

Evaluating Technical Efficiency of Kermanshah City Universities by Means of Data Envelopment Analysis Model

¹HamidRezaShetabi, ²SeyedQasemMirbahari, ³Amir AshkanNasiripour,

⁴Meysam Safi Keykale, ⁵Hadis Mohammadi, ⁶AfshinEsfandnia,

⁷Shahla Safari, ⁸Mahmoud Kazemi and ⁹Mohsen Mohammadi

¹Department of Anesthesiology Kermanshah of Medical Science,
Kermanshah University of Medical Sciences, Kermanshah, Iran

²Department of Pathology, Kermanshah University of Medical Sciences, Kermanshah, Iran

³Department of Health Services Management, School of Management and Economics,
Science and Research Branch, Islamic Azad University, Tehran, Iran

⁴Department of Health in Emergencies and Disasters, School of Health, Safety and Environment,
Shahid Beheshti University of Medical Science, Tehran, Iran

⁵Pharmaceutical Science Branch, Islamic Azad University, Tehran, Iran

⁶Kermanshah University of Medical Sciences, Kermanshah, Iran

⁷Department of Biostatistics, Kermanshah University of Medical Sciences, Kermanshah, Iran

⁸Department of Healthcare Management,
Kermanshah University of Medical Sciences, Kermanshah, Iran

Abstract: The rate of efficiency could be a measure to evaluate performance and profitability of resources usage in hospitals, considering their importance as the biggest and most expensive medical and health system, operative unit. Present research aims to evaluate Kermanshah City's educational and academics hospitals efficiency. Present research is descriptive-analytical and was executed in cross sectional manner among 7 educational universities of Kermanshah City during 2013 and data was gathered by Data Envelopment Analysis (DEA) and are analysed by means of Deap2 Software. Considering research's findings, the median of technical, managerial and scale efficiency of educational-medical hospitals of Kermanshah Medical University was equal to 0.876, 0.969 and 0.901 during 2013, respectively. Among all studied hospitals, 1 hospital (14.28% of all hospitals) had an increase in their efficiency and 2 hospitals (28.57% of all hospitals) had a decrease in their efficiency and 4 hospitals (57.14% of all hospitals) had a constant efficiency equal to number one. What's more, 57.14% of hospitals had a constant efficiency in comparison to the scale, 28.57% of hospitals had a decreasing efficiency in comparison to the scale and 14.58% of hospitals had an increasing efficiency in comparison to the scale. Considering that active bed is an important factor at decreasing and increasing hospitals' technical efficiency, eliminating surplus human resources, proper energy management to decrease hospital's surplus expenses with a complete plane and based on DEA Method's findings are suggested to increase hospitals' efficiency.

Key words: Hospital, technical efficiency, Data Envelopment Analysis (DEA), educational hospitals, profitability

INTRODUCTION

Nowadays, the issue of increasing the efficiency is the focus point of all governmental and public institutes and organizations due to increasing environmental complexities and existence of numerous variants effecting the process of decision making of managers and the need to decrease government's current expenses (Kazemi, 1387). Discussing the efficiency in scientific literature has

a long history and we can find its trace where there is an activity or work. Among the reasons considered for this long history and many discussions around it we could mention its importance for the whole society. The main discussion about efficiency and its effecting factors is that how achieve better results for the activities and works we do with less cost and equipments, use the existing forces to their maximum potential and prevent wasting of material and human equipments and forces

and meanwhile improving efficiency and profitability has received a great deal of attention based on 5th article of law in forth development program and applying performance management in various organizational level based on chapters 2 and 11 of state services management law from government and various organizations such as Ministry of Health, Medication and Medical Education. Economic efficiency is achieves as the result of multiplying technical efficiency and allocative efficiency. Therefore, to increase economic efficiency we should improve technical and allocative efficiency. Lack of allocative efficiency mentions improper resource distribution among interventions and different medical methods and proper usage of various technologies. Lack of technical efficiency means wasting resources and monetary capital such as buying poor quality equipments or using too many employees in an unit.

Efficiency means doing the job in right manner and achieving the expected output level from a certain institution. Efficiency means producing the minimum rate of waste and minimum level of expense or effort while we keep the quality and quantity stable. Based on this hypothesis that constant and limited resources are presented to an organization, level of desired usage of these resources in turning them into desired products is determined based on efficiency measure. Measuring efficiency has various methods like measuring profitability and each of them have their special advantages and disadvantages. Evaluating efficiency is actually evaluating the progress and downfall just like measuring profitability. Data envelopment analysis measures a decision making unit's efficiency in comparison to other units or institutions and similar outputs. This method is most used in service provider units like banks, hospitals, city halls and universities. A health system has its economic efficiency when it provides proper and right type of services (allocative efficiency) and the most important is that these services should be presented in a usefull and proper (technical efficiency) manner.

Since, paying attention to health and medication and investing on this issue increases the production, therefore allocating enough resources and proper usage of resources is very important in this unit. During past years, expenses related to hospital services has increased extremely, this issue has led to paying special attention to decreasing hospital expenses. Hospitals allocate a great part of health and medication budget to itself despite the fact that it presents its services to a limited population. These centers cause 50-80% of all expenses in health department and despite the great volume of allocated resources, a great difference is observed between growth of reachable resources and required resources in this study. Such issue leads to essentiality of creating extra possible resources and effective usage of existing

resources by means of resource allocation patterns and increasing hospital management efficiency. Weak management of hospitals leads to wasting resources such as money, human force, building and equipment such waste means that creating a specefic level of services could be achieved by using less resources. By preventing or decreasing this waste we could use this accessible resource to present more services or developing access and improving hospital services' quality. This resource usage by hospitals should be analyzed by means of comparing repeated data to data in order to evaluate efficiency and organizational profitability (Sadqhani, 1997).

First time, Scherman emphasized the trustworthiness and usefulness of DEA Method in evaluating patients; efficiency and its usefulness for hospitals' management in a study titled "Hospital Efficiency Measurement and Evaluation: Empirical Test of a New Technique" (Sherman, 1984). Andes *et al.* (2002) concluded in a study by means of using data related to 115 medical services units which was called "Measuring Efficiency of Physician Practices Using Data Envelopment Analysis" that first, the extension of these units doesn't increase efficiency and second, increasing efficiency of these units is only possible through better management of resources (Andes *et al.*, 2002). Evelyn Kwakey also concluded in a research titled "Relative Efficiency of Some Selected Hospitals in the Accra-Term Metropolis" and using data related to 20 hospitals in Metropolice City that the higher rate of bed occupation and bigger the activities of outpatient units in comparison to inpatient services will decrease function but ownership type doesn't explain hospitals' function or lack of function.

Ganon concluded in a study titled "Testing for Variation in Technical Efficiency of Hospitals in Ireland" by means of two accidental frontier and data envelopment analysis methods of hospitals' technical function data that technical function is more than data envelopment analysis and technical function is more than accidental frontier analysis method (Gannon, 2005). Reza Goudarzi, in Iran, concluded in a study titled "Factors Affecting the Technical Efficiency of Hospitals in Iran, Using Two Inputs Analysis and Stochastic Frontier Analysis (SFA)" that increase in personnel of reception and other members leads to a decrease in productivity and presenting hospital services, economic activities requires capital.

Volume of hospital's operative expenses and lack of enough efficiency of health system leads to questions about how these resources are used by hospitals. In developing or undeveloped countries, when issues related to acquiring capital and human force are mixes with lack of full usage of existing equipments which is a result of working method and office traditions, level of efficiency or profitability will decrease and a kind of wasting capital

and human force while there are other shortages will be presented. The main motive of using practical-scientific methods in evaluating hospital performances and activities is to use existing physical equipments, technolog and human force in best way possible and in this manner we could use economic tools and analysis. One of these economic tools is determining efficiency of these units. In this study, we evaluate the efficiency of educational hospitals (medical-educational) in Kermanshah City based on efficiency indexes and mathematical model of Data Envelopment Analysis (DEA) during 2013 by means of one of techniques used in linear programming.

MATERIALS AND METHODS

Present research is descriptive-analytical and cross sectional. The studied society includes all hospitals dependant to Kermanshah City Medical University which are 7 educational hospitals in Keranshah City during 2012-2013. The data of present study were gathered by two methods of library and field study. Used data were presented in form of tables after further studies and consulting with scholars and using a cheklist which are: inpatients submission number, outpatients number and percent of bed occupation and data tables titled: number of beds, number of doctors, number of nurses and other staff. The advantage of using DEA technique to evaluate the efficiency is that hospitals placed in one area are determined by means of computer analysis and in other words they become comparable. The used data in this study is DEA with multi-level DEAP2. What's more we used data were analysed by means of variant productivity and minimising production factors model. The reason we used the mentioned model is that they can mix obligations, create new obligations and draw new lines. The reasons we use minimising production factors model are as fallow:

- Hospitals as an input can decrease production factors more easily than increasing the output

- Using variant profitability, since, it gives us the efficiency components (managerial efficiency and scale efficiency)

The used DEA equation:

$$\frac{\sum_r U_r y_{rj_0}}{\sum_i V_i x_{ij_0}} \leq 1; \forall j, U_r, V_i \geq 0; \forall r, \forall i, TE_0 = \max \frac{\sum_r U_r y_{rj_0}}{\sum_i V_i x_{ij_0}}$$

RESULTS

In studying the hospitals, from activity point of viwe, 7 medical-educational hospitals with 1519 active beds as the subordinates of Kermanshah Medical University exist in Kermanshah City and the minimum number of hospital beds is related to Motazedi hospital with 80 beds and the maximum number of beds is related to Imam Reza hospital with 578 active beds. Findings of present research shows that the maximum number of doctors equal to 208 belongs to Imam Reza hospital and the minimum number of them belongs to Motazedi hospital equal to 13 individuals and what's more Imam Reza hospital with 673 individuals 900 individuals and Motazedi Hospital with 60 individuals 90 individuals have the maximum and minimum number of nurses other staff among studied hospitals. In relation to percentage of occupied beds, the Farabi hospital with 81.23% and Motazedi hospital with 35.02% have respectively the maximum and minimum percent of bed occupation.

Findings about hospital acceptance of inpatients and outpatients shows that Imam Reza hospital with respectively 38754 outpatients and 137848 outpatients has the highest number of patients and Farabi Hospital with 4625 inpatients and Motazedi Hospital with 19962 outpatients have the minimum amont of patients acceptance.

Data used in this research includes inputs with titles, number of active beds, number of doctors, number of nurses and other staff and output include titles as number of accepted inpatients, number of outpatients and percent of bed occupation (Table 1).

Table 1: Table of inputs with titles, number of active beds, number of doctors, number of nurses and other staff) and (outputs include titles as, number of accepted inpatients, number of outpatients and percent of bed occupation

Hospitals	No. of doctors	No. of nurses	No. of active beds	Other staff	No. of inpatients	Occupied beds (%)	No. of outpatients
Imam Khomeini	55	238	192	240	16212	52/10	109197
Imam Reza	208	673	578	900	38754	71/06	137848
Imam Ali	34	229	167	170	20199	69/37	76656
Taleghani	118	277	213	354	36934	71/87	84779
Farabi	37	125	174	128	4625	81/23	40173
Kermanshahi	33	158	115	120	9285	60/35	81610
Motazedi	13	60	80	90	6585	35/02	19962
Total	498	1760	1519	2002	132594	63/02	550225

Table 2: Hospitals efficiency by considering inputs of number of beds, number of doctors, number of nurses and other staff and outputs including number of inpatients, number of out patients and occupied beds

Hospitals	Technical efficiency	Managerial efficiency	Scale efficiency	Profitability in comparison to the scale
Imam Khomeini	0/959	1	0/959 drs	Decreasing
Imam Reza	0/549	1	0/546 drs	Decreasing
Imam Ali	1	1	1	Constant
Taleghani	1	1	1	Constant
Farabi	0/624	0/780	0/800 Irs	Increasing
Kermanshahi	1	1	1	Constant
Motazedi	1	1	1	Constant
Median	0/876	0/969	0/901	-

Table 3: Median of using the inputs more than its required

Other staff	No. of active beds	No. of nurses	No. of doctors	Inputs
0/000	6/320	0/767	1/329	Median

Considering findings of the study, median of technical, managerial and scale efficiency of Kermanshah Medical University's Medical-Educational Universities during 2013 was equal to the following, respectively, 0.876, 0.969 and 0.901 and this shows the proper condition of efficiency.

Among all studied hospitals, one hospital (14.28% of all hospitals) had an increase in efficiency and 2 hospitals (28.57% of all hospitals) had a decrease in their efficiency and 4 hospitals (57.14% of all hospitals) had a constant efficiency of one. What's more, 57.14% of hospitals had a constant profitability in comparison to the scale, 28.57% of hospitals had a decreasing profitability and 14.58% of hospitals had an increasing profitability in comparison to the scale.

Research findings shows that considering inputs and outputs in studied hospitals, the technical efficiency is obtained which is the result of multiplying managerial efficiency in scale efficiency. Based on this hospitals are considered to be efficient that have an efficiency coefficient equal to 1 ($E = 1$) and hospitals where their efficiency is lower than this amount are considered to be inefficient. During 2013, the lowest level of technical efficiency was related to Imam Reza hospital equal to 0.549 which had a decreasing profitability in comparison to the scale and increasing production factors to a specific rate leads to production decrease and leads to a higher rate of increase at inputs (Table 2).

Considering the obtained results from technical, managerial and scale median of Kermanshah City hospitals during 2013 which are respectively equal to 0.876, 0.969 and 0.901 and considering the method of calculating the technical efficiency that equals the multiplying of managerial efficiency in scale efficiency, findings show that scale inefficiency has the greater share in studied hospitals inefficiency.

Present study used the hypothesis of inputs minimizing in data development analysis method and based on obtained results among studied hospital inputs,

number of nurses had the lowest surplus and active bed input devoted the minimum surplus to itself and details (surplus of general hospital production factors in inefficient hospitals) are presented in Table 3.

DISCUSSION

The median of technical, managerial and scale efficiency in hospitals of Kermanshah City during 2013 was respectively equal to 0.876, 0.969 and 0.901. Considering these findings and based on data development analysis model and by hypothesising that the profitability variant to scale and capacity of increasing the efficiency improvement in studied hospitals no type of increase in expenses and using the same amount of inputs was observed similar to Saber Mahhani research titled "Estimation of Technical Efficiency of General Hospitals of Kerman University of Medical Sciences by Data Envelopment Analysis (DEA) Method in 2007" and Goudarzi study titled "Factors Affecting the Technical Efficiency of Hospitals in Iran, Using Two Inputs Analysis and Stochastic Frontier Analysis (SFA)" around 9%. The median of technical efficiency of medical-educational hospitals of Kermanshah City is equal to 0.876, in other words these hospitals create the same current level of inputs by 87% of their resources. Research findings show that technical efficiency includes multiplying managerial efficiency in scale efficiency and changes in technical efficiency are due to changes in production factors:

- Technical efficiency = Managerial efficiency × Scale efficiency

For example, considering Table 2, Imam Khomeini hospital with technical efficiency of 0.959, Imam Reza hospital with technical efficiency of 0.549 and Farabi hospital with technical efficiency of 0.624 we could say that respectively 95, 54 and 62% of production factor (inputs: number of beds, number of doctors, number of nurses and other staff) have an active role in hospital productivity and <5, 46 and 38% of inputs have no role in

hospital productivity or in Imam Ali, Taleghani, Dr. Kermanshahi and Motazedi the productivity factors (inputs) were used in optimized manner and in order to increase the efficiency of hospitals by increasing scale efficiency (optimizing hospitals' productivity capacity) has a greater priority to general planning to increase the managerial efficiency of studied hospitals which presented similar results to findings by Akbari *et al.* (2012) in 2011 titled "Analysing Tabriz Medical University Hospital's Technical Efficiency" and Najafi in 2007 aiming to study the Ardabil hospitals technical efficiency and findings of this research (Table 2).

In present research, the maximum rate of surplus is related to active bed input with 6.32% that considering Pourreza findings in hospitals covered by Tehran Medical University the maximum surplus rate is related to number of nurses and based on Ghaderi *et al.* (2005) study, in hospitals covered by Iran Medical University the maximum surplus is related to the input of doctors and Sabermahani also found out that the maximum rate of the input in Kerman Medical University was related to other staff. So, we can conclude that a similarity in relation the maximum level of input surplus exists among various studies and these findings aren't similar to findings of researches by Ghaderi *et al.* (2005) are in relation with the surplus level related to active bed.

Findings show that 57.14% of hospitals (4 hospitals) have a constant productivity compared to the scale, 28.57% of hospitals (2 hospitals) have the decreasing productivity in comparison to the scale and 14.58% of hospitals (1 hospital) has the increasing productivity in comparison to the scale. From the productivity compared to the scale point of view in studies such as Sabermahani and Kiadaliri and AsgarAhmadi say that hospitals could decrease their usage of input significantly by optimizing their performance and increasing efficiency and as a result they can decrease their expenses and waste, what's more, in a study by Goudarzi increasing number of doctors and other staff decreased hospital's productive ability and presenting and producing hospital services is a capital consuming economic activity. The mentionable point is that educational hospitals have a more desired efficiency in comparison to medical hospitals due to higher median of staying duration and active bed and what's more type and activities and branch of activities in a hospital is an effective factor at inefficiency of hospitals (Arian and Shahhoseini, 2013).

CONCLUSION

Finally, considering the proper condition of under study hospitals' efficiency, hospital managers should have required plans to increase their efficiency. Finally, studying the level affecting factors such as the quality of presenting services and employees and patients' satisfaction and also executing programmes such as the hospitals credit allocation programmes and health system transformation programme and their effect on mentioned hospitals performance should be notices.

ACKNOWLEDGEMENTS

Present study is a result of study programme titled "Evaluating Kermanshah Medical University Technical Efficiency by Means of Data Envelopment Analysis Model" approved by Kermanshah Medical University research and technology office of assistant during 2014 with the code 93282.

REFERENCES

- Akbari, F., M. Arab, K. Keshavarz and A. Dadashi, 2012. Technical efficiency analyses in hospitals of Tabriz University of Medical Sciences. Hospital J., 11: 65-76.
- Andes, S., L.M. Metzger, J. Kralewski and D. Gans, 2002. Measuring efficiency of physician practices using data envelopment analysis. Manage. Care, 11: 48-54.
- Arian, S.R. and R. Shahhoseini, 2013. Assessment of technical efficiency of hospitals under Hamadan University of Medical Sciences on performance indicators and data envelopment analysis model in 2010. Pajouhan Sci. J., 11: 27-34.
- Gannon B., 2005. Testing for variation in technical efficiency of hospitals in Ireland. Econ. Social Rev., 2: 94-273.
- Ghaderi, H., R. Goudarzi and M.R. Gohari, 2005. Determine the technical efficiency Hospital University of Medical Sciences, using two analysis comprehensive data. J. Health Manage., 9: 31-38.
- Sadghiani, E., 1997. Problems of health and the hospitals in developing countries. J. Manage., 1: 78-59.
- Sherman, H.D., 1984. Hospital efficiency measurement and evaluation: Empirical test of a new technique. Med. Care, 22: 922-938.