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INVESTIGATING FUZZY TOPSIS TECHNIQUE IN EVALUATING THE PERFORMANCE OF EDUCATIONAL AND NON-EDUCATIONAL HOSPITALS OF QOM PROVINCE BY DEA TECHNIQUE

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Abstract: *Hospitals, as one of the main organizations providing health services and for the critical role that they play in society health, it is necessary for them to be assessed and evaluated according to their performance more than the other organizations. Hence, this research has been conducted to Investigate fuzzy TOPSIS technique in evaluating the performance of educational and non-educational hospitals of Qom province by DEA technique which is applied descriptive from the point of its goal and enjoys field data collection method.*

The participants of this research were 190 nurses, physicians and staff of 10 hospitals of Qom province which have been selected by available non-probabilistic method and were accounted as the statistic sample of the present study. For analyzing the collected data six step algorithm of fuzzy Topsis for investigating the suitable indexes as inputs and outputs of the DEA technique, have been investigated. The results of investigating fuzzy technique for input data shows that the highest rank belongs to two indexes of Types of expertise in hospital and the number of beds in hospitals and for output variables, the highest rank belong to the full time bed and the bed turnover interval. DEA output have assessed the performance of five hospitals of Shahid Beheshti, Kamakar, Nekooi, Hazrate Masume and Hazrate Zahra to other hospitals more efficient and the other five hospitals of Ayyatollah Golpayegani, Imam Reza, Valieasr and Aliebne Abi Taleb have been accounted as less efficient.

Keywords: *Performance Assessment, DEA, Fuzzy Topsis, Hospitals of Qom Province*

1. INTRODUCTION

One of the prominent features of pioneer organizations, private or public, is the successful appliance of their performance assessment for gaining a correct Insight and judgment about the effectiveness and efficiency of their programs, processes and staff. In this regard, assessing the organizations' performance is one of those

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topics that is of utmost favorite and attention to the managers and researchers and up to now, there have been lots of articles about it. There is a direct relationship between existence and not existence of Effective performance appraisal system and life and death of the organization. (Salehzade & Ketabi, 2011) One of the significant problems in developing countries is the resources required for health sector. This is because of the fact that more than 5 % of national gross production and 5 to 10 percent of government's costs are dedicated to this part. (Werdes Vers and et al, 2005) hence, To increase the efficiency and effectiveness of resource allocation and improve service quality, controlling the costs and assigning appropriate policies, will be important. Hospitals, as one of the main organizations providing health services and for the critical role that they play in society health, it is necessary for them to be assessed and evaluated according to their performance more than the other organizations (Massii, 2007) since the quality of providing services in each system (Healthcare, industrial and etc.) is dependent to the efficiency of provided services and management of that system. The effectiveness of Health Management Services is an issue which has been the interest of Government officials in various countries from long ago. As providing healthcare services is a very complicated process, Proving its efficiency and effectiveness of it is a very complicated process and needs an exact process of assessment. (1: 2003) with regard to the importance of the topic, there are various methods for assessing the performance and the efficiency of the organizations. With regard to this fact that in most of the cases, there is no specific standard for assessing the hospitals performance in Iran. One of the effective tools in this regard is DEA. By this method, Units of a predetermined standard level will not be compared together and the efficiency of the units is assessed by being compared to the performance of other units. (Salehzade & Ketabi, 2011) In order to choose the best variant of the DEA technique, TOPSIS is a multi-criteria decision-making method which ranks m options with n standards. Basis of this method is choosing the option which has Minimum distance from the favorable answer and farthest distance from the unfavorable reply. In this regard, present study has been conducted for investigating fuzzy TOPSIS technique in evaluating the performance of educational and non-educational hospitals of Qom province by DEA technique.

2. THEORETICAL FRAMEWORK AND RESEARCH HISTORY

2.1 Evaluation Performance[1]

Evaluation performance is called to the Comprehensive performance assessment process and in the form of expressions like : Efficiency, effectiveness, empowerment, accountability capabilities in a rational framework, concepts for achieving goals,

1. Evaluation Performance

Organizational responsibilities, structural, long-term development program and evaluate the organization's performance. In the other words, evaluating performance means that manager compares all the consumed facilities of spiritual and materialistic with the efficiency of the operation according to the accepted standards to get clear that whether the quantitative and qualitative goals are met or not. (Sohrabi & Khan Mohammadi, 2007:6)

2.2 Balance Score Card[2]

Balance Score Card is one of the new methods for evaluating the efficiency of organizations and a multi-criteria approach to decision-making and assessing the company's performance. Balance Score Card A mathematical programming model to evaluate the efficiency of DMUs which have so many inputs and so many outputs. (Mehregan, 2011)

2.3 TOPSIS Techniques

This method in 1981, was presented by Hwang & Yoon[3]. The m option by n indices are evaluated and any problems can be as a geometric system[4] includes the m points in an n-dimensional space considered. This technique is based on the notion that selection option should be the minimum distance from the positive ideal solution (The best possible state A^+ i) and most distance with the negative ideal solution (the worst possible state A^+ i). It is assumed that the utility of any index, uniformly increasing or decreasing. Solve a problem by Topsis, including 6 steps that have been identified as follows:

1. Step One: normalizing the decision matrix
2. Step two: making the weighted matrix from the matrix normalized
3. Step Three: identify the positive and negative ideals
4. Step Four: Determine the Euclidean distance of each option
5. Step Five: Calculation of the relative closeness ratio of the options to the ideal solution
6. Step six: Ranking Options (Asgharpour, 2011).

3. METHODOLOGY

Since this study was to examine the functioning of fuzzy TOPSIS technique in evaluating the performance of educational hospitals and non-educational of Qom

2. Balance Score Card
3. Hwang & Yoon
4. Geometric System

with using the DEA technique, study is descriptive based on purpose is application and to collect data used the questionnaire so this research may also contract as fieldwork.

3.1 Statistics Population and Sampling Method

The statistics population consisted of all nurses, doctors and administrative staff working in the 10 hospitals of Qom and the number is 5084 people and as in this study, uses available on possible method (such as nurses, doctors and support staff) have been studied as sample 190 staff members.

3.2 Measuring Instruments and Statistical Techniques

In this research, with the aim of selecting the best inputs variable (inputs) and output variables (outputs) and achieve the weight rate and importance of each of them used fuzzy TOPSIS techniques. So, the first between the 5 selected option as input variable through the study of research literature (ie: number of Nursing department, the number of doctors (general, specialist, specialty), the number of non-management staff (administration and services), type of Specialties in hospital and the number of beds active) two case of the most important ones, which ranked first and second were evaluated with the fuzzy TOPSIS techniques, as the most important input variables to evaluate hospital performance enter the data covering analysis technique sent and this procedure for 9 option is selected as the output variable (ie occupancy rate of hospital active beds, rotating beds, total day beds, average length of patients stay in hospitals, direct admission, direct registration, admission ratio to beds, the number of clinical acceptance, the number of deaths in 1000) is also implemented.

In this study, based on the data collected was developed questionnaire and placed in the hands of experts. These people, according to the amount of each indicator in every hospital one of the 5 options (very low, low, medium, high and very high) were scored from 1 to 5 (on a five-point Likert interval scale) and finally using data covering analysis method evaluated.

3.3 Validity and Reliability of Research

Since in this study (according to the specific nature of the questionnaire, data covering analysis) was used researcher questionnaire, the validity of its content have been approved by professors and experts and in order to determine the reliability of the test was used Cronbach's alpha. For this purpose, at first a primary sample contains 30 pre-tested questionnaire and then use the archived data reliability coefficient rate with Cronbach's alpha method for the results of the questionnaire and SPSS statistical software for the questionnaire calculate 87%.

4. FINDINGS

Demographic information of this research is as below.

Table 1
Statistics population demographic information

Contributors gender	*10.0% male and 90.0% woman*
Education	7.4% Diploma, 60.5 % license, 3.5% master percent, 16.8% Ph.D.
Job experience	27.9 % less than 10 years, 48.9% 10 to 20 years, 17.9 % 20 to 30 years, 5.3% over 30 years
Post	23.2 % 20 to 30 years, 47.9% 30 to 40 years, 18.9% 40 to 50 years, 10.0% over 50 years

4.1 Analytical Findings

4.1.1 Fuzzy TOPSIS technique

Results are as follows the six-step algorithm of TOPSIS.

The first step: create a decision matrix

In this study, 5 input index (input) and 9 Output Index (output) as the options and the whole 5-point Likert as criteria were evaluated which the decision matrix are as followed table 2 and 3. It should be noted that, before enter the data in the TOPSIS solver software make fuzzy the data.

Table 2
Create decision matrix of inputs

Matrix	*Very high*	*High*	*Medium*	*Low*	*Very low*
The nurses number of nursing group	62	108	20	0	0
Number of doctors	67	110	13	0	0
The number of non-medical staff	44	109	33	4	0
A variety of available specialties	55	105	15	11	4
Number of active beds	24	106	44	13	3
Type of criteria	Positive	Positive	Positive	Positive	Positive
Criteria weight	5	4	3	2	1

Table 3
Create a decision outcomes matrix

Matrix	*Very high*	*High*	*Medium*	*Low*	*Very low*
Employment rate of active beds	67	119	4	0	0
Rotating bed	38	85	44	19	4
Total day bed	36	81	46	21	6
Average length of stay	40	89	34	22	5
Direct admission	59	111	13	4	3
Direct clearance	48	108	20	8	6
Acceptance rate	49	103	23	13	2
The number of admissions	51	101	24	11	3
The number of feet	35	97	44	12	2
Type of criteria	positive	positive	positive	positive	positive
Criteria weight	5	4	3	2	1

Step Two: normalization or without scaling matrix

Table 4
Normalization or without scaling the inputs matrix

Without scaling matrix	*Very high*	*High*	*Medium*	*Low*	*Very low*
The nurses number of nursing group	0.526446	0.448809	0.323635	0	0
Number of doctors	0.568901	0.457121	0.210363	0	0
The number of non-medical staff	0.373607	0.452965	0.533997	0.228665	0
A variety of available specialties	0.467008	0.436343	0.242726	0.628828	0.8
Number of active beds	0.203785	0.440498	0.711996	0.743161	0.6

Table 5
Normalization or without scaling the outputs matrix

Without scaling matrix	*Very high*	*High*	*Medium*	*Low*	*Very low*
Employment rate of active beds	0.464104	0.396508	0.042558	0	0
Rotating bed	0.263223	0.28322	0.468138	0.447834	0.339276
Total day bed	0.249369	0.269892	0.489417	0.494975	0.508913
Average length of stay	0.277077	0.296548	0.361743	0.518545	0.424094
Direct admission	0.408689	0.369852	0.138314	0.094281	0.254457
Direct clearance	0.332493	0.359856	0.21279	0.188562	0.508913
Acceptance rate	0.33942	0.343196	0.244709	0.306413	0.169638
The number of admissions	0.353273	0.336532	0.255348	0.259272	0.254457
The number of feet	0.242443	0.323204	0.468138	0.282843	0.169638

Step Three: weighted normalized matrix

Table 6
Weighted to the inputs normalized matrix

Weight matrix	*Very high*	*High*	*Medium*	*Low*	*Very low*
The nurses number of nursing group	2.632228	1.795238	0.970904	0	0
Number of doctors	2.844504	1.828483	0.631088	0	0
The number of non-medical staff	1.868033	1.81186	1.601992	0.45733	0
A variety of available specialties	2.335041	1.74537	0.728178	1.257656	0.8
Number of active beds	1.018927	1.761993	2.135989	1.486321	0.6

Table 7
Weighted to the outputs normalized matrix

Weight matrix	*Very high*	*High*	*Medium*	*Low*	*Very low*
Employment rate of active beds	2.320521	1.586032	0.127674	0	0
Rotating bed	1.316116	1.13288	1.404414	0.895669	0.339276
Total day bed	1.246847	1.079568	1.468251	0.989949	0.508913
Average length of stay	1.385386	1.186192	1.085229	1.03709	0.424094
Direct admission	2.043444	1.479408	0.414941	0.188562	0.254457
Direct clearance	1.662463	1.439424	0.63837	0.377124	0.508913
Acceptance rate	1.697098	1.372784	0.734126	0.612826	0.169638
The number of admissions	1.766367	1.346128	0.766044	0.518545	0.254457
The number of feet	1.212213	1.292816	1.404414	0.565685	0.169638

Step Four: Determine the positive ideal solution and negative ideal

Table 8
Determine the positive ideal solution and negative ideal of inputs

Optimal solution	*Very high*	*High*	*Medium*	*Low*	*Very low*
+	2.844504	1.828483	2.135989	1.486321	0.8
–	1.018927	1.74537	0.631088	0	0

Table 9
Determine the positive ideal solution and negative ideal of outputs

Optimal solution	*Very high*	*High*	*Medium*	*Low*	*Very low*
+	2.320521	1.586032	1.468251	1.03709	0.508913
–	1.212213	1.079568	0.127674	0	0

Step Five: Determine the distance from the positive ideal solution and negative ideal

Table 10
Determine the distance from the positive ideal solution and negative ideal of inputs

Distance	+	–
The nurses number of nursing group	2.062217	1.649455
Number of doctors	2.261389	1.827468
The number of non-medical staff	1.713987	1.370112
A variety of available specialties	1.5168	1.990799
Number of active beds	1.837703	2.198671

Table 11
Determine the distance from the positive ideal solution and negative ideal of outputs

Distance	+	–
Employment rate of active beds	1.76966	1.218546
Rotating bed	1.125623	1.600323
Total day bed	1.188067	1.742797
Average length of stay	1.090069	1.487844
Direct admission	1.40796	1.016683
Direct clearance	1.2565	0.99712
Acceptance rate	1.126135	1.045565
The number of admissions	1.0915	1.057967
The number of feet	1.286751	1.422785

Sixth step: Calculate the close to the positive and negative ideal solution also ranking options

Table 12
Calculate the close to the positive and negative ideal solution also ranking options of inputs

Result	*Nearly coefficient*	*Rank Acquired*
A variety of available specialties	0.567568	1
Number of active beds	0.544714	2
Number of doctors	0.446939	3
The nurses number of nursing group	0.444397	4
The number of non-medical staff	0.44425	5

Table 13
Calculate the close to the positive and negative ideal solution also ranking options of outputs

Result	*Nearly coefficient*	*Rank Acquired*
Total day bed	0.594636	1
Rotating bed	0.587071	2
Average length of stay	0.577151	3
The number of feet	0.525103	4
The number of admissions	0.4922	5
Acceptance rate	0.48145	6
Direct clearance	0.442452	7
Direct admission	0.419312	8
Employment rate of active beds	0.407785	9

4.1.1 Data envelopment analysis technique

The first step: the introduction of decision-making units

In the data envelopment analysis techniques study units called as decision-making units and displayed with the DMU. In this study, 10 hospitals in Qom province are as the 14 unit decision makers.

Table 14
Introduction of decision-making units

Decision-making units	*Name of hospital*
DMU1	Ayatollah Golpayegani
DMU2	Imam Reza (AS)
DMU3	Vali asar (as)
DMU4	Ali ibn Abi Talib (AS)
DMU5	Shahid Beheshti
DMU6	Kamkar
DMU7	Nekoee
DMU8	Hazrat Massomeh (AS)
DMU9	Hazrat Zahra (SA)
DMU10	Izadi

It should be noted that, according to the hospital with sufficient documented information have been studied by the Census methods.

Step two: Descriptive evaluate of input factor

In this section to provide research collection descriptive data, in relation to input factors (input variables of research) that includes a variety of specialties in the hospital and the number of active beds in the hospital, has been paid.

Table 15
Descriptive evaluate of input factor

Decision-making units	*Name of hospital*	*Input variable 1*	*Input variable 2*
		variety of specialties in the hospital	*Number of active beds in the hospital*
DMU1	Ayatollah Golpayegani	19	152
DMU2	Imam Reza (AS)	17	102
DMU3	Vali asar (as)	13	158

DMU4	Ali ibn Abi Talib (AS)	14	67
DMU5	Shahid Beheshti	25	384
DMU6	Kamkar	21	215
DMU7	Nekoee	14	118
DMU8	Hazrat Massomeh (AS)	14	174
DMU9	Hazrat Zahra (SA)	9	77
DMU10	Name of hospital	10	78

Step Three: Descriptive evaluate of output factor

In this section, to provide research collection descriptive data, in relation to output factors (output variables of research) that includes the total day bed and the rotating bed investigated.

Table 16
Descriptive evaluate of output factor

Decision-making units	*Name of hospital*	*Input variable 1*	*Input variable 2*
		total day bed	*rotating bed*
DMU1	Ayatollah Golpayegani	11250	0.07
DMU2	Imam Reza (AS)	6750	0.04
DMU3	Vali asar (as)	13779	0.04
DMU4	Ali ibn Abi Talib (AS)	6000	0.02
DMU5	Shahid Beheshti	30120	0.08
DMU6	Kamkar	19290	0.08
DMU7	Nekoee	10680	0.04
DMU8	Hazrat Massomeh (AS)	15660	0.04
DMU9	Hazrat Zahra (SA)	2310	0.07
DMU10	Name of hospital	7020	0.02

Step Four: evaluating the performance of hospitals in Qom province

According to what was observed, studied hospital performance rating is below. It should be noted that, in this study CCR oriented input method has been used.

Table 17
Performance rating of hospitals in Qom province

	Efficiency	Graph	✓
DMU1	95.5 %	96%	
DMU2	83.7 %	84%	
DMU3	98.4 %	98%	
DMU4	98.9 %	99%	
DMU5	100 %	100%	✓
DMU6	100 %	100%	✓
DMU7	100 %	100%	✓
DMU8	100 %	100%	✓
DMU9	100 %	100%	✓
DMU10	99.4 %	99%	

1

✓ : Efficients
* : Weak Efficients

6. CONCLUSIONS AND RECOMMENDATIONS

In this study, the function of fuzzy TOPSIS technique in evaluating the performance of educational hospitals and non-educational of Qom province using the technique of DEA has been studied and in the identify step of input variables and the output and determine the weight and importance it close coefficients to be observed between the most important and least important of criteria which this values for the input variables, (a variety of specialties in the hospital, "0.56" and, number of active beds in the hospital, "0.54") and for output variables (total day bed "0.59" and rotating bed "0:58") that firstly, represents the right choice of variables being questioned from statistics population which totally favorable view to the importance of the variables involved and the secondly represents multi-attribute reflects of the performance evaluation in hospitals due to the nature of their work, because the hospital provides a wide range of activities in the fall and at view of one dimension to their performance will not follow

consequences result. Choose two variables (a variety of specialties in the hospital, number of active beds in the hospital) as an input to evaluate the performance and efficiency of hospitals suggests that in view of the studied population if the number of specializations that services related to them in a hospital provide for patients is more and at the same time appropriate active beds with demand would have existed, leads to all patients welcome of that hospital and led to the growth of their performance (through evaluate the two index" total day bed" and "rotating bed ") will be. Obviously, hospitals that have the best-performing efficient use of two input variables considered as organizational sources have shown to have higher performance. For example, Imam Reza Hospital (which in this research has been the weakest performance) despite offering 17 kinds of specialized services, there are only 102 active bed or likely to be used and this despite the fact that, Beheshti Hospital (which in this study is one of the efficient hospital) despite offering 25 kinds of specialized services, (less than twice) have 384 active beds, (ie, more than 3 times) even Kamkar hospital (one of the other hospitals that assessment efficient) despite less expertise, "14 specialties" more active beds number (118) is capable to Imam Reza Hospital. Because of this research used the returns method to the oriented input fixed scale, the reason of efficiency and inefficiency in hospitals should know in the absence of efficient use from inputs (organizational resources) and Search out its incompatibility with together. Although the review output is the expression of the results, because the efficient hospitals with optimal use of its resources have the best performance in two output variables are also accounted. It should be noted that, despite the mentioned content, the results of the data covering analysis technique show performance relatively close to the hospitals than to each other that suggests relatively good performance of hospitals in the province, although it is important to note that data covering analysis shows only the efficiency of decision-making units with respect to each other, indicate the efficiency of these units is not absolute. This means that, by changing the inputs and outputs can be observed different results, which need to be further analysis. In line with the results of the research, the following is recommended.

- To hospitals (including hospitals, Ali ibn Abi Talib (AS), Vali asr (as) and Imam Reza (AS)) that despite offering numerous specialties, active beds according to requests of patients have suggested that, in this context do the necessary investment.
- To hospitals including Hazrat Zahra (SA) and Izadi suggested that to stay in the competition area more expertise in providing their services.

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