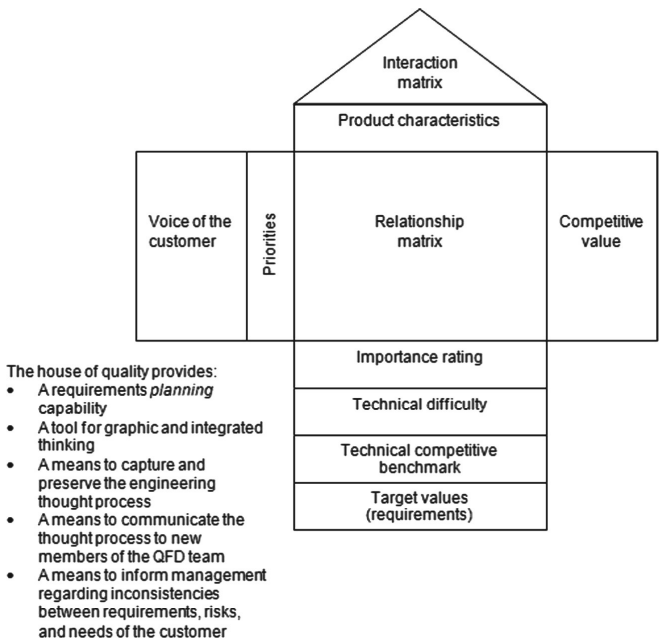

Fig. 3. Methodology for house of quality or quality function deployment (URL1)

In QFD, the weights of Priorities are calculated and the relationship matrix is constructed. Respectively, the QFD methodology consists of

1. Assessing the customer demands
2. Rating of importance of customer demands
3. Evaluation of Customer Evaluations
4. Assessing the technical requirements
5. Understanding the interrelationship between technical requirements in order to assess hows and whats
6. Calculating column weights (Zaim and Şevkli 2002)

4 Application

Firstly, the sustainability criteria in a hospital are weighted by using AHP method. The criteria are taken as

1. Green certification, which is given to fulfill green building requirements
2. Facility Design is for evaluation of the Green buildings
3. Professional Credibility is in order to evaluate if the hospitals are well-known or not
4. Customization is for evaluating if the private hospitals are more sustainable than public ones
5. Regulatory and Law is for measuring if there exist some laws forced to save energy, water and to regulate air conditioning
6. Communication is for being able to understand if there is any better connection between the workers and to satisfy patient needs
7. Technical Services is for measuring how important technical services are in order to be sustainable and satisfy patient needs
8. Admission and Discharging are administrative stuff
9. Workers' Awareness is for understanding if the workers are aware of the sustainability concept or not
10. Indoor quality is for measuring air conditioning, infrastructure of hospitals and hygiene.

These factors have been evaluated by experts who study mainly in sustainability area and the AHP matrix have been calculated in order to measure sustainability criteria pairwise comparison weights in order to put in quality function deployment as seen in the Table 2.

Then the normalized matrix has been calculated based on the comparison matrix as seen in the Table 3.

The weights of each factors of sustainability have been found as respectively in the Table 4. Table 4 shows us that the most important criteria for sustainability in hospitals are Regulatory and Law, Green Certification and Indoor Quality when the least important one is admission and discharging.

The weights have been put in QFD in order to interrelate the patient satisfaction factors and sustainability criteria. The QFD leads to understand which sustainability criteria are interrelated with patient satisfaction factor in hospitals as seen in the Fig. 4.

While building QFD matrix, the patient satisfaction qualifications have been taken as

- Nurse Care
- Housekeeping
- Courtesy and Attitude
- Infrastructure of Hospital
- Safety Indicators
- Administrative Procedures
- Hospital's Image
- Process of Clinical Care

- Hygiene
- Doctors' Experiences

By the view of experts, the highest relative weights are found as Infrastructure of Hospitals, Hospitals' Image and Safety Indicators which are normally the needs that patients desire mostly in a hospital.

Table 2. AHP comparison matrix for sustainability criteria in hospitals in Turkey

	Green Certification	Facility Design	Professional Credibility	Customization	Regularities and Law	Communication	Technical services	Admission and Discharging	Workers Awareness	Indoor Quality – Air condition etc
Green Certification	1	3	4	3	1/2	5	2	4	3	1/2
Facility Design	1/3	1	3	3	1	3	3	3	2	1
Professional Credibility	1/4	1/3	1	1/4	1/3	2	1/2	3	1/4	1/5
Customization	1/3	1/3	4	1	1/4	2	3	5	2	1/3
Regularities and Law	2	1	3	4	1	2	4	6	2	2
Communication	1/5	1/3	1/2	1/2	1/2	1	1/3	2	1/2	1/4
Technical services	1/2	1/3	2	1/3	1/4	3	1	4	1/3	1/2
Admission and Discharging	1/4	1/3	1/3	1/5	1/6	1/2	1/4	1	1/2	1/3
Workers Awarenes	1/3	1/2	4	1/2	1/2	2	3	2	1	1
Indoor Quality – Air condition etc	2	1	5	3	1/2	4	2	3	1	1

Table 3. The normalized matrix for sustainability criteria in Hospitals in Turkey **Cw (Normalized)**

1	0.139	0.367	0.149	0.190	0.1	0.204	0.105	0.121	0.238	0.07
2	0.046	0.122	0.112	0.190	0.2	0.122	0.157	0.091	0.159	0.141
3	0.035	0.041	0.037	0.016	0.067	0.082	0.026	0.091	0.02	0.028
4	0.046	0.041	0.149	0.063	0.05	0.082	0.157	0.152	0.159	0.047
5	0.278	0.122	0.112	0.253	0.2	0.082	0.21	0.182	0.159	0.281
6	0.028	0.041	0.019	0.032	0.1	0.041	0.017	0.061	0.04	0.035
7	0.069	0.041	0.075	0.021	0.05	0.122	0.052	0.121	0.026	0.07
8	0.035	0.041	0.012	0.012	0.033	0.02	0.013	0.03	0.04	0.047
9	0.046	0.061	0.149	0.032	0.1	0.082	0.157	0.061	0.079	0.141
10	0.278	0.122	0.186	0.190	0.1	0.163	0.105	0.091	0.079	0.141

Table 4. Weights of each criteria

1	0.168	16.8%
2	0.134	13.4%
3	0.044	4.4%
4	0.095	9.5%
5	0.188	18.8%
6	0.041	4.1%
7	0.065	6.5%
8	0.028	2.8%
9	0.091	9.1%
10	0.146	14.6%

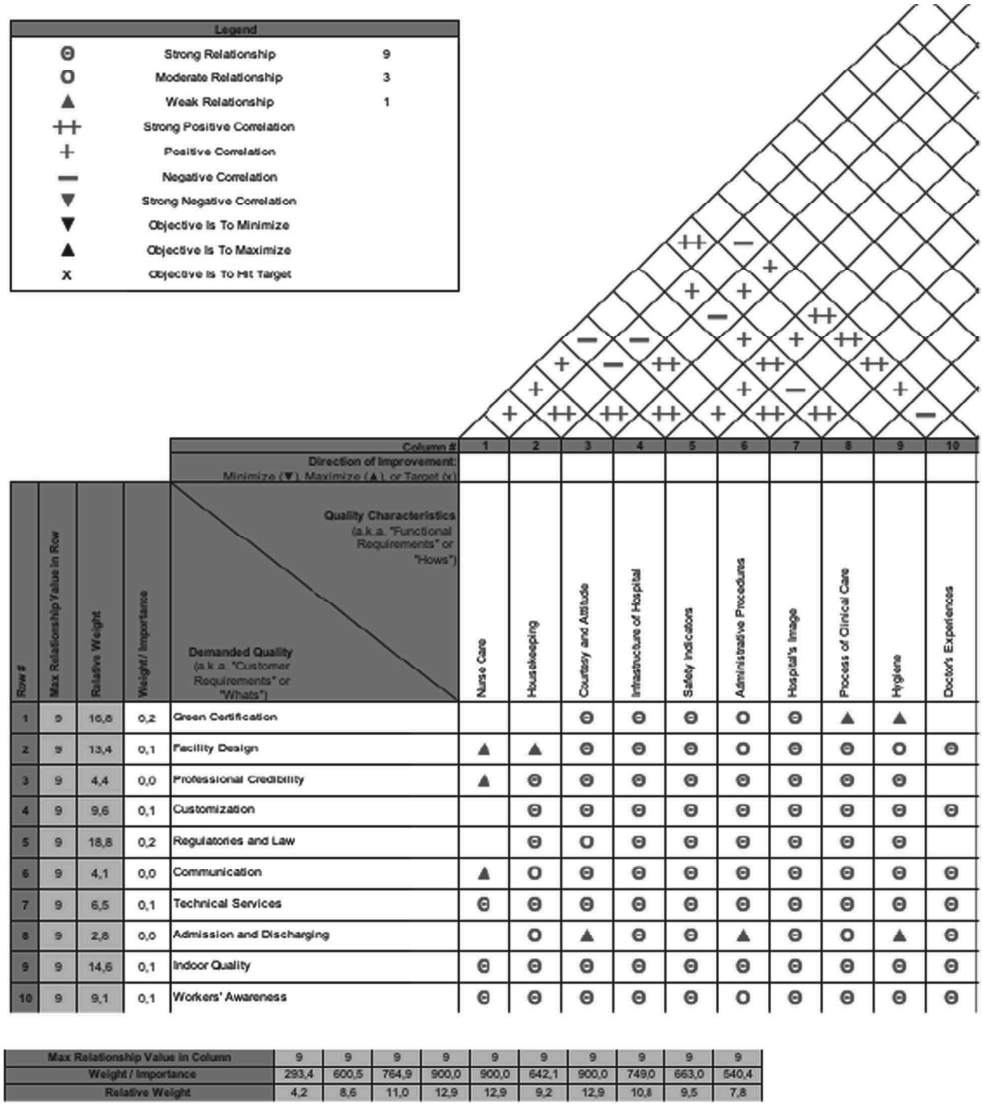

Fig. 4. House of quality for sustainability and patient satisfaction

5 Conclusions

Patient satisfaction is very crucial topic while sustainability is gaining importance. Hospitals are trying to be sustainable when they meet patient needs. In this study, it has been tried to interrelate the sustainability factors and patient needs. It has been seen that regulatory and law and green certification have the highest weights compared to other sustainability factors when Infrastructure of Hospitals, Hospitals' Image and Safety Indicators which are the needs that patients desire mostly in a hospital that are interrelated to the highest weighted sustainability factors. In conclusion, for an improved quality management in terms of sustainability and patient satisfaction, these factors should be improved vice-versa. For further researches, a large scope of sustainability factors and patient satisfaction qualifications should be taken into consideration.

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