



Investigating the Quality of Electronic Services Using Multiple Attribute Decision-Making Techniques Case Study (Aria, Ghaem, and Golsar Hospitals)

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Abstract. IT and its remarkable abilities created positive changes, and in addition to the possibility of increasing effectiveness and efficiency in industries and businesses, has led to an increasing interest in this technology and to presentation of more functions of it. One of these areas which is more important to people is the industry of health care and health and treatment services. Reduction of health care costs and provision of these high quality services has become a global priority. Due to the use of electronic services the need to use these services in the field of health care is felt more than ever. The purpose of this research is to answer the question of how to choose the most appropriate hospital in terms of electronic service delivery by using multiple attribute decision-making techniques. In this research, SERVQUAL method and criteria related to the electronic services is used, which has 6 major criteria of Tangible, Responsiveness, Reliability, Information quality, Assurance and Empathy factors, and 19 sub criteria. This research uses Multiple Attribute Decision Making (MADM), including the composition process of ANP to gain the criteria weight and fuzzy TOPSIS in order to rank the dimensions. According to the research results, Golsar, Arya and Ghaem hospital, respectively, earned the first to the third place. Among the criteria Information quality earned the first place, Assurance earned the second place and last place was devoted to responsiveness among the six criteria. Among the sub-criteria also Information accuracy and trust, respectively ranked first and second, and customerization got the last place.

Keywords: Quality of Electronic Services, Health Care, Electronics, ANP, Fuzzy TOPSIS

1. INTRODUCTION

In recent years the concept of web-based electronic services quality emerged with the birth of e-commerce and the quality of monitoring and evaluation of electronic services quality has increased (Buyukozkan and Cifci, 2012)

IT and its remarkable ability to create positive changes, in addition to the possibility of increasing effectiveness and efficiency in industries and businesses, has caused an increasing interest in this technology and provision of functions and effects.

One of these areas which have more importance for people is the industry of health care and health treatment services as the largest service industry in the world that is proposed under coverage of electronic health cares. In fact electronic health care is a new and joint discussion between the fields of medical informatics, public health and business which is referred to as the provision of services and health information through the internet and its related technologies.

Reduction of health care and treatment costs and provision of high quality health services has become a global priority. Among the various services, health care services are, costly, complex and are a totally global phenomenon which uses services that significantly influence the economy and quality of life and are also one of the growing areas of financial services. Among all service organizations, hospitals are the most important element of the health care system. Using their own facilities, they play a major role in line with producing something in the name of preserving, restoring and improving the physical and mental health of the population and conduction of medical research and the training of skilled human resources for the health sector. (Notagh and Rezaei Rad, 2011). Access to adequate health care is a fundamental right of the general public. Providing sufficient human resources and facilities with suitable electronic

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equipment everywhere, especially in remote and deprived areas, is a difficult and expensive job. By taking advantage of Information and Communication Technology, people will be able to equally access to health and medical services in order to maintain their health and manage their health care process more efficiently. (Modarresi, 2003) According to the literature reviewed, the discussion of quality of e-services in the health services of the country has been considered to a lesser degree and further research is needed in this area. Due to increasing use of electronic services more than ever there is a need to use electronic services in the field of health care. This can reduce complications of patients such as reducing the presentation time to hospital and cost of transportation. With a correct program the medical and administrative costs can be reduced which can be of benefit to both the patients and payers. Using electronic services we can save both in cost and time (Buyukozkan and Cifci, 2012).

Quality of services as an important and strategic leverage has a special role in the success of the service organizations. (Kong and Jogaratnam, 2007). Electronic health care services are like other production centers for customer service or on the other hand for patients. Among different service provider centers, a patient can choose a center that with different prices offers better services (Li et al, 2000).

Assessment of the quality of electronic services is one of the strategies that will allow us to get aware of the quality of establishing different information and communication technology applications, including e-commerce, e-government, e-banking, e-teaching and by using this feedback we can make our efforts to improve the situation of the country in this area. (Zahedi, Biniaz, 2008). Given the close relationship of health services in public health, applying measurement in the process of e-health services, should be seriously considered by policy-makers and executives in this industry. One of the essential steps to achieve this objective, is providing a systematic and comprehensive way to measure so that the highest quality is presented. In this study, we sought to answer the question of how to choose the most appropriate hospital in terms of electronic service delivery by using multiple attribute decision-making techniques. The main aim of this study is to use multiple decision-making techniques to measure the quality of e-services and choose the most suitable hospital in terms of provision of electronic services.

2. RESEARCH METHOD

The present research is applied in terms of purpose and is descriptive in terms of data collection method and is a survey. Golsar hospital, Aria Hospital and Ghaem Hospital websites in Rasht were selected as case study of the research. Given that this research is not based on statistical analysis, there is no need to determine the community and statistical sample in the proper sense.

Because of the multidimensional nature of the problem of measuring the quality of electronic health care services, that fully understanding need proficiency in areas such as health care, particularly medical care and information technology, etc., the administrators and hospital officials of electronic services of Golsar, Ghaem and Aria Hospital were selected as the expert community. In general, available experts of the noted hospitals who were familiar with electronic health care services and dealt with these services formed the respondents of the research. In this study, the identification of criteria have been carried out with combination of library studies and field surveys. The instrument used in this study is questionnaire. Standard questionnaires were used to collect opinions of the experts which is consisted of SERVQUAL Model and Fuzzy TOPSIS and network analysis process (ANP).

In the present study the research methods in operations, multi-criteria decision-making models, including the ANP and TOPSIS fuzzy method is used to analyze data. The instrument used in this study was questionnaire. The study used two types of questionnaires. ANP standard questionnaire in the form of matrices of paired comparisons is used to obtain the weighting of

criteria and sub-criteria and the TOPSIS questionnaire is used to rank hospitals. Both questionnaires are answered by experts. In questionnaires that are based on paired comparisons because the rate of adaptations is calculated, the adaptation rate of matrices are used for the validity of the model. In this study, the adaptation rate of all the matrices has been under 0.1 and due to the standardization of the questionnaires there was no need for the validity test. So far, various tools and methods have been presented to solve the problem of the indexes. One of the most efficient techniques is Analytical Hierarchy Process (AHP), which was introduced in 1980 by Thomas L. Saaty. After a while because the AHP method was not comprehensive enough, so he presented a developed method as Analytical Network Process (ANP) in 1996. Hierarchy has a linear top-down structure.

Network spreads in all directions, and includes between cluster cycles and rings within each cluster. Many decision-making issues can not be structured hierarchically and must be treated as a network because it involves dependence and mutual impact of higher elements on lower level elements. To solve the problems with ANP method a network is drawn and the existing nodes in this network are equal to the objective, criteria and options in accordance with our needs. And directed vectors that connect these nodes together are equivalent to the direction and existence of nodes on each other. Like AHP method in ANP method, the weight of criteria and desirability of options, was directly obtained by receiving the judgment of people and using paired comparisons. One way to perform calculations in ANP method is to place the weights obtained from the matrix of paired comparison in a matrix called super matrix. To understand the concept of super matrix imagine that the problem has n branches C_1, C_2, \dots, C_n and there are n_i elements in the branch i^{th} . Now if the two branches of i and j are selected and all the i elements are compared in form of paired in relation to the first element j then the paired comparison matrix will suggest the paired comparison of all the elements of the branch element i in relation to the first branch element j .

If this comparison is not significant the related vector would be zero, after the formation of the initial super-matrix which is called uneven super-matrix, if necessary, the columns of the matrix are normalized and the weighted or normal super-matrix is obtained (Azar and Rajab Zadeh, 2010). The expression of understanding and judgment is usually subjective, uncertain or ambiguous. Such uncertainty and subjectivity is controlled by Probability and Statistics (Dubois and Prade, 1986). Since words are less accurate than the numbers, the concept of linguistic variables approximately express and identify phenomena. In order to eliminate confusion, ambiguity and subjectivity of human judgment in decision-making process, fuzzy logic, came to exist to express linguistic variables. Zadeh and Bellman (1970) were the first researchers who noted the decision-making by applying fuzzy sets and created fuzzy multi-criteria decision-making. Fuzzy multiple criteria decision-making was created to remove the carelessness in weight allocation, importance of criteria, and options priority (Chen and Klein, 1997). This approach helps the decision maker to solve complex issues in a systematic, sustainable and profitable way. Several methods have been proposed for fuzzy TOPSIS. Since all of these methods are obtained with a small change in the method of fuzzy TOPSIS Chen et al (1992) we used fuzzy TOPSIS method of Chen et al. (1992) in the proposed method and will extend it to triangular fuzzy numbers. Suppose that we have m alternatives, n criteria and k decision-makers in which A_1, A_2, \dots, A_n are alternatives that should be selected or prioritized. C_1, C_2, \dots, C_n are criteria or evaluation characteristics. \mathcal{X}_{ij}^k shows A_i alternative in relation to the C_j criteria or specification and through K assessor. In order to integrate K \mathcal{X}_{ij}^k fuzzy performance score assessor the mean value is used. Raw data obtained must be normalized to remove the deviation of units and different scales of measurement in multiple attribute decision-making issues (Azar and Rajab Zadeh, 2010). In this method linear normalization is used. The next step is to create a weighted normalized fuzzy decision matrix. By taking into account the different weights for each attribute or criterion, weighted normalized decision matrix can be calculated by multiplication of the importance of the criteria of weights in normalized fuzzy decision matrix.

The next step is to determine the positive ideal fuzzy and negative ideal fuzzy for criteria. In this study, the value of positive ideal fuzzy and negative ideal fuzzy introduced by Chen is used for all criteria. The distance of each option with the fuzzy ideal solution (positive) and the ideal solution (negative) is calculated as follows:

$$d_i^+ = \sum_{j=1}^n d(\vartheta_{ij}^+, \vartheta_j^+), \quad i=1,2,\dots,m; j=1,2,\dots,n \quad (1)$$

$$d_i^- = \sum_{j=1}^n d(\vartheta_{ij}^-, \vartheta_j^-), \quad i=1,2,\dots,m; j=1,2,\dots,n \quad (2)$$

The distance of each option with the fuzzy ideal solution (positive) and the ideal solution (negative) is calculated as follows:

$$d_i^+ = \sum_{j=1}^n d(\vartheta_{ij}^+, \vartheta_j^+), \quad i=1,2,\dots,m; j=1,2,\dots,n \quad (3)$$

$$d_i^- = \sum_{j=1}^n d(\vartheta_{ij}^-, \vartheta_j^-), \quad i=1,2,\dots,m; j=1,2,\dots,n \quad (4)$$

In which $d(\vartheta_{ij}^+, \vartheta_j^+)$ represents measurement of the distance between the two fuzzy numbers, and d_i^+ represents the distance of option i from the positive ideal solution and d_i^- represents the distance of options i from the negative ideal solution. By determining the closeness coefficient the ranking of all options can be calculated and decision-makers can choose the best option. Closeness coefficient of each option will be calculated as follows:

$$C_i = \frac{d_i^-}{d_i^+ + d_i^-}, \quad i=1,2,\dots,m \quad (5)$$

In the present study with the aim of evaluating the quality of electronic services in hospitals and selection of the most appropriate hospital in terms of provision of electronic services. We design the criteria and sub-criteria related to the six dimensions of electronic SERVQUAL model using ANP techniques in four levels. In Figure 1, the hierarchy of the proposed research model is shown.

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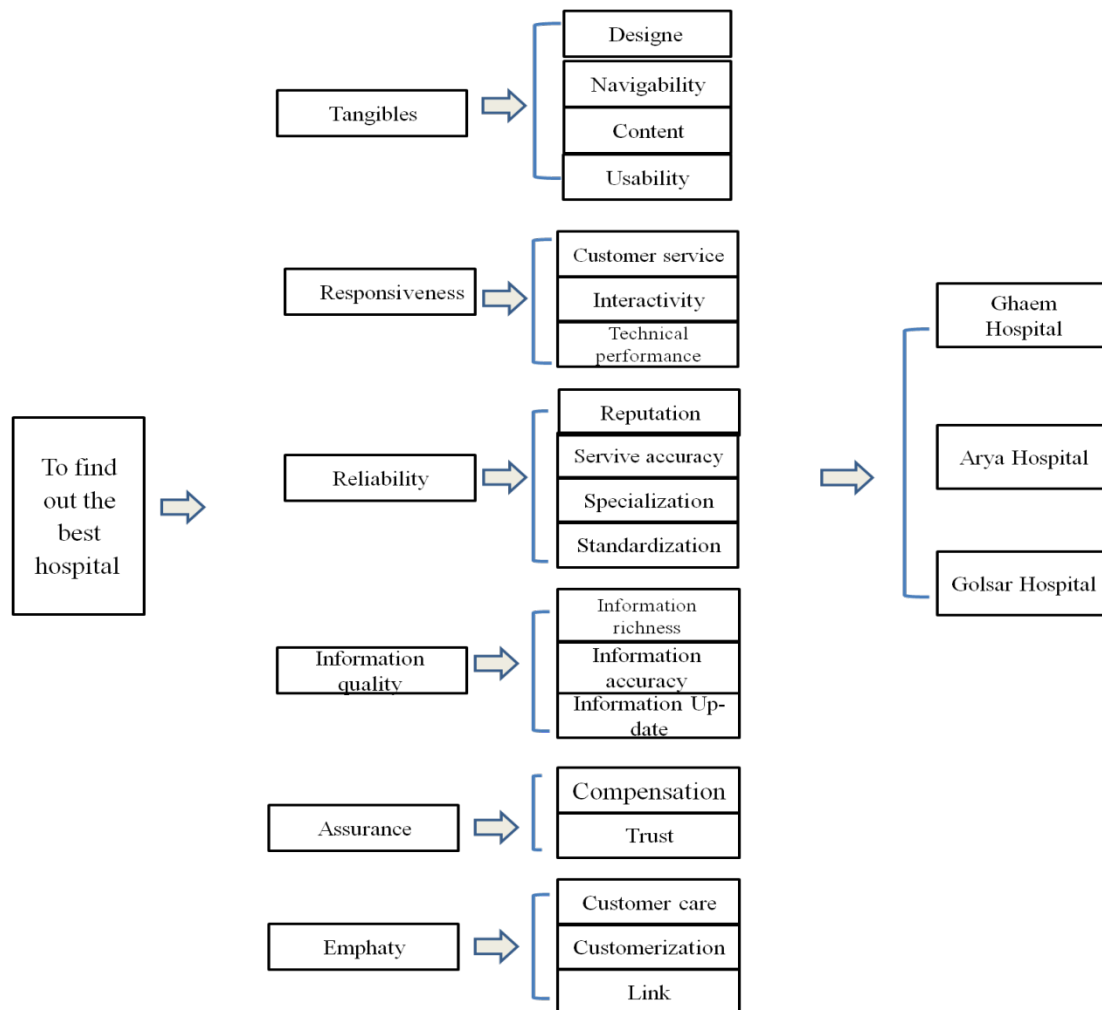


Figure 1. The Hierarchy of the proposed model of the issue to assess the quality of electronic services of hospitals (Buyukozkan, cifci, 2012).

3. FINDINGS

After gaining the significance of the criteria using network analysis process, it turns to rating the intended hospital Web sites in meeting the criteria.

To rate the hospital web sites toward each of the criteria, the mean opinions of the whole people for all Web sites of the hospitals were considered. In the subsequent stage the decision-making tables which were obtained out of the mean views of people were normalized. It should be noted that all the criteria used in this study have positive aspects and the result of the normalization of decision-making matrix is triangular fuzzy matrix with positive numbers. After determining the positive and negative ideal solution it is time to compute the distance of the positive and negative ideal solution. From what has been said so far, we can calculate the sum of every positive and negative fuzzy ideal for all options. After calculating the total distance of the options of positive and negative ideals it turns to calculate the closeness coefficient for each option. CC_i or closeness coefficient is defined as a criteria for ranking the options. In table 1 the sum of the distance of every option is shown from the positive ideal solution and negative ideal solution and closeness coefficients and the rank for each of the websites of the hospitals.

Table 1. Alternatives Ranking.

Ranking	CC	Negative distance	Distance	Alternatives
1	0.042	0.804	18.219	Golsar Hospital
2	0.04	0.767	18.258	Arya Hospital
3	0.037	0,708	18.322	Ghaem Hospital

The results obtained of determination of the weights of the criteria and sub- criteria of electronic services quality is shown in Tables 2 and 3.

Table 2. Criteria weights.

Ranking	Weight	criteria
3	0.179706	Tangibles
6	0.1069	Responsiveness
4	0.178026	Reliability
1	0.230442	Information quality
2	0.192768	Assurance
5	0.112158	Emphaty

Table 3. Sub-criteria weights.

Ranking	Weight	Sub- criteria
18	0.010504	Designe
6	0.072318	Navigability
5	0.074956	Usability
12	0.02193	Content
4	0.079444	Customer service
17	0.013606	Interactivity
16	0.013852	Technical performance
8	0.046868	Reputation
14	0.015756	Service accuracy
3	0.099858	Specialization
15	0.015546	Standardization
9	0.039336	Information Richness
1	0.169972	Information Accuracy
13	0.021134	Information Up-date
11	0.03489	Compensation
2	0.157876	Trust
16	0.035614	Customer care
19	0.01036	Customerization
7	0.066182	Links

According to Table 2, and according to the ideas of experts, the factor of " information quality " is the most important factor in assessing the quality of electronic services of hospitals and then the factor of "Assurance" has more importance and finally " responsiveness" has the least importance in evaluating electronic services of hospitals. According to the results of Table 3, among the sub-criteria of assessing the quality of electronic services, according to experts, the sub-criteria of "Information accuracy" has the utmost importance. Then "trust " has the second most importance according to the idea of experts. The sub-criteria of "Specialization" is in the third place after the two criteria that shows the increasing importance of the factors in the quality of electronic services in health care services today. After these sub-criteria, the sub-criteria of "customer service", "usability" and "Navigability" are the next priorities. The "customerization" has the lowest importance.

4. DISCUSSION AND CONCLUSION

In previous research, the results obtained by Buyukozkan et al in (2012) showed that hospitals should focus more on Specialization, compensation and service accuracy among the sub-criteria, and among the criteria the Reliability and responsiveness for managing websites, should get more attention. However, in the present study the sub-criteria of trust, information accuracy and Specialization should be considered more. And among the criteria the information quality and Assurance should be considered more in managing websites. Also in a research in 2006 conducted by Bilsel et al in Turkey which was conducted to measure website performance, the results showed that the dimensions of information quality and tangible factors, and among sub-criteria Privacy had more importance. Chang (2007) in his research studied the approach of electronic structure of the hospital and used the quality of services provided by the website based on five criteria of service quality. But we used six criteria in this study.

The results of this research show that the criterion of " information quality " in the eyes of experts, is the first and most important factor in providing high quality electronic services, also the sub-criteria of "Information accuracy" related to this criteria had the most importance. Therefore, it is suggested that the correct, clear and understandable information about the hospital services be presented in a more organized manner and with easy search capability. Existence of guiding titles such as Map Site guide, virtual tours, history, information about the hospital, contact with authorities, announcements and medical information and information of health department of hospital as well as other parts, as well as access to journals and articles in the field of Medical Sciences is effective in improving the information quality dimension. The second contributing factor, in high quality provision of electronic services according to experts is "Assurance" and its related sub-criteria of "trust" which are of more importance. Therefore, hospital administrators are advised to focus more on increasing the ability and knowledge of employees to transfer the trust of service clients, and by setting standards related to the security and confidentiality of information attempt to attract the " trust". Also, the criterion of "tangible " got the third place. Therefore it is recommended that the hospital managers consider the visual appeal of the websites and use related high quality images, the right colors and legible fonts to cause improvement in sub-factor of "design". Also by employing the proper structure to make it easy for different users to easily search for the desired section, improve the "usability" of the web site.

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