Research on Medical Service Design Model Based on Patient Service Demand Classification

Jing Wang

School of Economics and Management, Xidian University, Xi'an 710126, China

wjxidian@sina.cn

Abstract

Medical services are related to people's health. The design of medical services can provide scientific guidance for medical service organizations to improve the quality of medical services. In this paper, according to the medical service design problem, the Kano model is used to classify the patients' needs. Secondly, the linguistic assessment of the patient's demand weights is obfuscated. The QFD (quality function deployment) method is used to determine the service component weights. On this basis, using the degree of service elements to determine the degree of patient satisfaction, taking into account the constraints of medical service organizations, establishing a service design optimization model with the goal of maximum patient satisfaction, through the model to obtain the optimal service design. Finally, an example analysis proves the feasibility and effectiveness of the proposed method.

Keywords

Medical services, Service design, QFD.

1. Introduction

Medical services are an important part of the service industry. They are hot issues of concern to the public and are related to the lives and health of patients. With the improvement of the people's income level and the change of health concepts, medical consumer demand has developed to a diversified and multi-level direction. People's demands for medical services are also getting higher and higher, and they begin to pay more attention to psychological and emotional satisfaction. With the entry of private capital, the competition in the medical service industry has become increasingly fierce. With the rapid development of telemedicine and mobile medical care, medical institutions managers have rethought the operating model of medical institutions and started to pay attention to how to improve the quality of medical services. Under this background, the patient needs are changed from the previous cure for illness, restoration of health, and the cost of medical care to a concern for medical treatment, medical care, and mental satisfaction such as feelings of security and respect.

The transformation of patient needs and the development of the market require medical service organizations to change the mode of medical services. With patient needs as the center, resource optimization can be achieved through service design, and medical service organizations can enhance market competitiveness. The level of service design directly determines the competitiveness of service products. The growth and development of medical institutions need to be based on the provision of high-quality services for patients. The questions in the service include whether the services provided can meet the needs of the patients, the timeliness of the provision of medical services, and the reasonableness of the service prices. Solving these problems requires the service design to provide scientific guidance.

2. Related literature

At present, there has been some research on service design and medical service design. In the aspect of service design, inspired by the two-factor theory, Prof. Kenno Kano proposed using the Kano model to classify quality, and from the cognitive quality of the two-dimensional model, for the first time introduced satisfaction and dissatisfaction standards into quality management. Tan and Shen[1] introduced the Kano model in the QFD model to correct the improvement rate of customer satisfaction level in the model. Wu[2] combined the Kano model with IPA analysis to identify the key influencing factors of the market competitiveness of enterprises by classifying the quality characteristics of products and services, so as to determine the allocation of enterprise resources and improve the service quality of enterprises. Matzler and Hinterhuber[3]proposed to use customer satisfaction as an aid in the QFD process. In terms of basic needs products should meet expectations, products should be competitive in terms of performance requirements, products should be prominent in the customer's surprise needs. The QFD method is used in many industries such as: manufacturing, transportation, construction, education and service industries[4].

In the design of medical services, Lee[5]evaluated the quality of comprehensive health services according to the measurement dimensions, quality rewards and service quality certification or certification system of previous medical service quality, and the most important influence factor was the degree of care improvement. Heidari et al[6] analysed the data obtained from prison experience of the Swiss elderly prisoners, assessed the health care services in prisons from the perspective of prisoners, and made recommendations accordingly. Lingg et al[7] used a qualitative approach to analyze the regulation, assessment, and management of Mexican orthopaedic medical devices, and how to improve the output and outcomes of the functions and have a positive impact on the quality of medical care provided. Maji and Dikshit[8] used objective methods to determine the optimal number of ambient air quality stations based on a human health risk monitoring network. Miao etal[9] introduced a novel visualization technique that presents the fetal and maternal side of the placenta in a standardized manner to monitor fetal development. Joseph[10] analyzed the influence and role of budget makers in the medical insurance system and the medical service system by reviewing the typical pressures and attitudes of the budget experts and political authorities when selecting health policies. Gilles[11] targeted low-income countries, considering the impact of professional monopolies on the performance of health care delivery systems, and provided a feasible course of action.Bowen [12] proposed a service design method based on user experience, taking into account the inconvenience of mobility and the limited range of activities of the elderly in outpatient service for the elderly.

The related research on service design has provided research ideas for the research of this paper. However, most of the existing researches are focused on the theoretical level, without considering the actual application background and other specific factors, and lacking the practical results after applying the service design method. . Second, the research related to service design mainly focuses on qualitative research, and less literature applies modeling methods to study service design optimization. There have been studies based on service quality assessment and satisfaction surveys, but there is less research on medical service design in the field of medical services.

3. Model

3.1 Problem Description

Medical services use medical technology as a basic service method to provide patients and people with medical needs with services that meet their needs. Modern medical services include content prevention, disease prevention, and patient-to-medical institutions for diagnosis and treatment, as well as rehabilitation and post-hospital care and other medical activities. How to scientifically transform medical resources into service output and improve patient satisfaction is the issue to be studied in this paper.

The medical service design of this article is divided into three phases: preparation phase, decision analysis phase and service innovation phase. The preparation phase includes obtaining access to patient needs and patient needs weights. In the decision analysis phase, the patient's demand weight is first determined by the expert scoring method, and then the Kano model is used to determine the patient's demand category and assignment, and adjust the patient's demand weight. Secondly, QFD model is used to map patient needs into medical service design elements, and use quality house to convert patient demand weights into service element weights. Then use the expert scoring method to determine the degree of service elements provided, and determine patient satisfaction based on the weight and degree of service elements. Finally, an integer programming model with the goal of the highest degree of patient satisfaction as the constraint and the constraint on the budget of medical institutions and other resources is established. Through the solution of the model, an optimal medical service design portfolio solution is obtained.

3.2 Patient needs analysis

Firstly, the patient needs were obtained through literature analysis field interviews, etc. Next, according to the Kano model questionnaire, questions were set separately for each patient's needs that were determined from whether the demand was met. The options were: satisfaction, reason, and so on. It does not matter, can be tolerated or unsatisfied, the respondent evaluates the demand, and simultaneously investigates the patient's evaluation of the demand weight. For example, the problems set for a certain requirement are shown in Table 1:

Table 1 Kano Questionnaire example

Service requirements	Demand weight	Problem	Not satisfied	acceptable	Indifferent	reasonable	satisfied
Appointment registration	Unimportant() general() Important() Very important() most important()	Medical institutions provide booking service					
		Medical institution without reservation service					

After completing the patient needs survey by using the Kano questionnaire, the customer needs are classified using the Kano model classification assessment table, and the category with the most occurrences in the classification result is determined as the category to which the patient needs belong.

When determining the weight of patients' needs, the patient's evaluation of medical demand habits uses natural language forms such as "not important", "very important", "more important" and other vague language. In this paper, the triangular fuzzy number is used to deal with the evaluation of patient needs weight in the questionnaire. The respondent selects the evaluation element that best fits his or her opinion from a set of predefined language evaluations S .The number of evaluation elements in S is $i+1$ .This article will use the five-point scale method, s_0 express Unimportant, s_1 express general, s_2 express Important, s_3 express Very important, s_4 express most important. Language evaluation information is converted into triangular fuzzy numbers $\tilde{N}_i = (l_i, m_i, r_i)$.

$$\tilde{N}_i = (l_i, m_i, r_i) = [\max(\frac{i-1}{t}, 0), \frac{i}{t}, \min(\frac{i+1}{t}, 1)], \quad i = 0,1,...,t \tag{1}$$

According to the formula(1), The corresponding triangular fuzzy numbers in the set S are: $S_0=(0,0,0.25)$, $S_1=(0,0.25,0.5)$, $S_2=(0.25,0.5,0.75)$, $S_3=(0.5,0.75,1)$, $S_4=(0.75,1,1)$. Set the surveyee's collection is $E=(e_1,e_2,...,e_f)$, Patients select patient needs in the questionnaire $CR=(cr_1,cr_2,...,cr_n)$, The evaluation matrix is $\tilde{A}$, $\tilde{a}_{ij}$ denotes the ambiguous linguistic assessment of the ith patient's need for the jth patient, $i=1,2,...,f, j=1,2...,n$. Set the patient demand fuzzy weight as $\tilde{a}=(\tilde{a}_1,\tilde{a}_2,...,\tilde{a}_n)$, $\tilde{a}_j$ is Vague language weights for the needs of the jth patient, $\tilde{a}_j=(a_j{}^1,a_j{}^2,a_j{}^3)$.

$$\tilde{a}_j=(a_j{}^1,a_j{}^2,a_j{}^3)=(\sum_{i=1}^{f}a^1{}_{ij}\Big/f,\sum_{i=1}^{f}a^2{}_{ij}\Big/f,\sum_{i=1}^{f}a^3{}_{ij}\Big/f), i=1,2,...,f, j=1,2,...,n \tag{2}$$

Suppose $\tilde{a}_1=(a_1{}^1,a_1{}^2,a_1{}^3)$ and $\tilde{a}_2=(a_2{}^1,a_2{}^2,a_2{}^3)$ is two triangular fuzzy numbers of the same granularity, and the addition algorithm of triangular fuzzy numbers is:

$$\tilde{a}_1+\tilde{a}_2=(a_1^1+a_2^1,a_1^2+a_2^2,a_1^3+a_2^3) \tag{3}$$

In order to facilitate the analysis, the fuzzy weight vector $\tilde{a}=(\tilde{a}_1,\tilde{a}_2,...,\tilde{a}_n)$ of the patient needs CR is inversely blurred to obtain the absolute weight of the service element $\bar{a}=(a_1,a_2,...,a_n)$. The inverse fuzzy calculation rule for triangular fuzzy numbers is:

$$a_j=(a_j^1+4a_j^2+a_j^3)/6, j=1,2,...,n \tag{4}$$

After determining the patient needs category, each patient needs to be assigned according to its category, adjust its weight, and set the adjusted patient demand weight to $\bar{a}'=(a_1^{'},a_2^{'}...,a_n^{'})$. w_j is the number of weight adjustments that represent the needs of patient j. when the jth patient is attractive demand (A) $w_j=5$, when the jth patient is 1st-time demand (O) $w_j=3$, for 1st-request (M) $w_j=1$, and unrelated demand (I) $w_j=0$, for reverse demand (R) $w_j=3$, when the problem demand (Q) $w_j=0$. The adjustment weights are calculated as:

$$a_j^{'}=w_j\times a_j, j=1,2,...,n \tag{5}$$

3.3 Medical service design element weights

After using the Kano model to determine the patient's needs for patient care, it is also necessary to determine the medical service elements that meet the patient's needs. According to the needs of different patients, relevant medical service elements satisfying the needs of patients are determined based on hospital service standards and related literature research. According to the results obtained, the medical service factors are summarized and the following medical service factor items are determined:

Table 2 Medical service elements

Service elements	definition	Service elements	definition
Department configuration	Medical departments cover the range of diseases	hospital environment	The hospital is clean
Staffing	The number of medical staff	Civilized service	Medical staff friendly
professional skill	Medical professional level	Service efficiency	Patient waiting time
Medical equipment	Whether the medical equipment is complete	Doctor-patient communication	Doctor patient communication is smooth

This stage is based on QFD to establish a quality housing to convert patient needs into medical service elements. The patient needs are input as the left wall of the quality house, and the medical service elements are used as the input of the ceiling to form a two-dimensional matrix, and the correlation between patient needs and service factors is analyzed. The collection of service elements is SA, $SA=sa_1,sa_2...sa_o$. sa_k is the kth service elements of SA, $k=1,2,...,o$. The correlation matrix of patient needs and medical service factors is R, r_{jk} represents the correlation coefficient between the jth patient needs of the first item and the kth elements of the first medical service. The weighting of service elements is calculated by multiplying patient demand weights with service factor and patient demand correlation coefficients, and then summing each column longitudinally. According to the patient demand weight $\tilde{a}$ and correlation matrix R in the quality housing, the absolute weight $\bar{B}=(b_1,b_2...b_o)$ of the service element SA is obtained through calculation. The absolute weight of kth service element b_k is calculated as follows:

$$b_k=\sum_{j=1}^{n}a_j^{'}r_{jk},k=1,2,...,o \tag{6}$$

After determining the absolute weight of service elements, normalize them to get the relative weight of service design elements $\bar{B}'=(b_1^{'},b_2^{'},...,b_o^{'})$. $b_k^{'}$ is the Relative weight of the kth first service element ,The calculation method of $b_k^{'}$ is:

$$b_k^{'}=b_k\Big/\sum_{k=0}^{o}b_k,k=1,2,...,o \tag{7}$$

Table 3 Correlation matrix between patient needs and service factors

Patient needs CR	Patient demand weight $a_j^{'}$	Service elements			
		sa_1	sa_2	…	sa_o
cr_1	$a_1^{'}$	r_{11}	r_{12}	…	r_{1o}
cr_2	$a_2^{'}$	r_{21}	r_{22}	…	r_{2o}
…	…	…	…	…	…
cr_n	$a_n^{'}$	r_{n1}	r_{n2}	…	r_{no}
The absolute weight of service elements b_k					
Relative weight of service elements $b_k^{'}$					

This article follow the calculation method of Li Desheng's service item comprehensive satisfaction, and uses the product of service factor weight and service factor to provide the degree of satisfaction to measure patient satisfaction level. The expert scoring method was used to determine the extent to which service elements could be provided. Experts were from hospital management and staff of medical institutions, and the expert collection is Q, $Q=q_1,q_2,...,q_l$, q_m is the mth expert of Q, $m=1,2,...,l$, The evaluation matrix provided by the expert staff to the extent of the service elements is P, q_m is the provided degree evaluation by the expert to the kth service element, $p_{mk}=0,1,...,9$, $p_{mk}=0$ means cannot provide this service, $p_{mk}=9$ means can provide. The degree of Service elements $P=(p_1,p_2...,p_o)$.

$$p_k=\frac{\sum_{m=1}^{l}p_{mk}}{l},k=1,2,...,o \tag{8}$$

The degree of patient satisfaction is the product of the degree of service element weight and the degree of service factor provided. The patient satisfaction set of each service element is $D=(d_1,d_2,...,d_o)$, d_k represent the patient satisfaction of kth service element. The calculation method of d_k is:

$$d_k=p_k\times b_k^{'},k=1,2,...,o \tag{9}$$

3.4 Medical service optimization design satisfaction model

Medical service agencies invest resources to take measures to improve patient satisfaction. The limitations of medical service organization resources will affect the extent to which service elements can be provided. The resources of medical service organizations include human resources, medical equipment, places, etc. The resources involved can be expressed in the form of fees. This article examines service design options that maximize patient satisfaction under the constraints of improving the budget for medical service quality.Assuming that the total budget is C, the required cost for optimizing each service element is $\bar{c}=(c_1,c_2,...,c_o)$, c_k represent the cost of optimizing the kth service design element, $C\le\sum_{k=1}^{o}c_k$. X_k is 0-1 variables, $x_k=1$ means to improve the service elements sa_k , and $x_k=0$ means there is no need to improve the service elements. The model aims to maximize patient satisfaction and establish the following optimization model:

$$\max\ D=\sum_{k=1}^{o}x_k d_k=\sum_{k=1}^{o}x_k p_k b_k \Big/ \sum_{k=0}^{o}b_k, k=1,2,...,o \quad (10)$$

$$\sum_{k=1}^{o}c_k x_k\le C, k=1,2,...,o \quad (11)$$

$$x_k=0或1, k=1,2,...,o \quad (12)$$

Formula (10) represents the established service design model with the goal of maximizing patient satisfaction. Formula (11) represents that the sum of service element provision costs is lower than the total budget. Equation (12) is a 0-1 constraint that indicates whether the service element is optimized. In the model, there are 0-1 variables. Therefore, the medical service design optimization model established in this paper is 0-1 integer programming. Using Lingo software to solve the model can determine the medical service components that the medical service organization needs to improve.

4. Example - X hospital medical service design optimization

4.1 Hospital Profile

X Hospital is a Class II B general hospital that integrates medical treatment and preventive health care. It provides community health services such as medical treatment, preventive health care, health education and rehabilitation. The hospital is equipped with clinical departments such as emergency department, internal medicine, and surgery; medical technology departments such as pharmacy department and laboratory department; and functional departments such as medical department and nursing department. The hospital emphasizes “medical service as the leading factor and technical quality as the fundamental”, stressing that medical management should be continuously strengthened to improve the quality of medical services.

4.2 Patient needs analysis

First of all, through the analysis of the medical service related literature, and the hospital X hospital medical service satisfaction questionnaire and communication with patients, medical staff to obtain the initial needs of the patient. Through the organization and analysis of patient needs, referring to the index system of the SERVQUAL model, the patient needs are classified from five dimensions, and a patient requirement deployment table is established. Tangible mainly refers to the physical facilities in medical institutions; reliability refers to the provision of reliable services for patients; responsiveness refers to the efficiency of services provided by TCM staff in the service process; and guarantee refers to the ability of medical service personnel to obtain patients. Trust; empathy means that the medical staff will consider the interests of the patient from the perspective of the patient and provide personalized care for the patient. In addition, an open question was designed in the patient needs survey to supplement the service needs of patients.

Table 4 Hospital patient needs in X

First-level indicators	Secondary indicators	Third-level indicators
Patient needs	Physicality	Advanced medical equipment（cr_1） The medical environment is good and comfortable（cr_2） Medical staff have good service and enthusiasm（cr_3）
	reliability	Highly skilled medical staff（cr_4） Accurate and timely inspection test results（cr_5）
	Responsiveness	Waiting time is short（cr_6） Provide outpatient appointment service（cr_7） Patients have the right to know about treatment options and options（cr_8） Medical institutions make it easy for patients to reach doctors（cr_9）
	Guaranteed	The charging system is transparent and reasonable（cr_{10}） The doctor explained the patient's condition in detail（cr_{11}） Medical staff provide medication guidance to patients（cr_{12}）
	Empathy	Medical institutions provide detailed medical instructions（cr_{13}） Medical staff caring about the condition of the patient（cr_{14}） Medical institutions protect patient privacy（cr_{15}）

In this phase, the Kano questionnaire was used to investigate the patient's evaluation of the medical service needs of the X hospital. After the investigation, the Kano attribute classification table was used to classify the patients' needs. When calculating the weight of patients' needs, there is no difference in demand and the problem needs a value of 0. In this study, the investigation of patient needs does not involve the problem of causing patient disgust. Therefore, only the attractive needs, necessary needs, and expected needs are considered when classifying patient needs. The most frequently occurring category is the category to which the patient's needs belong. The results obtained are given in Table 5:

Table 5 Classification of patient needs

Patient needs	A	O	N	type	Weight adjustment w_j
Advanced medical equipment（cr_1）	38	30	12	A	5
The medical environment is good and comfortable（cr_2）	35	40	5	O	3
Medical staff have good service and enthusiasm（cr_3）	42	30	8	A	5
Highly skilled medical staff（cr_4）	35	25	20	A	5
Accurately and timely provide inspection results（cr_5）	18	20	42	N	1
Waiting time is short（cr_6）	7	53	20	O	3
Provide outpatient appointment service（cr_7）	40	28	10	A	5
Patients and their families have the right to know about treatment options and options（cr_8）	22	38	20	O	3
Medical facility to facilitate patient arrival（cr_9）	15	30	35	N	1
The charging system is transparent and reasonable（cr_{10}）	15	20	45	N	1

The doctor explained the condition in detail（cr_{11}）	20	36	24	O	3
Provide medication guidance for patients（cr_{12}）	15	53	7	O	3
Provide detailed medical instructions（cr_{13}）	20	45	15	O	3
The hospital cares about the patient's condition（cr_{14}）	40	30	10	A	5
Medical institutions protect patient privacy（cr_{15}）	20	24	36	N	1

In addition to determining the content of patients' needs who need medical service, the weight of each patient's needs needs to be considered. In this paper, the patient's demand weight is determined by the patient's evaluation. The patient's linguistic assessment of the weight of the demander will be transformed into triangular fuzzy numbers. This article uses a 5-grit language evaluation set. Patient's Language assessment set is $S = S_0, S_1, S_2, S_3, S_4$, $S_1 = \mathrm{L}$ means unimportant; $S_1 = \mathrm{L}$ means general; $S_2 = \mathrm{M}$ means important; $S_3 = \mathrm{H}$ means very important; $S_4 = \mathrm{VH}$ means most important. The triangular fuzzy number corresponding to each demand weight is as follows $S_0 = (0,0,0.25)$, $S_1 = (0,0.25,0.5)$ $S_2 = (0.25,0.5,0.75)$, $S_3 = (0.5,0.75,1)$, $S_4 = (0.75,1,1)$. In order to facilitate the analysis, this paper inversely ambiguously deals with the patient's demand fuzzy weight, converts it to a certain number, assigns the patient's demand according to the patient's needs classification result, and calculates the adjusted patient's demand according to formulas (1)-(5), as shown in Table 6:

Table 6 Patient needs weights

Patient collection / Patient needs	e_1	e_2	…	e_{80}	Demand fuzzy weight	Demand absolute weight
cr_1	H	L	…	H	（2.5,3.5,4）	0.10
cr_2	VL	M	…	VH	（1.2,1.8,2.4）	0.06
cr_3	L	L	…	M	（3,4.2,5）	0.13
cr_4	VL	VH	…	L	（3,4,3.5）	0.11
cr_5	L	M	…	M	（0.5,0.75,0.8）	0.01
cr_6	VL	L	…	VH	（0.7,1.5,2.1）	0.04
cr_7	VL	M	…	VL	（2.3,3.8,4.5）	0.11
cr_8	L	VH	…	M	（1.8,2.4,3）	0.07
cr_9	L	M	…	VH	（0.4,0.7,0.9）	0.02
cr_{10}	VH	M	…	H	（0.5,0.7,0.9）	0.02
cr_{11}	VL	L	…	H	（1.4,2,2.7）	0.06
cr_{12}	M	VH	…	VH	（1.6,2.2,2.5）	0.07
cr_{13}	VL	H	…	M	（1.7,2.3,2.8）	0.07
cr_{14}	VH	L	…	M	（2,3.4,4.4）	0.10
cr_{15}	H	VL	…	VH	（0.6,0.7,0.5）	0.02

4.3 X Hospital Medical Service Quality Function Deployment

At this stage, it is necessary to determine the content of medical services that meet the needs of patients. This article combines X hospital management standards and the contents of the medical service elements in Table 3.2 to determine the service elements applicable to X hospitals. In order to ensure that the medical service factors are related to the needs of the patients, first of all, the medical personnel in the hospital are required to convert the needs of the patients. For example, the needs of the patients "the hospital's advanced medical equipment can provide most of the medical examinations" are converted into "sound medical equipment". Then based on the hospital management standards, the hospital service standards are appropriately developed to determine the service elements related to the patient's needs.

Table 7 Medical service elements

Service elements	details
Optimize department configuration	Department settings and hospital functions Department setting to consider patient's disease needs
Reasonable staffing	Reasonable ratio of doctors and nurses Doctors in all departments can provide medical services for patients
Improve hospital management	Protect patient privacy strengthen quality management of medical services
Improve technology	Train medical staff Can properly handle and refer to incurable diseases
Sound medical equipment	Regular maintenance, maintenance of equipment, introduction of new equipment Basic medical equipment such as first aid and referral
Improve the hospital environment	Ensure the hospital environment is clean and tidy Controlling hospital noise
Adhere to civil service	Medical personnel comply with medical staff medical ethics Establish patient monitoring mechanism
Improve service efficiency	Set up medical guides to provide consultation for patients Provide outpatient appointment service
Strengthen communication between doctors and patients	Detailed explanation of medical condition in medical diagnosis Protecting patients' right to know about treatment options and options

After determining the relevant medical service elements, the weight of X hospital medical service elements can be determined through the correlation matrix of patient needs and service elements in the quality housing. In order to facilitate the calculation of the weight of medical service elements, here we assign values to the correlation strengths between patient needs and service factors based on the degree of relatedness. when there is a strong correlation between service factors and patient needs $r_{jk} = 5$;When the two are related $r_{jk} = 3$; When the two are weakly related $r_{jk} = 1$; When the two are not relevant $r_{jk} = 0$. Multiply each patient's need weights with the correlation coefficient in the correlation matrix. After summing longitudinally, the weight of each service element can be determined. After getting the absolute weights of the various medical service elements and normalizing them, the relative weight of service elements can be determined.

Table 8 Patient demand weight conversion table

Demand item \ Service elements		Department configuration	Staffing	Hospital Management	Medical skills	Medical equipment	hospital environment	Civilized service	Service efficiency	communication
Patient needs	Absolute weight									
Advanced medical equipment	0.10	0	1	3	3	5	0	0	1	0
Medically comfortable environment	0.06	0	3	3	0	0	5	5	0	3
Medical staff friendly service	0.13	0	1	5	0	0	1	5	1	5
Highly skilled medical staff	0.11	0	1	5	5	3	0	0	3	1
Accurately and timely provide inspection results	0.01	3	3	3	3	3	0	3	5	1
Waiting time is short	0.04	0	3	5	1	1	0	1	5	0
Provide outpatient appointment service	0.11	0	1	1	0	3	1	0	5	1
Patients have the right to know about treatment and options	0.07	0	0	1	0	0	0	5	1	5
Medical convenience	0.02	0	0	0	0	0	3	0	3	0
Reasonable fee system	0.02	1	1	1	1	3	1	3	1	3
The doctor explained the condition in detail	0.06	1	3	3	0	0	1	5	1	5
Provide medication instructions	0.07	1	3	3	1	0	1	5	0	3
Provide medical advice	0.07	3	1	3	0	3	3	3	3	3
Provide personal care for patients	0.10	3	1	1	0	0	3	5	0	3
Protect patient privacy	0.02	0	1	3	3	3	0	3	0	3
The absolute weight of service elements		0.69	1.39	2.86	1.1	1.61	1.24	2.82	1.83	2.54
Relative weight of service elements		0.04	0.09	0.18	0.07	0.1	0.08	0.18	0.11	0.2

4.4 X Hospital Medical Service design plan

The design of services needs to consider the limitations of medical institutions' resources. The optimization costs of the service elements in Table 2 cannot be directly determined, such as hospital management level, doctor-patient communication, etc. This paper uses the method of analyzing hospital operating costs to quantify the cost of providing services for X hospitals. For example, medical skills can be quantified using training fees, and hospital management levels can be quantified using management fees. By quantifying the cost of service element optimization and determining the cost of optimizing each service element of the X hospital as shown in Table 9, the budget for the hospital's service design is 450,000.

Restrictions on resources will affect the extent of services can be provided. For example, the configuration of departments is limited by the number of hospital sites and medical personnel. Buy medical equipment is affected by the hospital budget and supporting equipment. The degree of service elements provided in this article is determined by experts based on experience and the actual conditions of medical institutions. Table 9 shows the extent to which service elements can be provided. The absolute weights of service elements can be determined through the correlation matrix in Table 8. According to equation (9), patient satisfaction is determined by the product of the service component weight and the degree of service factor provided. For example, the degree of provision of the service element department configuration is 4, and the corresponding relative weight is 0.04. Then the patient satisfaction degree of the service element “department configuration” is $0.04 \times 4 = 0.16$, the patient satisfaction degree of all service elements can be calculated .

Table 9 Service Factor Summary Table

Service elements	Weights	Service availability	Patient satisfaction	Optimization costs (million)
Department configuration	0.04	4	0.16	8
Staffing	0.09	6	0.36	5
Hospital management level	0.18	7	1.26	5
Medical skills	0.07	6	0.42	6
Medical equipment	0.10	5	0.50	12
Medical environment	0.08	4	0.32	2
Civilized service	0.18	5	0.9	2
Service efficiency	0.11	4	0.44	2
Doctor-patient communication	0.16	7	1.12	3

Through the above analysis, the budget of X hospitals to improve service quality is used as the cost constraint for service design optimization, and the goal of maximum patient satisfaction is the goal. According to (10)-(12), the following service design optimization model can be established:

$$\max \ \mathrm{D} = \sum_{k=1}^{9} x_k d_k = \sum_{k=1}^{9} x_k p_k b_k' \tag{13}$$

$$\sum_{k=1}^{9} c_k x_k \le 45 \tag{14}$$

$$x_k = 0 \text{或} 1, k = 1, 2, \ldots, 9 \tag{15}$$

This model is 0-1 integer programming. After solving with Ligno, we get $x_1 = 0$, $x_2 = 1$, $x_3 = 0$, $x_4 = 1$, $x_5 = 1$, $x_6 = 1$, $x_7 = 0$, $x_8 = 1$, $x_9 = 1$ 。. Therefore, under the constraints of the hospital's expense budget and the satisfaction of the patients, the hospital can invest resources in staffing, medical skills, medical equipment, medical environment, and service efficiency to communicate with doctors and patients to achieve the goal of improving service levels.

5. Conclusion

This article aims at the medical service design problem, studies the medical service design method and the medical service optimization model construction. The Kano model was used to classify patients' needs. The weight of patients' needs was transformed into weights of medical service elements through quality houses, and patient satisfaction was determined by the extent to which the medical service elements in medical institutions could be provided, taking into account the limitations of the resources of medical service organizations. Determine the service design plan with the highest degree of patient satisfaction. The proposed method has strong operability and practicality, and proves that it is feasible to apply the service design method to the medical service field. It should be pointed out that the service design optimization model of this paper is based on the needs of patients. Based on the Kano model, different types of patient needs are given different weights. In the actual application, as time changes, the patient needs category changes due to changes in the patient's expectations. In future studies, the influence of demand changes on service design may be considered.

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