http://jhmi.sums.ac.ir
Health Man & Info Sci 2022, 9(2), 76–86

HMIS
Health Management and Information Science

Original Article

Evaluating the Performance of Hospitals Affiliated to Shiraz University of Medical Sciences based on Medical Professional Ethics Indicators by Fuzzy Data Envelopment Analysis

Mehdi Golrizkhatami[1,2], Morteza Shafiee[3]*, Amir Kazemi[4]

[1]Student in Cultural Management and Planning, Economics and Management Faculty, Shiraz Branch, Islamic Azad University, Shiraz, Iran
[2]Student in Cultural Management and Planning, Fars Science and Research Branch, Islamic Azad University, Fars, Iran
[3]Department of Industrial Management, Economics and Management Faculty, Shiraz Branch, Islamic Azad University, Shiraz, Iran
[4]Department of Management, Economics and Management Faculty, Shiraz Branch, Islamic Azad University, Shiraz, Iran

Abstract

Introduction: One of the most complex decision-making problems for managers is evaluating the performance of hospitals using various criteria.

Methods: To do this, we first divided the indicators into four categories using the Balanced Scorecard (BCS) and then analyze the indicators using the Data Envelopment Analysis (FDEA) method. First, all the relationships between the four perspectives were obtained using the DEMATEL method and this network structure was used to create the DEA network model. Satisfactory performance evaluation indicators have been selected by reviewing the literature and opinions of hospital managers and physicians with real practical experiences in medical professional ethics. Then, the causality between the four BSC perspectives as well as the relative weights between the evaluation indicators were determined using test and decision evaluation (DEMATEL), respectively.

Results: The average efficiency of medical professional ethics based on the results of growth and training stage was 84.73% , internal process stage 92.09%, capital stage 100%, and financial stage 95.81%, based on the designed model of an input and output. The steps were obtained. The results were below the overall performance evaluation of the hospitals. General performance of hospitals (DMU) No. 1, 3, 5, 8, 12, 13, 17, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 32, 33, 35, 36, and 37 were obtained 100%, and 2 hospitals were 92.9% efficient, 4 hospitals 91.5%, 6 hospitals 58.4%, 7 hospitals 67.1%, 9 hospitals 95.1%, 10 hospitals 98.4%, 11 hospitals 98.4%, 13 hospitals 92.6%, 14 hospitals 85.1%, 15 hospitals 88.8%, 16 hospitals 94%, 18 hospitals 87.2%, 19 hospitals 86.3%, and 20 of them were 98/6% efficient.

Conclusion: This study used the non-financial approach of medical ethics to evaluate the performance of hospitals; it can be said that the method and type of perspective used are completely new.

Keywords: Medical professional ethics, Balanced scorecard, DEMATEL, Fuzzy data envelopment analysis, Shiraz hospitals.

Article History:
Received: 22 December 2021
Accepted: 31 February 2022

Please cite this paper as:
Golrizkhatami M, Shafiee M, Kazemi A. Evaluating the Performance of Hospitals Affiliated to Shiraz University of Medical Sciences based on Medical Professional Ethics Indicators by Fuzzy Data Envelopment Analysis. Health Man & Info Sci. 2022; 9(2): 76-86. doi: 10.30476/jhmi.2022.94035.1112.

***Correspondence to:**
Morteza Shafiee,
Department of Management, Faculty of Management and Economics, Shiraz Branch, Islamic Azad University, Shiraz, Iran
Tel: +98 9171130039
Email: ma.shafiee277@gmail.com

Introduction

In different periods of human history, the observance of ethics and behavior in society has been considered as one of the most important crises in human social life. With the growth of social life, the issue of morality has become broader and more complex, and the moral definition of human relations in society has become more difficult; it has also become more difficult to distinguish moral from immoral. The category of ethics has always been discussed among philosophers, scientists, professionals, religious scholars, etc. Morality is something that is different from the function of law. Legal behavior is rooted in a set of principles and regulations that determine the type of action individuals take. Hippocrates was the first to incorporate the moral principles into medicine in the form of an oath and present it to physicians as a moral oath. Then, different civilizations, especially that in Islam and Iran, paid special attention to ethics in medicine. Performance appraisal in the current era of dramatic changes in management knowledge, the existence of an evaluation system has become inevitable, so that the lack of evaluation system in

different dimensions of the organization, including evaluation in the use of resources and facilities, goals, strategies, managers, and employees, is considered as one of the indicators of the organizational diseases. Every organization needs an evaluation system to be aware of the desirability and quality of its activities, especially in complex and dynamic environments. On the other hand, the lack of evaluation and control system in an organization means lack of communication with the environment inside and outside the organization, which results in the aging and eventual death of the organization (1). A performance appraisal process gives the organization the opportunity to identify problems and take the right action before the problems escalate. In general, the efficiency of medical professional ethics, which is usually managed as a series of functions, is measured by considering its overall efficiency in the system. The emergence of several performance metrics has made it difficult to measure performance. Traditional performance management ignores non-financial factors and does not seem to be sufficient to meet the needs of hospital management in understanding how to calculate comprehensive performance. At that point, financial indicators can only reflect the past performance of the hospital and do not reflect the hospital outlook in terms of services. This is usually followed by performance management, highlighting traditional assets, and passing on intangible assets. Hospital fixed assets are important, but the other part is a knowledge organization and its financial knowledge, intellectual resources, and other intangible assets (2). The emergence of several performance metrics has made performance measurement difficult. Therefore, the tools used to measure performance should not only provide quantitative reasoning, but also be qualitatively in line with the strategic goals of the organization. As Qalavini and Nobel emphasized (3), the literature on performance measurement has two stages. In the first phase, which lasted until the 1980s, the focus was on measuring performance based on the financial metrics provided by the management accounting system. The second phase began in the late 1980s and is still ongoing. During this time, many changes have been made in performance measurement, and interest in this field has increased greatly. In the late 1980s, the limitations of the traditional method of measuring performance were well known, and researchers began to talk about introducing new performance measures such as shareholder value, economic profit, customer satisfaction, internal operations performance, intellectual capital, and intangible assets (4). There are many studies on performance appraisal; some of them have identified and defined tangible and intangible goals as performance indicators (2). However, the number of studies on performance and performance indicators based on intangible goals is very small. The main purpose of this article was to evaluate performance by focusing on medical professional ethics. The performance process in hospitals can be determined and controlled using this idea.

Methods

The aim of this study was to evaluate the performance of 37 hospitals affiliated to Shiraz University of Medical Sciences (public and private), based on the evaluation of professional ethics. This is an applied study and the research method is contextual-case.

Performance Evaluation by BSC

Several studies including Kramer (5), Krauss & Lind (6), Huang (7) and others have focused on performance appraisal Based on the Balanced Scorecard (BSC). Kaplan and Norton (8) argue that the BSC provides the managers with the means they need to navigate future competitive success. It includes more non-financial measures derived specifically from the organizational strategy. BSC is one of the comprehensive and simplistic performance measurement tools that emphasizes both the aspects of the financial and non-financial, long-term and short-term strategies, and emphasizes internal and external business measures. The strongest point of BSC is its ability to illustrate the cause and effect relations between strategies and processes through four perspectives: “Financial perspective”; “Customer perspective”; “Internal business process perspective”; and “Learning and growth perspective”. Based on this reasoning, to achieve its financial benefits, an organization should initially take its customers’ needs and expectations into account.

Decision Making Trial and Evaluation (DEMATEL) Approach

The DEMATEL approach can detect the interactions between alternative systems and evaluation criteria (9) because it can successfully calculate the effects between the criteria. Using this method of use, we can easily derive the interdependencies between different criteria and the power of interdependence (10). Although BSC is a powerful technique, it cannot determine an efficient and inefficient unit. Many studies have been done on this subject. To solve this problem, some researchers used a combined method, especially

Data Envelopment Analysis (DEA) and BSC. DEA is a linear programming method that can evaluate Decision Making Units (DMUs) qualitatively as well as quantitatively; it also calculates multiple inputs and outputs. The term DMU stands for Decision Unit and can be used to compare different organizations or evaluate the performance of a company's over time. In 1984, Bunker et al. proposed an evolutionary form of the CCR model called BCC (11). In the following years, DEA received more attention and a large number of researchers studied it and developed different models (12, 13). In general, these models differ in terms of orientation, disposability, diversification, and return to scale and types of measurements. DEA is a powerful way to evaluate DMU, but it has its limitations. In recent years, some researchers have used the concept of comparing fuzzy numbers and proposed methods for solving DEA models with fuzzy data (14).

Step 1. Determine the relationships between the defined factors. With a brainstorming system or a literature review, element expression and relationships between elements are judged mentally by professionals using a questionnaire design; by comparing the criteria for each element pair, a professional questionnaire with numbers from 0 to 4 has been formed, each marked for a level from "no effect" to "very much".

Step 2. A matrix is set with a direct relation because with the degree of influence between one element and another comparison, a matrix n is generated. The matrix is shown to be directly related to Z, and the shapes inside the matrix show the degree of influence between the elements.

Step 3. The matrix calculates the normalized direct relationship.

$$Markings = \frac{1}{\text{Max}\, n \leq i \leq 1(\sum_{j=1}^{n} Z_{ij})}$$

Then, the elements of the direct relation matrix (Z) are multiplied by S, which leads to the standard direct relation matrix (X). As an equation:

X=S×Z

Step 4. The matrix calculates the total relation (direct / indirect). We used T to represent a whole relation matrix and the title of the unit matrix, where X is used as a whole relation matrix.

$$X = [x_{ij}]_{n\times n}, \lim_{k\to\infty}(x^2 + \cdots + x^k)$$

$$When\ 0 \leq X_{ij} < 1, then \lim_{k\to\infty} X(1 + X + X^2 + \cdots X^k$$

$$T = \lim_{k\to\infty}(X + X^2 + \cdots + X^k) = \lim_{k\to\infty} X(1 + X + X^2 +$$

$$T = X(1 - x)^{-1},$$

$$T = [t_{ij}], \qquad i, j \in \{1,2, \ldots, n\}$$

Step 5. Draw a causal diagram and display the result analysis. The total value of each row is denoted by Di and the value of each column is denoted by Rj.

$D_{i=}\sum_{j=1}^{n} t_{ij} (i=1,2,\ldots,n),$

$R_{i=}\sum_{j=1}^{n} t_{ij} (i=1,2,\ldots,n),$

The cause diagram uses D + R, D-R as ordered pairs. The horizontal axis (D + R) shows the degrees of influence and the relationships between the elements where the vertical axis (D-R) shows the degree of influence of the relationship between one element and the others. Thus, the elements of their complex causality can be seen as a simple and clear structure by the causal diagram, and the structure can be seen as a guide to advice or strategy by decision makers or managers against problems.

Proposed Performance Evaluation Framework and Analytical Method

Based on the analysis of the previous literature review, the model of medical professional ethics evaluation by this research is shown in Figure 1. The analytical process is divided into four stages and performed: 1- In the first stage, we reviewed the measurements of medical professional ethics with literature review and expert ideas; 2- In the second step, we divided these measurements into four perspectives of the BSC approach; 3- We determined the causal relationships and interactions from the perspective of the DEMATEL method; and 4- An empirical analysis of the combined performance of medical professional ethics across the DEA network has been performed for sequencing grading among hospitals. The analytical methods, BSC, DEMATEL, and Network DEA employed by this research are introduced in brief as follows: Since BSC is based on causal relationships, DEMATEL was used to determine these relationships in the next stage. These relationships organize a network structure. Therefore, the DEA network model was developed to determine the efficiency of hospitals based on professional ethics. The hospital was then ranked by the DEA network method using the BSC approach.

The reason for choosing this field was that in the last decade, due to issues related to public health and treatment, the evaluation of the performance of medical professional ethics has received much attention. Obviously, in near future, the design and operation of medical professional ethics will be done

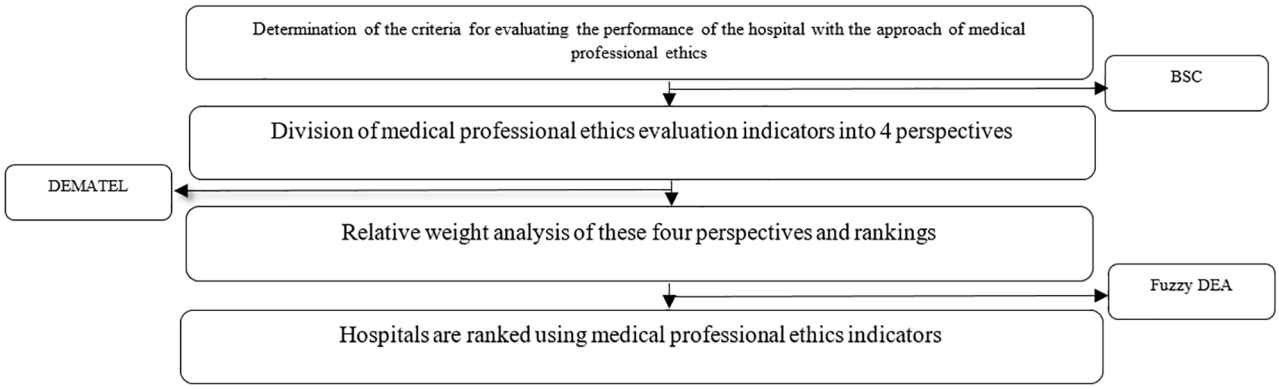

Figure 1: Proposed model for evaluating the performance of hospitals in Shiraz

according to stricter regulations and supervisions. In this study, the efficiency of professional ethics of 37 hospital centers located in Shiraz has been evaluated and a new DEA network model with BSC approach has been proposed for performance evaluation. For development of a model for evaluating the performance of medical professional ethics, the following conceptual framework and the relationships between members of the performance of medical centers can be considered.

Criteria for Evaluating Medical Professional Ethics

The data of the researcher-made questionnaire designed based on modern international standards of medical professional ethics were analyzed by examining the areas of evaluation indicators in the management of medical centers and hospitals and reviewing the texts, articles, and interviews with medical education specialists. (15-18). The validity of the questionnaires was determined by medical education experts and professors of health care management. Also, its reliability was evaluated in a pilot study and confirmed with Cronbach's alpha=0.8.9. Then, its face and content validity were examined and confirmed. For selection of the final criteria, a questionnaire with sections of medical professional ethics criteria including three main sections was prepared, validated, and distributed among physicians and hospital managers, and respondents were asked to use the 7-point Likert scale to measure the importance of the criteria, respectively. The scores ranged from 1 as very important and 7 as unimportant. The sample size was estimated to be 378 people using Morgan table and random sampling method. After distributing the questionnaire, 300 standard questionnaires were collected. Samples are assigned from employed physicians and hospital managers. The second questionnaire in the selected criteria considered both financial and non-financial characteristics. Therefore, in the third part of the questionnaire, respondents were asked to determine which criteria belonged to which BSC perspective or to assign criteria to the four BSC perspectives, namely finance, customer, internal processes, and learning and growth. The criteria classified in the four BSC perspectives are shown in Table 1. This percentage reflects the views of employed physicians and hospital managers, respectively.

Then, by examining the backgrounds related to the indicators of medical professional ethics, 66 effective indicators in hospitals were obtained (15-18). As shown in Table 1, the index with an average higher than 4 degrees is important, which has been selected as an efficient index, and all these indicators are classified in BSC perspectives. In the BSC column, the following tables summarize the letters P, L, C, and F as the four BSC perspectives (internal trends, learning and growth, customers, and finance), respectively. See the list of medical ethics for more information (19-32).

Fuzzy DEA Models Proposed

This section presents an integrated approach to evaluating medical professional ethics. In this case, there are four steps, and each step uses its own inputs to generate its own outputs. Also, there are links between several steps; for example, consider Outlook C; links L-C, F-C and C-C show that learning and growth, financial and customer perspective metrics affect customer metrics, respectively. Therefore, it is possible to say that the criteria of learning and growth, financial perspective and customer are the inputs of the criteria of financial perspective and internal process (Table 2).

In this model, Financial Outlook and Internal Process Criteria are the input for Learning and Growth; and the Customer, Financial and Internal Process Outlook Criteria are the output at the

Table 1: Ranking of indicators of medical professional ethics and the final list of indicators of medical professional ethics

Rank	Important indicators	Average	Standard deviation
1	Putting the patient's interests before the doctor's	6.272	1.09
2	Pay attention to the patient's wishes	6.202	1.122
3	Spend time and patience explaining information to the patient	6.108	1.156
4	Active search for feedback	5.898	1.223
5	Recognize your limitations and seek help from others in cases of insufficient knowledge and skills	5.532	1.241
6	Fair distribution of health care resources	5.204	1.609
7	Doctrine based on cost effectiveness	5.198	1.358
8	A critical attitude towards oneself and the ability to recognize areas of one's ability and knowledge	4.986	1.398
9	How to use per capita research costs	4.957	1.661
10	Correct and complete transfer of responsibility for patient care	4.934	1.458
11	Adaptation to changing circumstances	4.837	1.486
12	Observance of rules and regulations	4.696	1.691
13	Performing tasks and being available on call time (online)	4.543	1.603

Financial index	Perspective of growth and learning	Perspectives on internal processes	Customer and customer criteria
	L1: Active search for feedback		C1: Putting the patient's interests before the doctor's
		P1: Observance of rules and regulations	C2: Pay attention to the patient's wishes
F1: Fair distribution of health care resources	L2: A critical attitude towards oneself and the ability to recognize areas of one's ability and knowledge	P2: Performing tasks and being available on call time (online)	C3: Spend time and patience explaining information to the patient
F2: Doctrine based on cost effectiveness	L3: Recognize your limitations and seek help from others in cases of insufficient knowledge and skills		
	L4: Adaptation to changing circumstances	P3: Correct and complete transfer of responsibility for patient care	
F3: How to use per capita research costs			

Table 2: Average efficiency of medical professional ethics

Average overall performance	Average stage L	Average stage P	Average stage C	Average stage F
92.30%	84.73%	92.09%	100%	95.81%

customer stage, respectively. On the other hand, the criteria of the customer view are at the input and output. At the same time, therefore, it is possible to decipher what the customer attracts. Other relationships between the four perspectives of the BSC approach can be explained in the same way. The inputs and outputs of each step are shown in Table 1. In the present study, all inputs and outputs for each section of professional ethics are regulated in one of four aspects of BSC. In fact, the BSC structure was embedded in DEA models, resulting in a powerful measurement tool for practical applications.

DEA Models

As shown in Figure 2, the inputs and outputs of this situation were determined based a network structure. For example, P1, P2 and P3 are outputs of Internal Process stage, and at the same time, the internal process stage is input of education and growth stage. The other connections between four perspectives of balanced scorecard are shown in Figure 2. It is important to say that some inputs and outputs of this situation are qualitative indexes. However, we use a fuzzy approach to convert these qualitative indexes into quantitative indexes (33).

Now, let us assume that we have a set of DMUs (hospitals) consisting of DMUj, j=1,… n, for

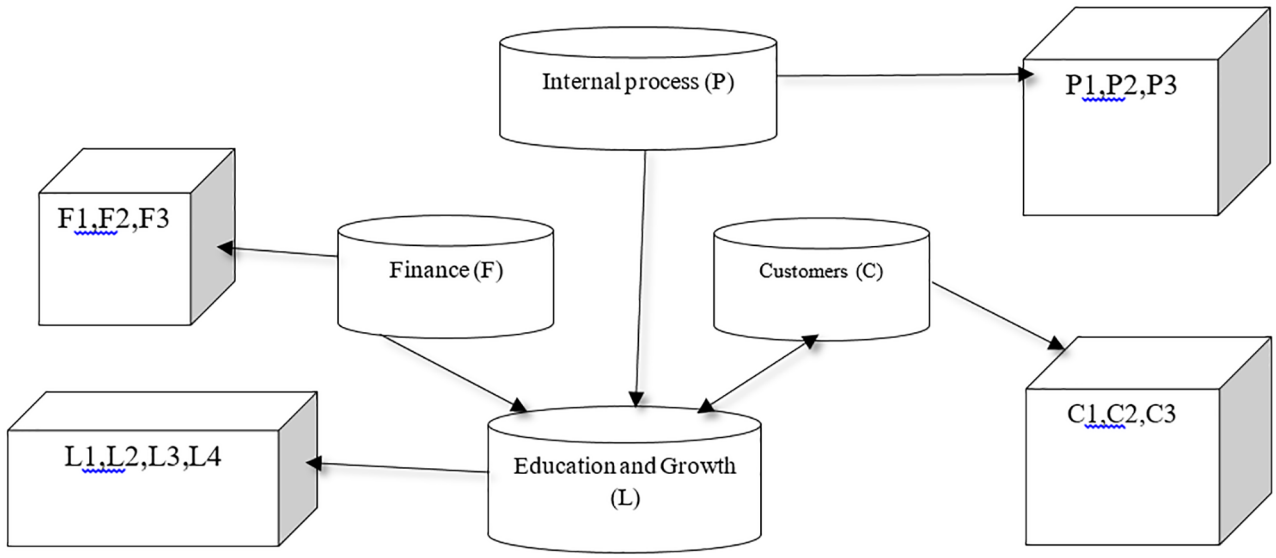

Figure 2: Networked evaluation structure

evaluating the performance of DMUj (34).

z_{rj}^{pq} is the r-th component (r=1… s_{pq}) of s_{pq} -dimensional for DMU_j flowing from stage p and entering to stage q.

u_r^{pq} is a multiplier for z_{rj}^{pq} when z_{rj}^{pq} is as the output of stage p.

v_r^{qp} is a multiplier for z_{rj}^{qp} when z_{rj}^{qp} is as the input of stage p.

Thus, the efficiency ratio for stage p from DMU_j is explained as:

$$\theta_{pj} = \frac{\sum_q \sum_r u_r^{pq} z_{rj}^{pq}}{\sum_q \sum_r v_r^{qp} z_{rj}^{qp}} \quad (1)$$

We define the overall efficiency of the network as a convex combination of P stage, so we have:

$$\theta_j = \sum_{j=1}^{p} w_p \theta_{pj} = 1 \text{ and } \sum_{j=1}^{p} w_p = 1 \quad (2)$$

It is evident that choosing weights (W_p) is very important for evaluating the performance of the network, so a suitable choice for w_p is the proportion of the input used at the p-th stage to the input used in the network (35)

$$w_p = \frac{\sum_q \sum_r u_r^{pq} z_{rj}^{pq}}{\sum_p \sum_q \sum_r v_r^{qp} z_{rj}^{qp}} \quad p=1,\ldots, k \quad (3)$$

Thus, the overall efficiency can be rewired as in the form:

$$\theta_j = \frac{\sum_p \sum_q \sum_r u_r^{pq} z_{rj}^{pq}}{\sum_p \sum_q \sum_r v_r^{qp} z_{rj}^{qp}} \quad j=1,\ldots, n \quad (4)$$

For computing the performance of DMU_0 in the best condition, we use the following model:

Max θ_0

s.t

$$\theta_j \leq 1 \quad \forall j \quad (5)$$

$$\theta_{pj} \leq 1 \quad \forall j \; \forall p$$

$$u_r^{pq} \geq 0, v_r^{qp} \geq 0 \forall r \; \forall p \; \forall q$$

It is evident that $\theta_j \leq 1$ is redundant constraint; therefore, we rewrite model (5) as follows:

Max θ_0

s.t

$$\theta_{pj} \leq 1 \quad \forall j \; \forall p \quad (6)$$

$$u_r^{pq} \geq 0, v_r^{qp} \geq 0 \forall r \; \forall p \; \forall q$$

By substituting (1) and (3) in model (6), we have the following model:

Max $\sum_p \sum_q \sum_r u_r^{pq} z_{ro}^{pq}$

S.t

$$\sum_p \sum_q \sum_r v_r^{qp} z_{ro}^{qp} = 1 \quad (7)$$

$$\sum_p \sum_q u_r^{pq} z_{rj}^{pq} - \sum_p \sum_q v_r^{qp} z_{rj}^{qp} \leq 0 \quad \forall j \; \forall p$$

$$u_r^{pq} \geq 0, v_r^{qp} \geq 0 \forall r \; \forall p \; \forall q$$

Theorem1: If DMU_0 is the unit under evaluation; then, there is an optimal solution, say (v^*, u^*). For each index like L we have:

$$\sum_p \sum_q \sum_r u^{*pq}_r z^{pq}_{rl} - \sum_p \sum_q \sum_r v^{*qp}_r z^{qp}_{rl} = 0$$

Proof: we write model (7) as follows:

Max $\sum_p \sum_q \sum_r u_r^{pq} z_{ro}^{pq}$

S.t

$$\sum_p \sum_q \sum_r v_r^{qp} z_{ro}^{qp} = 1 \quad (8)$$

$$\sum_p \sum_q \sum_r u_r^{pq} z_{rj}^{pq} - \sum_p \sum_q \sum_r v_r^{qp} z_{rj}^{qp} \leq 0 \forall j$$

$$u_r^{pq} \geq 0, v_r^{qp} \geq 0 \forall r \ \forall p \ \forall q$$

Maintaining the Confidentiality of Information

In accordance with ethical principles, all physicians and managers were informed and assured that the information provided was confidential and the findings were anonymous. The managers of the hospitals whose staff were the target of the data collection were informed of the data collection process. The names of the researchers, contact numbers and organizations, and the reason for collecting data are mentioned in the surveys. All respondents were aware that they were free to withdraw from the study at any time without pressure or fear, and their participation was voluntary. At the end, all hospital evaluations based on DMUs were numbered and titled and the hospital was not named directly.

Results

For evaluating the medical professional ethics in hospitals and medical centers, the treatment presented in this paper is a DEA network model. Therefore, in this performance, the total was calculated directly using this model. This network is a combination of BSC and DEA model based on the above productivity definition. In this paper, from the evaluation of DEA network model, the performance of 37 hospitals affiliated to Shiraz University of Medical Sciences was evaluated. The process that separates the four BSC perspectives is determination of the input and output to calculate performance, which is a significant step in performance evaluation. The purpose of the present study was to evaluate medical professional ethics consisting of four sets of inputs and outputs shown in the previous section, on the other hand, the criteria of medical professional ethics were determined using the experts' ideas, as shown in Table 1, Using the DEMATEL method, we determined the relationships between the four BSC perspectives. According to the DEA program literature in medical professional ethics, only the inputs and outputs that are common in the medical professional ethics literature are listed. Then, the most important performance indicators in medical professional ethics were selected based on the experts' views and ideas of the staff of the treatment department and hospitals. In fact, four sets of indicators were identified. Based on the model proposed in this paper, medical professional ethics can be divided into four stages based on the BSC approach. The first stage is learning and growth in which three categories (internal process, customer, and financial perspectives) are considered as input and one category (customer perspectives) as output. Hence, we activated the search for the feedback of the inputs, critical attitude and ability to identify areas of ability and knowledge, recognizing their limitations and seeking help from others in cases of lack of knowledge and skills, adaptation to changing conditions were selected. The next step was the internal process perspective, in which a category (customer perspective) was considered as input and a category (learning and growth perspective) as output. Inputs were selected to comply with the rules and regulations, to perform tasks and to be available on call (online) and transfer the responsibility of the patient care correctly and completely. The third step was the customer perspective. As shown in Figure 3, this stage has three categories (learning and growth, customer) and (financial outlook) as input and four categories (learning and growth, internal trend, customer and financial outlook) as the output. Hence, at this stage, the inputs are, on average, suggestions including active search for feedback, a critical attitude towards oneself and the ability to identify areas of competence and knowledge, recognizing one's limitations and seeking help from others in the absence of adequate knowledge and skills, adaptability to changing circumstances, and equitable distribution of healthcare and medical resources on a cost-effective basis; finally, the outputs of this stage were, on average, suggestions for prioritizing the patient over the patient, paying attention to the patient's wishes, spending time and patience explaining information to the patient, actively seeking feedback, recognizing one's limitations, and seeking help. Others in cases

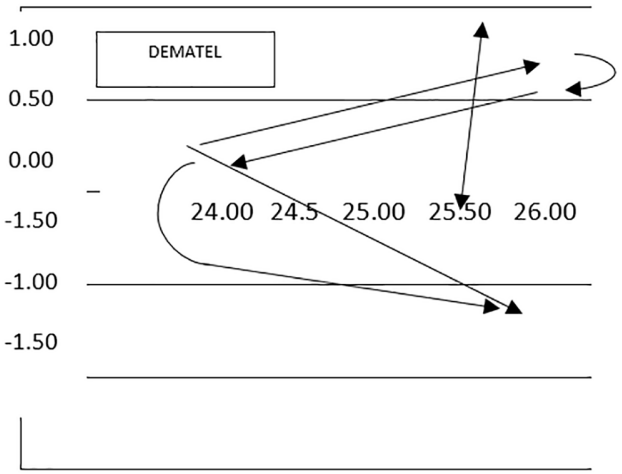

Figure 3: Total relation matrix with (Di + Ri) and (Di -Ri)

of insufficient knowledge and skills, equitable distribution of health care resources, cost-based medicine, critical attitude towards self and ability to identify areas of competence and knowledge, the way to use per capita research costs, correct and complete transfer of care responsibilities from the patient, adapting to changing conditions, following the rules and regulations, performing tasks, and being available at the time of call (online). Finally, the last stage was the financial stage in which one category (customer perspective) was considered as input and two categories (learning and growth and customer perspective) as output. Therefore, the inputs of this stage were to prioritize the patient's interests over theirs, pay attention to the patient's wishes, spend time and patience explaining the information to the patient; the outputs at this stage were to prioritize the patient's interests over their own. Paying attention to the patient's wishes, spending time and patience explaining information to the patient, actively seeking feedback, being critical of oneself and being able to identify the areas of one's ability and knowledge, recognizing one's limitations, and seeking help from others in the absence of adequate knowledge and

Table 3: Total relation matrix with (Di + Ri) and (Di-Ri)

X direct relationship matrix between views	1	Finance (F)	Customers (C)	Education and Growth (L)	Internal process (P)
Finance (F)		0.0000	2.8889	3.1111	3.2222
Customers (C)		2.7222	0.0000	2.9444	2.8889
Education and Growth (L)		2.7222	2.4444	0.0000	3.4444
Internal process (P)		2.7778	2.8889	3.2778	0.0000
The direct relationship of the X matrix between views	**2**				
Finance (F)		0.0000	2.8889	3.1111	0.3494
Customers (C)		0.2952	0.0000	2.9444	0.3133
Education and Growth (L)		0.2952	2.4444	0.0000	0.3735
Internal process (P)		0.3012	2.8889	3.2778	0.0000
T matrix with total relation	3				
Finance (F)		5.3570	5.5892	6.1580	6.2722
Customers (C)		5.2850	5.0510	5.8169	5.9150
Education and Growth (L)		5.3170	5.2936	5.6109	5.9854
Internal process (P)		5.4602	5.4606	6.0267	5.8696
Ri		21.4192	21.3944	23.6125	24.0422

Table 4: Results of medical professional ethics evaluation in Shiraz hospitals

DUMs	Overall performance	Step L	Step P	Step C	Step F	DUMs	Overall performance	Step L	Step P	Step C	Step F
DUM(1)	100%	1	1	1	1	DUM(20)	98/6%	0.8	0.73	1	1
DUM(2)	92/9%	0.73	1	1	1	DUM(21)	100%	1	0.97	1	1
DUM(3)	100%	1	1	1	0.99	DUM(22)	100%	1	1	1	1
DUM(4)	%91/5	0.71	0.92	1	0.93	DUM(23)	100%	1	1	1	1
DUM(5)	100%	1	1	1	1	DUM(24)	100%	1	1	1	1
DUM(6)	58/4%	0.11	1	1	1	DUM(25)	100%	1	1	1	1
DUM(7)	67/1%	0.14	1	1	1	DUM(26)	100%	1	1	1	.75
DUM(8)	100%	1	1	1	1	DUM(27)	100%	1	1	1	1
DUM(9)	95/1%	0.95	1	1	1	DUM(28)	100%	1	1	1	1
DUM(10)	98/4%	1	0.98	1	1	DUM(29)	100%	1	1	1	1
DUM(11)	98/4%	0.31	1	1	1	DUM(30)	100%	1	1	1	1
DUM(12)	100%	1	1	1	1	DUM(31)	100%	1	1	1	1
DUM(13)	92/6%	1	0.96	1	0.86	DUM(32)	100%	1	1	1	1
DUM(14)	85/1%	1	0.71	1	0.85	DUM(33)	100%	1	1	1	1
DUM(15)	88/8%	1	0.71	1	1	DUM(34)	100%	.70	1	1	1
DUM(16)	94%	0.89	0.91	1	0.9	DUM(35)	100%	1	1	1	1
DUM(17)	100%	1	1	1	1	DUM(36)	100%	1	1	1	1
DUM(18)	87/2%	1	0.68	1	0.69	DUM(37)	100%	1	1	1	1
DUM(19)	86/3%	1	0.7	1	0.86						

skills, and adaptability were considered. In this study, input and output data for September 2020 were used (Tables 3 and 4).

4. Discussion

Performance is no longer just a financial issue. Traditional performance management ignores non-financial factors and does not seem to understand how to calculate comprehensive performance to meet the needs of hospital management. At that point, financial indicators can only reflect the past performance of the hospital and do not reflect the services delivered by the hospital. This is usually followed by performance management, highlighting traditional assets and overcoming intangible ones. Hospital fixed assets are important, but the other part is a knowledge organization and its financial knowledge, intellectual resources, and other intangible assets (15). For the application of performance measurement, it is necessary that the tangible and intangible goals of organizations be defined in a way that is appropriate to the needs and goals (16). In general, the efficiency of medical professional ethics, which is usually managed as a series of functions, is measured by considering its overall efficiency in the system. Basically, organizational performance is to perform tangible and intangible plans and goals. These programs are financial and non-financial. Therefore, we combined medical professional ethics with four BSC perspectives and then used the fuzzy method to rank the performance of hospitals according to the main research problem. This idea is a new concept in evaluating the performance of the organization. General performance of hospitals (DMU) No. 1, 3, 5, 8, 12, 13, 17, 21,22,23,24,25,27,28,29,30,31,32,33,35,36, 37 was obtained 100%; hospital 2 92.9%; hospital 4 91.5%; hospital 6 58.4%; 7 hosptials 67.1%; 9 hospitals 95.1%; , we obtained 98.4% for hospital 10 98.4% for hospital 11, 85.1% for hospital 14, 88.8% for hospital 15, 94% for hospital 16, 87.2% for hospital 18, 86.3% for hospital 19, and 6.98% for hospital 20. Therefore, according to the efficiency score, we can say that hospitals 1, 3, 5, 8, 12, 13, 17, 21,22,23,24,25,27,28,29,30,31,32,33,35, 36 and 37 received acceptable scores for efficiency, and the other hospitals did not receive acceptable scores in and terms of medical professional ethics.

Based on the inputs of the bsc model, which are the average of professional ethics, the results showed that in most hospital centers, aspects of education and growth are less considered. Then, there areinternal processes that involve the lower average. Many factors may be involved in these cases, such as the type of hospital management, number of staff, whether it is private or public, and so on..

Agreements and Disputes

According to the obtained results, all hospitals observed professional ethics in 4 aspects of the bsc model, and there was a significant difference between them. Of course, as mentioned, different factors are involved in this difference, so this issue can be discussed in future research.

Strengths and Limitations

One of the strengths of this research is that it is new in terms of paying attention to the non-financial issues of hospital management and complex fuzzy modeling. Also, the limited access to physicians working in hospitals and the coincidence with the corona pandemic and the involvement of hospital wards with this issue were some of the limitations of this study.

Conclusion

As the findings show, in the proposed fuzzy model of evaluating the performance of Shiraz hospitals, the efficiency score of stage L is less than other stages, and all hospitals are efficient in stage C. This shows that managers have less emphasis on learning and growth and only pay attention to customers. This indicates the relatively poor performance of managers. This stage is considered as an alarm for these hospitals. There is no doubt that learning and growing are important factors in the stability of the system; the lack of sensitivity of managers in this issue in the long run causes the system to run with difficulty. Unfortunately, poor performance in learning and growth prospects leads to reduced productivity in the later stages, which can be solved by holding a workshop for employees. The main focus of the present study was to evaluate the medical professional ethics, but based on the ideas presented in this article, a proposed model for ranking the efficient supply of health care can be presented to identify its effectiveness. The present study measured professional ethics with respect to the nature of the variable, which is qualitative, and evaluated it. The mentioned model can be an important and new step in evaluating medical centers from different qualitative aspects and ultimately causes better performance and output and efficiency of the treatment complex.

Acknowledgment

The authors thank all the doctors and managers of the studied hospitals in Shiraz.

Ethical Consideration

Compliance with ethical guidelines

All ethical principles were considered in this article.

The present study was approved by the ethics committee of Azad University, Shiraz Branch (Code: IR.IAU.SHIRAZ.REC.1400.022).

Funding

This study was extracted from the PhD. dissertation of the first author in cultural management and planning, Economics and Management Faculty, Shiraz Branch, Islamic Azad University, Shiraz, Iran.

Authors' Contribution

All authors equally contributed to preparing this article.

Conflict of Interest: None declared.

References

1. Zhang Y, Li L, editors. Study on balanced scorecard of commercial bank in performance management system. 22-24 May 2009. China: Proceedings The 2009 International Symposium on Web Information Systems and Applications (WISA 2009); 2009.
2. Sun C-C. A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods. *Expert systems with applications*. 2010;37(12):7745-54. doi: 10.1016/j.eswa.2010.04.066.
3. Ghalayini AM, Noble JS. The changing basis of performance measurement. *International Journal of Operations and Production Management*. 1996;16(8):63-80. doi: 10.1108/01443579610125787.
4. Neely A, Bourne M. Why measurement initiatives fall. *Measuring Business Excellence*. 2000;4(4):3-7. doi: 10.1108/13683040010362283.
5. Creamer G, Freund Y. Learning a board Balanced Scorecard to improve corporate performance. *Decision Support Systems*. 2010;49(4):365-85. doi: 10.1016/j.dss.2010.04.004.
6. Kraus K, Lind J. The impact of the corporate balanced scorecard on corporate control—A research note. *Management Accounting Research*. 2010;21(4):265-77. doi: 10.1016/j.mar.2010.08.001.
7. Huang H-C. Designing a knowledge-based system for strategic planning: A balanced scorecard perspective. *Expert Systems with Applications*. 2009;36(1):209-18. doi: 10.1016/j.eswa.2007.09.046.
8. Kaplan RS, Norton DP. Using the balanced scorecard as a strategic management system. Boston: Harvard business review; 1996.
9. Fontela E, Gabus A. Current Perceptions of the World Problematique. In: A Dialogue C.W. Churchman and R.O. Mason, editors. World Modelling. Amsterdam: Oxford, North-Holland Publishing Company. 1976.
10. Tamura H, Akazawa K. Stochastic DEMATEL for structural modeling of a complex problematique for realizing safe, secure and reliable society. *Journal of Telecommunications and Information Technology*. 2005:139-46. doi: 10.9746/sicetr1965.41.358.
11. Banker RD, Charnes A, Cooper WW. Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*. 1984;30(9):1078-92. doi: 10.1287/mnsc.30.9.1078.
12. Lotfi FH, Navabakhs M, Tehranian A, Rostamy-Malkhalifeh M, Shahverdi R. Ranking bank branches with interval data the application of DEA. *International Mathematical Forum*. 2007;2(9):429-40. doi: 10.12988/imf.2007.07039.
13. Barzegarinegad A, Jahanshahloo G, Rostamy-Malkhalifeh M. A full ranking for decision making units using ideal and anti-ideal points in DEA. *ScientificWorldJournal*. 2014;2014:282939. doi: 10.1155/2014/282939.
14. Soleimani-Damaneh M. Fuzzy upper bounds and their applications. *Chaos, Solitons & Fractals*. 2008;36(2):217-25. doi: 10.1016/j.chaos.2006.06.042.
15. Medori D, Steeple D. A framework for auditing and enhancing performance measurement systems. *International Journal of Operations & Production Management*. 2000;20(5):520-33. doi: 10.1108/01443570010318896.
16. UW Medicine [Internet]. Ethics in Medicine. University of Washington, School of Medicine. c1998. Available from: https://depts.washington.edu/bhdept/ethics-medicine
17. Savulescu J, Rhodes R, Francis LP, Silvers A. The blackwell guide to medical ethics. New Jersey: Wiley-Blackwell; 2007.
18. Lovett LM, Seedhouse D. An innovation in teaching ethics to medical students. *Med Educ*. 1990;24(1):37-41. doi: 10.1111/j.1365-2923.1990.tb02435.x.
19. Schneider GW, Snell L. C.A.R.E.: an approach for teaching ethics in medicine. *Soc Sci Med*. 2000;51(10):1563-7. doi: 10.1016/s0277-9536(00)00054-x. doi: 10.1016/S0277-9536(00)00054-X.
20. Charon R, Fox RC. Critiques and remedies: medical students call for change in ethics teaching. *JAMA*. 1995;274(9):767, 71. doi: 10.1001/jama.274.9.767.

21. Martinez SA. Reforming medical ethics education. *J Law Med Ethics*. 2002;30(3):452-4. doi: 10.1111/j.1748-720x.2002.tb00415.x.
22. Huijer M, van Leeuwen E, Boenink A, Kimsma G. Medical students' cases as an empirical basis for teaching clinical ethics. *Acad Med*. 2000;75(8):834-9. doi: 10.1097/00001888-200008000-00017.
23. Asai A, Kishino M, Fukui T, Masano T. Postgraduate education in medical ethics in Japan. *Med Educ*. 1998;32(1):100-4. doi: 10.1046/j.1365-2923.1998.00171.x.
24. Miles SH, Lane LW, Bickel J, Walker RM, Cassel CK. Medical ethics education: coming of age. *Acad Med*. 1989;64(12):705-14. doi: 10.1097/00001888-198912000-00004.
25. Fox E, Arnold RM, Brody B. Medical ethics education: past, present, and future. *Acad Med*. 1995;70(9):761-9.
26. Singer PA. Recent advances. Medical ethics. *BMJ*. 2000;321(7256):282-5. doi: 10.1136/bmj.321.7256.282.
27. Tysinger JW, Klonis LK, Sadler JZ, Wagner JM. Teaching ethics using small-group, problem-based learning. *J Med Ethics*. 1997;23(5):315-8. doi: 10.1136/jme.23.5.315.
28. Self DJ, Olivarez M, Baldwin DC, Jr. The amount of small-group case-study discussion needed to improve moral reasoning skills of medical students. *Acad Med*. 1998;73(5):521-3. doi: 10.1097/00001888-199805000-00019.
29. Wood DF. Problem based learning. *BMJ*. 2003;326(7384):328-30. doi: 10.1136/bmj.326.7384.328.
30. Jones AH. Narrative based medicine: narrative in medical ethics. *BMJ*. 1999;318(7178):253-6. doi: 10.1136/bmj.318.7178.253.
31. Carson AM. That's another story: narrative methods and ethical practice. *J Med Ethics*. 2001;27(3):198-202. doi: 10.1136/jme.27.3.198.
32. Dibbern DA, Jr., Wold E. Workshop-based learning: a model for teaching ethics. *JAMA*. 1995;274(9):770-1. doi: 10.1001/jama.274.9.770.
33. Shafiee M, Saleh H. Evaluation of Strategic Performance with Fuzzy Data Envelopment Analysis. *International Journal of Data Envelopment Analysis*. 2019;7(4):1-20.
34. Shafiee M, Lotfi FH, Saleh H. Supply chain performance evaluation with data envelopment analysis and balanced scorecard approach. *Applied mathematical modelling*. 2014;38(21-22):5092-112. doi; 10.1016/j.apm.2014.03.023.
35. Cook WD, Hababou M, Tuenter HJ. Multicomponent efficiency measurement and shared inputs in data envelopment analysis: an application to sales and service performance in bank branches. *Journal of productivity Analysis*. 2000;14(3):209-24. doi: 10.1023/A:1026598803764.