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Integration PEM and AHP Methods to Determine Service Quality Improvement Strategy for the Medical Industry

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Abstract: Despite abundant research on service quality within the medical industry, few studies have applied performance evaluation matrix (PEM) and analytic hierarchy process (AHP) in this medical industry. Therefore, this study aims to discuss integrating the PEM and AHP methods in order to determine and prioritize areas of improvement in service quality. Data were analyzed through PEM in order to identify eight items that needed improvement. The improvement priority of these items was determined by the AHP method. Therefore, the results provide suggestions to improve service quality and to enhance the hospital standard processes to meet the customers' needs. This study serves as a guideline for hospitals to improve their service quality.

Keywords: Analytic Hierarchy Process (AHP); performance evaluation matrix (PEM); service quality, medical industry

1 Introduction

The medical industry is one of the fastest-growing industries in the service economy [1]. Service quality in this industry is currently at the forefront of professional and managerial attention, primarily because it is considered as a means of achieving increased patronage, competitive advantage, and long-term profitability [2] and ultimately, as an approach to achieving better health care services for patients [3]. The medical industry involves meeting the physical, psychological, and social needs of people who seek care [4], but 60% to 89% of the customers are dissatisfied with hospital service quality [5]. Against this background, service quality has become an important corporate strategy for medical industry organizations. The medical industry has been transformed from a philanthropic-oriented to a business-oriented service in many countries. Often, it is compared with professional finance services, since healthcare is almost always seen as a cost to a customer because no services are free [6]. Many healthcare organizations are beginning to recognize that service quality is needed for survival [7]. Service quality in the medical industry is intangible and often requires patient involvement in the operation process [8]. This normally involves intimate interactions and extensive communications between the patient and staff [9]. Service quality is difficult to define and measure [10][11]. Furthermore, medical industry professionals and patients may view it from different perspectives [12]. Although no consensus on or standard definition of service quality exists, patient satisfaction is regarded as an important indicator of medical industry quality [12][13]. The present study focuses on patients' satisfaction with various aspects of a medical encounter. Patients generally lack the knowledge and ability to judge the technical competence of doctors and nurses, but they may consider themselves to be better able to make judgments about non-technical characteristics [14]. Singh [8] proposed expanding the domain of medical service evaluation so as to add non-technical quality perceptions to technical quality perceptions. A review of the literature suggests several important factors relevant to patient satisfaction with a medical service, such as doctors' technical ability and interpersonal care skills, accessibility and convenience of the service, the physical environment of the hospital, doctors' duration of consultation, length of wait [15]. Since Taiwan began implementing national health insurance in 1995, the conveniences and options in medical treatment have increased in the case of public healthcare. Under the national health insurance regime, medical service quality has been the foundation of the revolution within the medical industry. The criteria

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include appropriate medical care in order to achieve optimal use of medical resources, and decreasing the inequitable distribution of services. Medical service providers who aim to improve the medical service quality have played a key role in reforming the American health care system. Patients perceive service quality as the most important factor of the medical industry and do not wish to sacrifice care quality when the government cuts back on costs; therefore, the importance of care service quality is quite clear [16]. However, when choosing hospitals, the general public tends to prefer renowned institutions to local hospitals. From a medical resources angle, this causes unnecessary waste. What are the factors involved in the public's choice of hospitals? Because customers have the right and freedom to choose their medical facilities, medical price is no longer the main factor. Therefore, service quality and the reputation of the hospital have become important factors when choosing a hospital; and hospitals have increasingly focused on service quality and satisfaction so that their managers can set high medical service quality as the primary goal in hospital management. Therefore, this study aims to confirm the methods by which patients evaluate service quality, and then explore hospitals to determine the items that need service improvement.

The performance evaluation matrix (PEM) method has been applied as an effective means of evaluating a firm's competitive position in the market, identifying improvement opportunities, and guiding strategic planning efforts. The matrix has been applied in higher education sectors [2], machinery industries [17], and semiconductor industries [18]. The analytic hierarchy process (AHP) method developed by Saaty [19] is a powerful and flexible multi-criteria decision-making (MCDM) tool for complex problems where both qualitative and quantitative aspects need to be considered [20]. AHP has been used in supplier selection, facility layout, selection green technology portfolio, and supply chain management. Despite abundant research on service quality within the medical industry [21][22][23], few studies have applied the PEM and AHP methods in this industry; therefore, this study aims to discuss integrating PEM and AHP application in service quality improvement of the medical industry. First, the study uses PEM to confirm the items that need improvement, and then uses AHP to prioritize the improvement of these items in order to establish a comprehensive method of assessing service quality. This serves as a guideline for hospitals to improve various service items. Good customer satisfaction leads to a loyal customer group, which increases the hospital's competitive ability. Therefore, a hospital should view patients' satisfaction as a key consideration of service quality; patient satisfaction should be the focus when discussing the importance of medical service quality.

2 Literature review

2.1 Characteristics of the medical industry and medical service quality

Since the implementation of national health insurance in Taiwan, the number of existing hospitals has rapidly diminished from 828 in 1995 to 495 in 2013. Along with the adjustments made in the payment system by the national health insurance scheme, the medical environment has been rapidly changing, causing highly competitive yet low-profit trends in national healthcare. Hospitals became increasingly difficult to run [22]. Zhaung [24] proposed that the unique characteristics of medical facilities distinguish such facilities from conventional corporations. Besides the information asymmetry between medical service providers and patients, progression of disease and provision of medical service encompass a considerable level of uncertainty. Patient satisfaction is paramount for medical service providers, not only because it is a quality indicator but also because of increased competition in the profession [25]. Continuous quality improvement programs improve patient satisfaction and enable medical providers to succeed in an increasingly competitive environment [26, 27]. Achieving higher patient satisfaction can lead to loyalty and generate referrals that enhance long-term success. Tsai [28] pointed out the following characteristics of the medical industry: (1)Severe medical information asymmetry. (2)High location factors. (3)Abundant legal regulations but weak market pricing regulations. (4)Ease of initiating litigations. (5)Obvious economy scale of medical industry phenomena. (6)Very important medical information system support.

According to the above literatures, the care quality provided by hospitals has been the focus of early discussions of medical service quality; medical environment and equipment as well as actual patients' feelings have been less discussed. Through the years and change in environment, the spread of general education has caused people to start valuing medical quality; gradually, scholars began incorporating care quality, hospital administration, and patient satisfaction into the scope of medical service quality. The perimeters of these researches also include medical skills, the relationship between staff and patients, and even hospital hardware/software facilities. Hospitals aim to fulfill the hopes and needs of patients and thereby raise the standards of medical service.

2.2 Performance evaluation matrix (PEM)

Researchers have proposed using PEM to determine the best strategy for improving service quality and customers' satisfaction. This matrix consists of nine zones that represent the effectiveness of various

system-improvement items [29]. The performance matrix is illustrated in Fig. 1, and the service strategy in Table 1.

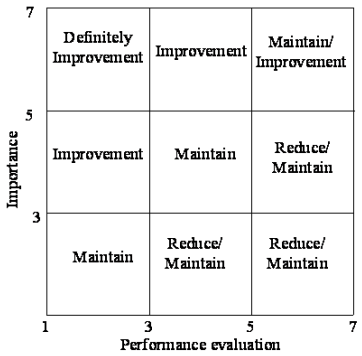

Fig. 1: Performance evaluation matrix

The PEM has been used in recent years by the logistics, semiconductor, and finance industries; however, there have been few applications of this method in the medical industry. This study chooses the PEM as a research tool. Based on ”service quality” viewpoints, the PEM has been rearranged to redefine the respective management strategies of the three industries mentioned above: ”maintenance”, ”improvement” and ”priority improvement”. Zones 1, 2, and 4 are three areas where perceived customer satisfaction surpasses importance; hospitals only need to maintain the status quo. Zones 3, 5, and 7 are three areas where customer satisfaction equals importance; hospitals need to improve their current service quality. Zones 6, 8, and 9 are three areas where importance surpasses satisfaction, that is, customers perceived the service quality items as not satisfactory; therefore, hospitals need to improve these items. The medical service items falling in this zone need to be prioritized for improvement (see Fig. 2).

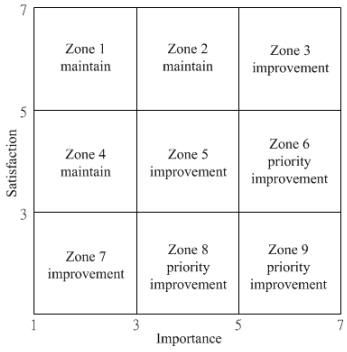

Fig. 2: modified management strategies the performance evaluation matrix

2.3 Analytic Hierarchy Process (AHP)

Saaty [19] originally introduced AHP back in the early 1970s in response to the scarce resources allocation and planning needs for the military. AHP, a mathematic-based MCDM tool, is becoming popular with academic researchers for data analysis and model verifications to provide critical information for managers to make business decisions. AHP has been widely employed in decision-making analysis in various fields such as political, social, economic, and management sciences [30][31]. This study uses AHP to measure the service quality of the medical industry. AHP comprises six major steps [19][32][33][34]:

1. Define the unstructured problem. The problem should be stated clearly and situated in a broad context including the objectives and outcomes.
2. Decompose the problem into a hierarchical structure, which can be obtained from the opinions of experts or decision makers with methods such as brainstorming.
3. Complete the following pairwise comparison matrix A for m objectives.

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mm} \end{bmatrix} \quad (1)$$

For all i and j, it is necessary that $a_{ii} = 1$ and $a_{ij} = 1/a_{ji}$. The possible assessment value of a_{ij} with the corresponding interpretation is shown in Table 2.

4. Find the maximum eigenvalues and eigenvectors in order to estimate the relative weights of the decision elements. After a comparison matrix has been formed, the priority of the element can be compared by the computation of eigenvalues and eigenvectors with the following formula, where w is the eigenvector, the weight vector, of A, and is the largest eigenvalue of A:

$$A \cdot w = \lambda max \cdot w \quad (2)$$

5. Check the consistency property of the matrix. The quality of the ultimate decision of the AHP is strongly related to the consistency of the judgments that decision makers demonstrated during the series of pairwise comparisons. A consistency check is essentially testing the logical accordance of man’s cognition and judgment on things. When judgments deviate considerably from the accordance, some problems will occur if the sorted weight vectors are regarded as computational results. The consistency index (CI) and consistency ratio (CR) are defined as follows [32]:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (3)$$

Table 1: Service strategy of the PEM

Zones	Service strategy
High importance, high performance	Maintain or improve service quality
High importance, medium performance	Improve service quality
High importance, low performance	Improve definitely service quality
Medium importance, high performance	Reduce or maintain service quality
Medium importance, medium performance	Maintain service quality
Medium importance, low performance	Improve service quality
Low importance, high performance	Reduce or maintain service quality
Low importance, medium performance	Reduce or maintain service quality
Low importance, low performance	Maintain service quality

Table 2: The assessment of a_{ij}.

Value of a_{ij}	Verbal judgment or preference
1	Equal importance
3	Weak importance of one over other
5	Essential or strong
7	Very strong importance
9	Absolute importance
2, 4, 6, 8	Intermediate values

$$CR = \frac{CI}{RI} \tag{4}$$

where n is the number of items being compared in the matrix, and RI is a random index, the average consistency index of randomly generated pairwise comparison matrices of similar size, as shown in Table 3.

6. Aggregate the relative priorities of the decision elements in order to obtain an overall rating for decision alternatives. If there is only one decision maker, an overall priority ranking of the decision alternatives can be obtained by combining the criterion priorities, and priorities of each decision alternative are relative to each criterion. The results are normalized and summed to 1.

3 Empirical study

3.1 Questionnaire design

The present dimensions and questionnaire were therefore based on the following: (i) A review of the literature [35][36], (ii) discussions with three experts, and (iii) discussions with 12 customers of the medical industry. This led to the following dimensions being used in the questionnaire: The final questionnaire was divided into the following three parts. Importance survey: responses requested on a Likert-type scale of 1 to 7 (with 1 representing ”extremely unimportant” and 7 representing ”extremely important”); Performance scale: responses requested on a Likert-type scale of 1 to 7 (with 1 representing ”extreme low performance” and 7 representing ”extreme high performance”); and Demographics: gender, age, and education background. The 33 service items regarding medical service quality in Taiwan were classified into five dimensions, namely, empathy, assurance, responsibility, tangibility, and reliability. The tangibility dimension includes hospital medical equipment, space, appearance, facilities, staff clothing, and explanation labels of various service items. The reliability dimension includes explanation of diseases given by doctors to patients, the treatment process, doctors’ problem-solving skills, and tailoring care according to the patient’s needs. The responsibility dimension includes the entire process of medical care, answers to medical inquiries, service attitude, and response to patient questions. The assurance dimension includes professionalism of medical staff, use of safety measures during the service process and attitude during treatment, and teamwork. The empathy dimension includes giving various kinds of care according to the patients, appropriately managing service time, caring for the patient, and giving priority to the patient in understanding patients’ needs.

3.2 Samples

This study used questionnaires to examine the medical service quality of seven hospitals in Taiwan. In all, 800 questionnaires were randomly distributed, out of which 567 were returned (response rate: 70.88%). Among the returned questionnaires, 35 were incomplete and therefore discarded, leaving 532 questionnaires for the analysis. About 44.5% of the patients were male and 55.5% were female. Approximately, 32.1%, 30.3%, and 16.4% of the patients were 31-40 years old, 21-30 years old, and 41-50 years old respectively. Among the patients,

Table 3: Random index (RI)

Order of matrix	2	3	4	5	6	7	8	9	10
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.52

Table 4: Decision criteria

Items		No	Percentage
gender	male	237	44.5
	female	295	55.5
age	Younger than 20	29	5.50
	21-30	161	30.3
	31-40	171	32.1
	41-50	87	16.4
	51-60	65	12.2
	Older than 61	19	3.60
education background	below high school	82	15
	high school	146	27.4
	University	236	46.3
	above master's	58	10.9

32% were university graduates and 46.3%, high school graduates (see Table 4).

3.3 Reliability and validity analysis

Cronbach's for each dimension of medical services quality in service importance and satisfaction ranged from 0.709 to 0.849 (see Table 5). Cronbach's for each dimension were greater than 0.7 [37]. In terms of validity, the questionnaire had been designed on the basis of related studies, consultation with service-quality professionals and consultants, and discussions with customers. This indicates that the scales of the formal questionnaire have considerable reliability.

Factor analysis was conducted to verify the construct validity of the formal question, and Cronbach's for each dimension was computed to verify the reliability of the same. The factor analysis was based on the principal component analysis with varimax rotation, eigenvalue exceeding 1, and factor loadings exceeding 0.4. The test values of Kaiser-Meyer-Olkin (KMO) were 0.951 (importance) and 0.897 (performance). The p-value of Bartlett's sphericity test was less than zero (see Table 6). Consequently, the construct validity of the questionnaire was quite good [37].

3.4 Performance evaluation matrix of case study

By using SPSS software, the average values of importance and satisfaction were calculated and plotted into the performance evaluation matrix, confirming the placement of each item. In Fig. 3, five items were in the "maintain zone": items 16, 22, 24, 28, and 32. Twenty items were in the "improvement zone". The eight items that were in the "priority improvement zone" were "the hospital has modern medical equipment (item 1)", "the medical staffs are passionate about helping patients to solve their problems (item 8)", "the medical staffs are not too busy and do not neglect patients (item 18)", "prompt management of emergency patients by the medical staffs (item 19)", "the medical staffs listens to patients' needs (item 20)", "doctors can offer detailed explanations of patients' status (item 26)", "doctors have good professional skills (item 27)" and "the hospital will initiate a follow-up of patients' recovery (item 31)". Owing to limited hospital resources, all the necessary improvements cannot be immediately made; therefore, priority improvements should be listed. This study marks these eight items as priority improvement by using AHP.

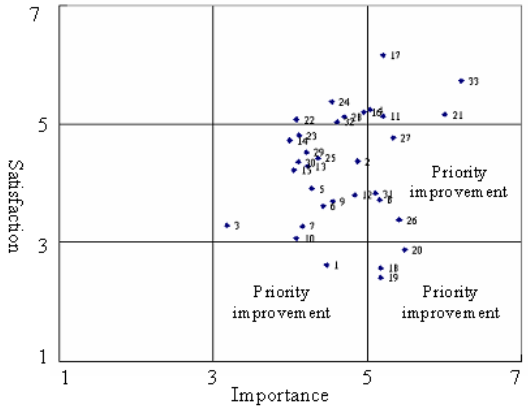

Fig. 3: performance evaluation matrix of case study

Table 5: Cronbach's value of questionnaire

Dimensions	Importance survey	Satisfaction survey
Tangibility	0.813	0.708
Reliability	0.849	0.734
Responsiveness	0.811	0.737
Empathy	0.834	0.716
Assurance	0.754	0.709
Total	0.851	0.821

Table 6: KMO and Bartlett test

Items	Importance	Satisfaction
KMO	0.951	0.897
Bartlett test	8347.478	5958.014
Significant test	0.000***	0.000***
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$		

3.5 Confirming improvement priority through AHP

Even after determining the items to be improved, not all items can be improved at once because of limited hospital resources; therefore, the order should be determined by taking into account hospital resources, abilities, and professional opinions from experts and scholars. AHP is the best tool as it incorporates the opinions of experts and scholars in relevant fields to establish the evaluation standard and basis. The results of the PEM in this study have been organized to form questionnaires. Data were analyzed through PEM in order to identify eight items that needed improvement. The improvement priority of these items was determined by the AHP method. This evaluation framework sees Fig. 4.

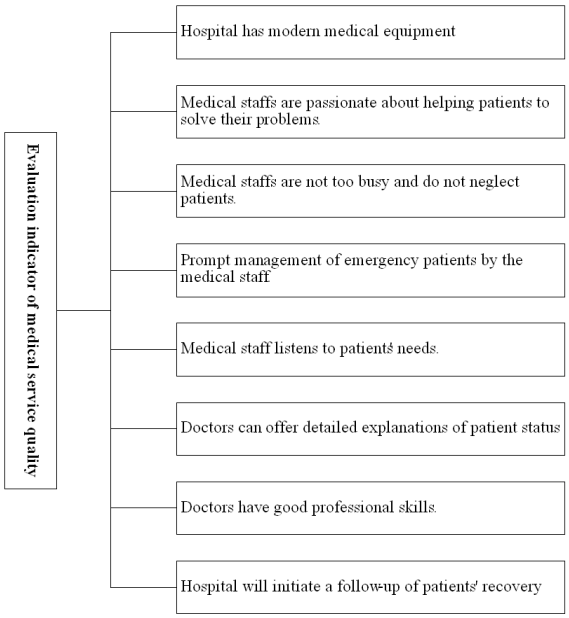

Fig. 4: Evaluation framework figure of AHP

3.5.1 AHP questionnaire participants

For questionnaire results to be representative, the following 10 participants were enrolled for the AHP: (1) Three scholars in fields related to service quality management and (2) seven experts with practical hospital management experience. Table 7 presents the professional backgrounds of these ten experts.

3.5.2 Questionnaire evaluation

The questionnaires were evaluated for consistency by using the consistency index (CI). When CI = 0, the participant has shown consistent judgment. However, increasing the number of items for evaluation hinders consistent judgment. Therefore, if CI ¡ 0.1, as proposed by Saaty (1980), with answers that are not completely consistent but with acceptable deviations, this study will treat the sample as consistent. In Table 8, an example of a questionnaire is given along with its pairwise comparison matrix.

The questionnaires filled by 10 experts and scholars were analyzed for consistency, to confirm the effectiveness of the evaluation. If the answers did not qualify, they were deleted. After the analysis, only seven questionnaires passed the evaluation consistency test.

3.5.3 Research analysis of AHP

1. Paired comparison matrix and factor value of medical service quality.
Use Equation 1 to calculate the pairwise comparison matrix (see Table 9).

Table 7: KMO and Bartlett test

Experts/scholars	Title
Practical experts 1	Hospital's Executive Director
Practical experts 2	Hospital's Executive Director
Practical experts 3	Hospital's Associate Executive Director
Practical experts 4	Director of Internal Medicine
Practical experts 5	Hospital's Financial Advisor
Practical experts 6	Medical Clinic Director
Practical experts 7	Director of Nursing
Scholars 1	Professor of Service Quality
Scholars 2	Professor of Hospital Management
Scholars 3	Professor of Customer Relationship Management

Table 8: Pairwise comparison matrix for a questionnaire

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Q1	1	3	1/3	1/7	1/5	1/5	1/5	1
Q2	1/3	1	1/5	1/9	1	1	1/5	1
Q3	3	5	1	1/5	3	1	1/3	5
Q4	7	9	5	1	5	4	1	9
Q5	5	1	1/3	1/5	1	1	1/5	5
Q6	5	1	1	1/4	1	1	1/3	3
Q7	5	5	3	1	5	3	1	9
Q8	1	1	1/5	1/9	1/5	1/3	1/9	1
λ_{max}= 8.5623; $CI = (\lambda_{max} - n)/(n-1) = 0.0803 < 0.1$; $CR = CI/RI = 0.057 < 0.1, (RI = 1.41)$;								

Table 9: Matrix vector

1	0.8024	0.2518	0.1856	0.2088	0.1938	0.1775	0.5209
1.2461	1	0.4843	0.3054	0.4916	0.3965	0.3075	0.9437
3.9703	2.0647	1	0.4115	1.4261	0.9057	0.4991	2.6826
5.3873	3.2739	2.4297	1	2.5084	2.3535	1.3894	3.2308
4.7869	2.0339	0.7011	0.3986	1	0.6244	0.4612	2.0458
6.1585	2.5214	1.1040	0.4248	1.6013	1	0.7011	3.1421
6.6331	3.2512	2.0035	0.7196	2.1678	1.4261	1	3.0613
1.9194	1.0596	0.3727	0.3095	0.4887	0.3182	0.3266	1

2. Incorporate Table 9 into Table 10, adding the vertical sum in order to calculate the paired comparison matrix (see Table 10).

3. Calculate standard values and weight values
Paired comparison matrix values are substituted into the various AHP algorithms in order to achieve the standard values, and the horizontal sum is used to calculate the weight values (see Table 11).

4. Matrix vector
By multiplying the weight values of Table 11 with corresponding target estimation values of Table 9, matrix vectors are calculated (see Table 12).

5. Eigenvalues
By adding up horizontal values of Table 12 and then dividing them by the weight values of Table 11, the maximum eigenvalues are calculated (see Table 13).

From the above results, the overall evaluation is acceptable and has been confirmed to be consistent. From Table 12, the AHP experts opinions regarding improvement priority are as follows: "prompt management of emergency patients by the medical staffs (0.2493)", "doctors have good professional skills (0.2049)", "doctors can offer detailed explanations of patients' status (0.1543)", "the medical staffs are not too busy and do not neglect patients (0.1275)", "the medical staffs listens to patients' needs (0.1096)", "the hospital will initiate a follow-up of patients' recovery (0.0595)", "the medical staffs are passionate about helping patients to solve their problems (0.0583)", and "the hospital has modern medical equipment (0.0366)". From the above findings, patients are the most unsatisfied with the promptness shown by the staff during emergencies because patients are usually desperate in such situations; the staff's professionalism or attitude can cause patient dissatisfaction, and hence, need to be improved drastically. Another important item is for doctors to have

Table 10: Integration pairwise comparison matrix

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Q1	1	0.8025	0.2519	0.1856	0.2089	0.1939	0.1775	0.5210
Q2	1.2462	1	0.4843	0.3054	0.4917	0.3966	0.3076	0.9437
Q3	3.9703	2.0648	1	0.4116	1.4262	0.9057	0.4991	2.6827
Q4	5.3873	3.2740	2.4298	1	2.5085	2.3535	1.3895	3.2309
Q5	4.7870	2.0339	0.7012	0.3986	1	0.6245	0.4613	2.0458
Q6	6.1585	2.5215	1.1041	0.4249	1.6013	1	0.7012	3.1421
Q7	6.6332	3.2512	2.0036	0.7197	2.1678	1.4262	1	3.0614
Q8	1.9195	1.0596	0.3728	0.3095	0.4888	0.3183	0.3267	1
Sum	31.1019	16.0075	8.3475	3.7553	9.8932	7.2186	4.8629	16.6276

Table 11: Standard values and weight values of service items

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Sum	Weights
Q1	0.0322	0.0501	0.0302	0.0494	0.0211	0.0269	0.0365	0.0313	0.2777	0.0347
Q2	0.0401	0.0625	0.0580	0.0813	0.0497	0.0549	0.0633	0.0568	0.4665	0.0583
Q3	0.1277	0.1290	0.1198	0.1096	0.1442	0.1255	0.1026	0.1613	1.0196	0.1275
Q4	0.1732	0.2045	0.2911	0.2663	0.2536	0.3260	0.2857	0.1943	1.9947	0.2493
Q5	0.1539	0.1271	0.0840	0.1062	0.1011	0.0865	0.0949	0.1230	0.8766	0.1096
Q6	0.1980	0.1575	0.1323	0.1131	0.1619	0.1385	0.1442	0.1890	1.2345	0.1543
Q7	0.1980	0.2031	0.2400	0.1916	0.2191	0.1976	0.2056	0.1841	1.6392	0.2049
Q8	0.0617	0.0662	0.0447	0.0824	0.0494	0.0441	0.0672	0.0601	0.4758	0.0595

Table 12: Matrix vector

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Sum
Q1	0.0347	0.0468	0.0321	0.0463	0.0229	0.0299	0.0364	0.0310	0.2801
Q2	0.0433	0.0583	0.0617	0.0762	0.0539	0.0612	0.0630	0.0561	0.4737
Q3	0.1378	0.1204	0.1275	0.1026	0.1563	0.1398	0.1023	0.1596	1.0462
Q4	0.1870	0.1909	0.3097	0.2493	0.2749	0.3632	0.2847	0.1922	2.0519
Q5	0.1662	0.1186	0.0894	0.0994	0.1096	0.0964	0.0945	0.1217	0.8957
Q6	0.0069	0.1470	0.1407	0.1059	0.1755	0.1543	0.1437	0.1869	1.0609
Q7	0.2302	0.1896	0.2554	0.1794	0.2375	0.2201	0.2049	0.1821	1.6993
Q8	0.0666	0.0618	0.0475	0.0772	0.0536	0.0491	0.0669	0.0595	0.4822

good professional skills; if the lack of experience causes delayed treatment or loss of life, it would be a major negative factor. The spread of education has caused an increased understanding of medical information and medical standards among the general public. Patients tend to choose hospitals where the reputation, service quality, and medical skills are better, and those that are fully equipped. Under the same competitive conditions, as the general public's expectations of medical service quality increase, medical service quality and customer satisfaction have become important indications of competition among medical facilities, as well as consideration factors when patients choose hospitals. Improving service quality and customer satisfaction has become an effective way for hospitals to increase their competitive advantage; therefore, many hospitals have adopted developed country policies, incorporating quality control methods adopted by manufacturing industries into the hospital management system. Therefore, besides increasing service quality and image, hospitals also need to improve their service quality, as well as add competitive advantage.

4 Conclusion and suggestion

The perimeters of medical service quality are diverse, including working methods, operating procedures, machinery operation, and even the medical management system. Since the implementation of nation health insurance in Taiwan, gradual emphasis was given to medical service quality for reasons such as the increase in government expenses because of medical costs, high inflation in healthcare costs, increased competition among medical service organizations, and a rise in customer consciousness. Thus, management methods aimed at increasing customer satisfaction are needed to improve medical service quality; besides patient consent, opinions from experts, lowering management costs and increasing service quality, and increased teamwork help to reach an

Table 13: Eigenvalues

Alternative items	Sum	Weights	Order	Eigenvalues
Q1: Hospital has modern medical equipment.	0.2801	0.0366	8	8.0682
Q2: Medical staffs are passionate about helping patients to solve their problems.	0.4737	0.0583	7	8.1226
Q3: Medical staffs are not too busy and do not neglect patients.	1.0462	0.1275	4	8.2081
Q4: Prompt management of emergency patients by the medical staff.	2.0519	0.2493	1	8.2291
Q5: Medical staff listens to patients' needs.	0.8957	0.1096	5	8.1740
Q6: Doctors can offer detailed explanations of patient status.	1.0609	0.1543	3	6.8751
Q7: Doctors have good professional skills.	1.6993	0.2049	2	8.2930
Q8: Hospital will initiate a follow-up of patients' recovery	0.4822	0.0595	6	8.1074
λ_{max}= 8.0097; $CI = (\lambda_{max} - n)/(n-1) = 0.0014 < 0.1$; $CR = CI/RI = 0.001 < 0.1, (RI = 1.41)$;				

operation continuum. To improve medical service quality, merely knowing patient opinions is not enough; the key is to increase the hospital's competitive ability. Besides focusing on how to improve service quality, a hospital needs to survey its resource status and check whether it is enough to promote efficient management methods and enrich management personnel. If hospital resources are adequate, modernized medical equipment must be purchased, professional and experienced medical staff hired, and professional medical management personnel trained. Hospitals must inspect all resources and personnel before considering the results of this study, to efficiently distribute resources among items in most need of improvement. Service items with good performance should maintain the status quo, and more resources can be devoted to items needing improvement. This method will not waste resources and will ensure their optimum usage. This study places patient perceived satisfaction into the PEM to be quantified. Many researches consider patient opinions as a basis for improvement, but many neglect the aspect of whether the hospital itself has sufficient resources and capacity. All items that need to be improved must be prioritized; therefore, AHP has been used to decide the order of prioritization. Although the above method has been widely used during decision making in various other industries, its use in the medical industry lacks documented research. Therefore, researchers could further explore this method in the future, with regard to not just medical service management but also the purchase of medical equipment or employing of medical staff.

References

[1] S.S Andaleeb, Service quality perceptions and patient satisfaction: A study of hospitals in a developing country. Social Science & Medicine 52 (9), 1359-1370 (2001).

[2] S.H Chen, A performance matrix for strategies to improve satisfaction among faculty members in higher education. Quality & Quantity 45(1), 75-89 (2011).

[3] T.S Dagger, and J.C Sweeney, The effect of service evaluations on behavioral intentions and quality-of-life. Journal of Service Research 9(1), 2-19 (2006).

[4] R.C Rose, J. Uli, M. Abdul, and K.L Ng, Hospital service quality: a managerial challenge. International Journal of Health care Quality Assurance 17(3), 248-257 (2004).

[5] P.N.M Raja, S.G Deshmukh, and S. Wadhwa, Quality award dimensions: a strategic instrument for measuring health service quality. International Journal of Health Care Quality Assurance 20(5), 363-378 (2007).

[6] J.P Oxer, The philosophy of performance evaluation. IEEE Engineering Management Review 30(4), 119-200 (2002).

[7] R.P Mohanty, and R.R Lakhe, TQM in the Service Sectors. Jaico Publishing House, Mumbai (2002).

[8] J Singh, Understanding the structure of consumers' satisfaction evaluations of service delivery. Journal of the Academy of Marketing Science 19(3), 223-244 (1991).

[9] K Winsted, Patient satisfaction with medical encounters-a cross-cultural perspective. International Journal of Service Industry Management 11(5), 399-421 (2000).

[10] K Tasso, L Behar-Horenstein, A Aumiller, and K Gamble, Assessing patient satisfaction and quality of care through observation and interview. Hospital Topics 80(3), 4-10 (2002).

[11] A Donabedian, Evaluating the quality of care. The Milbank Quarterly 83(4), 691-729 (2005).

[12] S Williams, Quality and care: patients' perceptions. Journal of Nursing Care Quality 12(6), 18-25 (1998).

[13] V Mullen, The link between patient satisfaction and quality improvement. Clinical Data Management 6(11), 8-12 (2000).

[14] C Pope, Consumers' satisfaction in an HMO, in Greenlick, M., Freeborn, D. and Pope, C. (Eds), Health Care Research in an HMO: Two Decades of Discovery, The Johns Hopkins University Press, Baltimore, MD, 275-290 (1998).

[15] A Di-Paula, R Long, and D Wiener, Are your patients satisfied? Marketing Health Services 22(3), 28-32 (2002).

[16] J.S Schwartz, Measuring quality: Where are we? Where are we going? And how will we know when we get there? Annals New York Academy of Sciences 729, 150-174 (1994).

[17] W.T Lin, S.C Chen, and K.S Chen, Evaluation of performance in introducing CE marking on the European market to the machinery industry in Taiwan. International Journal of Quality & Reliability Management 22(5), 503-517 (2005).

[18] W.T Lin, S.C Chen, M.Y Lin, and H.H Wu, A study on performance of introducing ERP to semiconductor related industries in Taiwan. The International Journal of Advanced Manufacturing Technology 27, 1011-1020 (2006).

[19] T.L Saaty, The Analytic Hierarchy Process. New York: McGraw Hill (1980).

[20] M Bevilacqua, and M Braglia, The analytic hierarchy process applied to maintenance strategy selection. Reliability Engineering & System Safety 70(1), 71-83 (2000).
[21] P Fatma, and H Timothy, Patient satisfaction in a preoperative assessment clinic: an analysis Using SERVQUAL dimensions. Total Quality Management and Business Excellence 16(1), 15-20 (2005).
[22] M.A Lee, and Y.H Yom, A comparative study of patients' and nurses' perceptions of the quality of nursing services, satisfaction and intent to revisit the hospital: A questionnaire survey. International Journal of Nursing Studies 44, 545-555 (2007).
[23] A.H.I Lee, W.C Chen, and C.J Chang, A fuzzy AHP and BSC approach for evaluating performance of IT department in the manufacturing industry in Taiwan. Expert Systems with Applications 34, 96-107 (2008).
[24] Y.Z Zhuang, Management System of Medical Organizations. Taipei: Hua-Xing (2000).
[25] E Yellen, G Davis, and R Ricard, The measurement of patient satisfaction. Journal of Nursing Care Quality 16(4), 23-29 (2002).
[26] J Torres, and K Guo, Quality improvement techniques to improve patient satisfaction. International Journal of Health Care Quality Assurance 17(6), 334-338 (2004).
[27] J.L.M Tam, Linking quality improvement with patient satisfaction: a study of a health service centre. Marketing Intelligence & Planning 25(7), 732-745 (2007).
[28] S.Y Tsai, A discrepancy model examining the determinants of user satisfaction with the PACS systems in the radiology departments of Taiwan hospitals. Unpublished master dissertation, University of Chung-Cheng, Taiwan (2008).
[29] D.M Lambert, and A Sharma, A customer-based competitive analysis for logistics decisions. International Journal of Physical Distribution and Logistics Management 20, 17-24 (1990).
[30] Y.L Li, J.F Tang, K.S Chin, Y.S Jiang, Y. Han, and Y. Pu, Estimating the final priority ratings of engineering characteristics in mature-period product improvement by MDBA and AHP. International Journal of Production Economics 131, 575-586 (2011).
[31] W. Ho, T. He, C.K.M Lee, and A. Emrouznejad, Strategic logistics outsourcing: An integrated QFD and fuzzy AHP approach. Expert Systems with Applications 39, 10841-10850 (2012).
[32] T.L Saaty, How to make a decision: the analytic hierarchy process. Interfaces 24(6), 19-43 (1994).
[33] E.W.L Cheng, H Li, and D.C.K Ho, Analytic hierarchy process (AHP). Measuring Business Excellent 6(4), 33-37 (2002).
[34] S.H Chung, A.H.I Lee, and, W.L Pearn, Product mix optimization for semiconductor manufacturing based on AHP and ANP Analysis. Advanced Manufacturing Technology 25, 1144-1156 (2005).
[35] A Parasuraman, V.A Zeithaml, and L.L Berry, A conceptual model of service quality and its implications for future research. Journal of Marketing 49(4), 41-50 (1985).
[36] W.I Lee, T.H Chang, and P.J Chao, The relationship between quality of healthcare service and customer satisfaction- An example of hospitals in Taiwan. Journal of the Chinese Institute of Industrial Engineers 24(1), 81-95 (2007).
[37] J.C Nunnally, Psychometric Theory. New York: McGraw-Hill (1978).

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