



## **Efficiency Evaluation of University Hospitals In Bushehr Province before and after the Implementation of the Health System Development Plan**

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### **ABSTRACT**

**Background:** High hospital costs on one hand, and limited resources and facilities on the other hand, have led hospital managers to reduce costs and increase efficiency. Performance measurement is one of methods for assessing efficiency of hospital in terms of resource utilization. Therefore, the present study was conducted with the aim of evaluating the efficiency of hospitals affiliated with Bushehr University of Medical Sciences before and after the implementation of the Health development Plan.

**Methods:** This study is descriptive-analytic. The research population of this study was all hospitals affiliated with Bushehr University of Medical Sciences whose performance was evaluated in two years of 2013 and 2014. To measure the efficiency of these hospitals, data frontier analysis was used. The criteria of the total number of employees, the total number of physicians, the number of nurses and active beds were studied as input variables, and the percentages of cesarean section in total deliveries, number of surgeries, average residence. The data were collected in collaboration with the University's Center of Statistics as well as referring to the hospitals and analyzed using DEA software.

**Results:** The mean technical efficiency, managerial and scale of performance before the implementation of health system development plan were reported  $0.934 \pm 0.116$ ,  $1.00 \pm 0.0$  and  $0.934 \pm 0.116$ , respectively. Furthermore, six out of the eight hospitals studied were technically and scale-oriented efficient, and all eight hospitals were efficient regarding management. Only two hospitals had a surplus and two hospitals were inadequate. The mean efficiency after the implementation of the development plan was  $0.9504 \pm 0.131$ ,  $0.977 \pm 0.059$  and  $0.966 \pm 0.088$ , respectively. **Conclusion:** According to the findings of this study, the health system development plan has had a positive effect on the efficiency of hospitals, Although the efficiency of hospitals is desirable, it is essential that managers and policymakers of the health sector take measures to improve the efficacy and increase the use of resources.

**Keywords:** Data Envelopment Analysis, Health System Development Plan, Management Efficiency, Scale Efficiency, Technical Efficiency

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## Introduction

Health is one of the most valuable assets, as well as the basis for sustainable social, economic, political and cultural development of all human societies. Therefore, preserving and promoting it should be regarded as one of the most important efforts of everyday life of humans (1, 2). The main mission of the health system is to raise the level of health and respond needs of people and society (3). In this regard, hospitals have a special place in the health system, because these organizations as the arm of the provider of health services, in addition to attracting a huge share of health resources, have the greatest relationship with the quality of services provided for patients (4). Accordingly, the health system development plan was developed from May 3, 2014 after a long discussion across the country with three goals of financial protection of patients, establishing equity in access to health services and improving the quality of services. In fact, the main goal of the Health System Development Plan is to achieve three of the above priorities to increase efficiency, performance and justice through 7 executive packages of the Ministry of Health (reducing the amount of payments for patients admitted to state hospitals, supporting the survival of physicians in deprived areas, the presence of specialized doctors residing in state hospitals, improving the quality of hoteling in state hospitals, improving the quality of visiting services in state hospitals, promoting a natural birth plan, and financial plan for patients with special medical needs (5). Hospitals are the main promoter of the implementation of the development plan, which account for a large part of health care costs, and since they have a large share of educated personnel, the nature of the activities of these organizations is due to dealing with the life and health of humans have been identified the product of their actions as an indisputable essential necessity, and the provision of efficient and effective services has always been sought by the people and drawn attention of the authorities (6, 7). Studies show that more than half of national health resources are wasted in

different countries, and in underdeveloped countries, limited resources are being used inefficiently, and public funds are spent on services that do not have the appropriateness and effectiveness (8). Therefore, it can be said that proper distribution of health facilities and efficient use of these facilities are considered vital and the assessment and proper correction of the health system seems inevitable, and this correction is possible through the examination of policies, increasing efficiency, limiting unnecessary costs and meeting the needs of the community (9). One of the most important and most commonly used strategies and tools for evaluating and measuring the performance of an enterprise, such as a hospital is measuring productivity and efficiency as the main pillar of development, which in the past few decades has also examined the performance of various economic sectors or enterprises and micro-economic units have always been considered by researchers in various social sciences, especially in management and economics, through measuring and estimating productivity and efficiency (10). There are various ways to measure and evaluate performance. In most of the studies that have been conducted in the field of performance, the ratios analysis method has been used, but since this method is used to measure the efficiency between a data and output it is subject to limitations when the subject matter relates to the relationship between a data set or a multiplicity or a combination of data and multiplicity (11). Given the fact that the hospital is an organization that simultaneously faces multiple data and outcomes, so measuring its efficiency by this method alone is not accountable. The review of literature suggests that a comprehensive data analysis technique can be used to address the limitations in measuring hospital efficiency (12).

Data envelopment analysis is one of the most commonly used nonparametric methods in measuring efficiency. In this model, the efficient frontier curve is created from a series of points



that are determined by linear programming. For determining the points, one can use two assumptions of constant and variable output relative to the scale. The linear programming method, after optimization, determines if the decision maker unit is on the efficiency line. In this way, efficient and inefficient units are separated from each other (13).

Extensive studies have been conducted on the efficiency measurement using the DEA method in different countries, for example, Ersoy et al .(14), studies, which were among the first efforts in the field of efficiency analysis using the DEA technique, Krijia et al .(15), and Rhamk Rishnan (16), In internal research, Ghaderi et al .(17), Ardekani et al .(18), and Azad et al .(19), have used the frontier data analysis method to evaluate the efficiency of hospitals. By implementing the health system development plan, medical expenses decreased, which increased the number of patients referred to hospitals and, consequently, increased bed occupancy rates. In this case, if there is no change in the number of human resources provided to the health service provider in response to the high volume of referrals, there will be a lot of pressure on the health team, which if not properly used and available resources are not used properly, efficiency and productivity will also be affected. Therefore, one of the factors influencing the effectiveness of the development plan is to evaluate the efficiency of hospitals in order to help policy makers and managers to improve their performance and promote the activities of these hospitals by comparing their status with each other. In this regard, the present study uses the DEA technique to evaluate the efficiency of hospitals affiliated to Bushehr University of Medical Sciences before and after implementation of the health system development plan in 2013-2014.

### Materials and Methods

The present study was a descriptive-analytic study that analyzed the efficiency of university hospitals of Bushehr Province before and after the implementation of health system development plan in 2013 and 2014. Given that the results of this

study can be used by the authorities of the studied hospitals, other hospitals and, in general, policy makers of the health system, it is considered as an applied research. Due to the limited community size, sampling was not performed and all 8 educational hospitals of this university were considered as target society. The tool for collecting information for the background and theoretical literature of this research has been sources of library and online scientific documentation. The variables required in this study were used to calculate technical, scale, and management efficiency using the data frontier analysis method which includes: total number of doctors, number of full-time nurses, number of other full-time staff and the number of beds and outcomes including bed occupancy, number of surgeries, percentage of cesarean section in total deliveries, average residence of patients. Data on input and output indices were collected from the medical statistics unit of the department of medical services of Bushehr University of Medical Sciences in Bushehr, Iran. Data were analyzed using Deap1.2 software to determine the amount of output and input variables of decision-making units (hospitals). In Deap1.2 software there is the ability to measure pure technical efficiency and scale efficiency simultaneously. The pure technical efficiency (management) is achieved by division of technical efficiency (in the steady-state in relation to scale) by scale efficiency. The technical efficiency is the result of a multiplication of managerial efficiency in scale efficiency. The scale efficiency also refers to the technical efficiency in the static output ratio versus the scale divided by the pure technical efficiency under variable output conditions versus scale. Given the inputs and outputs in hospitals, hospitals that scored in each type of performance score 1 were well-known, and each time they were other than 1, they should reduce their inputs to achieve the maximum efficiency. Due to the extensive application of data frontier analysis technology in evaluating health sector efficiency, this technique was used as the basis for analysis in this study.



The methodology of this technique is to identify and calculate the input and output indicators that represent the resources consumed and products or services of the sector. The appropriate DEA model is then used to calculate the efficiency of the units. The feature of the DEA technique is that, after evaluating the efficiency of the decision-maker units (hospitals), it provides for each of its special means of correction and improvement, which, if the desired level of inputs and outputs is achieved, the status of that unit will reach to the desired state (efficient) society.

**Findings**

In this research, all university hospitals in Bushehr Province (8 hospitals) were examined separately before and after implementation of the health care development plan in 2013 and 2014. In terms of activity, one hospital was training-therapeutic and other hospitals were therapeutic. From the scope of activity, one hospital was specialized and others were general. A total of 925 active beds are available in the sub-category of this university, from which, Bushehr with a total of more than 305 beds has the highest number of beds and the city of Ahrom with 27 beds has the lowest number of beds.

Considering the issues mentioned in the methodology, hospitals were considered efficient that had the efficiency coefficient of 1 and hospitals with efficiency coefficient under unit were ineffective. According to Table 1, in 2013, out of 8 hospitals, 6 hospitals had technical and scale efficiency and all 8 hospitals had managerial efficiency.

Table 2 shows the extent to which changes needed in inputs and outputs combination using the DEA-VRS model. As it is shown, in 2013, of the hospitals under study, 2 hospitals have surplus value in the inputs. Furthermore, 2 hospitals have a shortage of inputs. In the case of output, no surpluses or shortages were reported. The highest number of surplus in the input was related to the rest of the hospital and the bed occupancy rate. On the other hand, the greatest number of deficiencies in the input was related to Imam Hussein Hospital and the input was bed occupancy rate.

According to Table 3, in 2014, out of the eight hospitals under study, 7 hospitals have technical, managerial, and scale efficiency and there is only one inefficient hospital. The DEA-VRS model was used to determine the required changes in inputs and outputs, the results of which are presented in Table 4.

According to the findings of Table 4, in 2013, only Borazjan Shahid Ganji Hospital had deficiency values in the inputs, and the number of surgeries was the most deficient. There were no shortages or surpluses in other hospitals.

Table 5 compares the mean and standard deviation of technical, managerial, and scale efficiency before and after implementation of the development plan. In the year 2013, managerial efficiency gained the highest efficiency ( $0 \pm 1$ ), and the mean of technical and scale efficiency was the same ( $0.934 \pm 0.116$ ). In year 2014, the managerial and technical efficiency also achieved the highest and lowest efficiency ( $0.977 \pm 0.056$  vs.  $0.131 \pm 0.950$ ).

**Table 1.** Technical-Managerial Efficiency and University Hospital Scale of Bushehr Province in 2013

No.	Hospital name	2013 efficiency			Output to scale
		technical	Management	scale	
1	Genaveh Burn Disaster	1	1	1	Constant
2	Deylam Baghiatollah	1	1	1	Constant
3	Ahrom Imam Hussein	0.790	1	0.790	Increasing
4	Borazjan Shahid Ganji	0.687	1	0.687	Decreasing
5	Khurmoj Zeinabieh	1	1	1	Constant
6	Kangan Imam Khomeini	1	1	1	Constant
7	Genaveh Amir al Momenin	1	1	1	Constant
8	Bushehr Persian Gulf Martyrs	1	1	1	Constant



**Table 2.** The required changes in outputs and inputs using the DEA-VRS model in 2013

Hospital name	Changes rate	Outputs				Inputs			
		Bed occupancy coefficient	Average inhabitanace	Number of surgeries	Cesarean rate to total deliveries	Active bed	Number of nurses	Total number of doctors	Total number of staff
Genaveh Burn Disaster	Initial amounts	17	5.5	-	-	28	19	2	94
	Ideal amounts	17	5.5	-	-	28	19	2	94
	Extra amounts	0	0	-	-	0	0	0	0
Deylam Baghiatollah	Initial amounts	22	2.2	-	-	19	14	7	95
	Ideal amounts	22	2.2	-	-	19	14	7	95
	Extra amounts	0	0	-	-	0	0	0	0
Ahrom Imam Hussein	Initial amounts	30	1.6	-	-	13	7	5	67
	Ideal amounts	30	1.6	-	-	13	7	5	67
	Extra amounts	0	0	-	-	0	0	0	0
Borazjan Shahid Ganji	Initial amounts	56	2.3	4450	32	203	115	49	574
	Ideal amounts	56	2.3	4450	32	203	115	49	574
	Extra amounts	0	0	0	0	0	0	0	0
Khurmoj Zeinabieh	Initial amounts	41	1.8	2049	42	60	51	15	228
	Ideal amounts	41	1.8	2049	42	60	51	15	228
	Extra amounts	0	0	0	0	0	0	0	0
Kangan Imam Khomeini	Initial amounts	48	1.7	4115	45	95	79	25	321
	Ideal amounts	48	1.7	4115	45	95	79	25	321
	Extra amounts	0	0	0	0	0	0	0	0
Genaveh Amir al Momenin	Initial amounts	53	5.5	3217	55	102	46	19	309
	Ideal amounts	53	5.5	3217	55	102	46	19	309
	Extra amounts	0	0	0	0	0	0	0	0
Bushehr Persian Gulf Martyrs	Initial amounts	68	3.3	13352	73	284	292	96	1054
	Ideal amounts	68	3.3	13352	73	284	292	96	1054
	Extra amounts	0	0	0	0	0	0	0	0



**Table 3.** Technical-Managerial Efficiency and University Hospital Scale of Bushehr Province in 2014

No.	Hospital name	2014 efficiency			Output to scale
		Technical	Management	Scale	
1	Genaveh Burn Disaster	1	1	1	Constant
2	Deylam Baghiatollah	1	1	1	Constant
3	Ahrom Imam Hussein	1	1	1	Constant
4	Borazjan Shahid Ganji	0.733	0.819	0.601	Decreasing
5	Khurmoj Zeinabieh	1	1	1	Constant
6	Kangan Imam Khomeini	1	1	1	Constant
7	Genaveh Amir al Momenin	1	1	1	Constant
8	Bushehr Persian Gulf Martyrs	1	1	1	Constant

**Table 4.** The required changes in outputs and inputs using the DEA-VRS model in 2014

Hospital name	Changes rate	Outputs				Inputs			
		Bed occupancy coefficient	Average inhabitance	Number of surgeries	Cesarean rate to total deliveries	Active bed	Number of nurses	Total number of doctors	Total number of staff
Genaveh Burn Disaster	Initial amounts	18	6.1	-	-	28	16	1	90
	Ideal amounts	18	6.1	-	-	28	16	1	90
	Extra amounts	0	0	-	-	0	0	0	0
Deylam Baghiatollah	Initial amounts	37	1.9	-	-	23	12	7	99
	Ideal amounts	37	1.9	-	-	23	12	7	99
	Extra amounts	0	0	-	-	0	0	0	0
Ahrom Imam Hussein	Initial amounts	27	2.7	-	-	17	10	6	72
	Ideal amounts	18	6.1	-	-	28	16	1	90
	Extra amounts	18	6.1	-	-	28	16	1	90
Borazjan Shahid Ganji	Initial amounts	0	0	-	-	0	0	0	0
	Ideal amounts	37	1.9	-	-	23	12	7	99
	Extra amounts	37	1.9	-	-	23	12	7	99
Khurmoj Zeinabieh	Initial amounts	0	0	-	-	0	0	0	0
	Ideal amounts	27	2.7	-	-	17	10	6	72
	Extra amounts	27	2.7	-	-	17	10	6	72
Kangan Imam Khomeini	Initial amounts	0	0	-	-	0	0	0	0
	Ideal amounts	62	2.6	3654	39	196	125	53	559
	Extra amounts	75.675	3.173	5882.521	47.952	137.90	125	43.857	500.466
Genaveh Amir al Momenin	Initial amounts	- 13.675	- 0.537	-2228.52	- 8.952	54.1	0	9.143	58.534
	Ideal amounts	44	2.1	1908	37	60	52	17	235
	Extra amounts	44	2.1	1908	37	60	52	17	235
Bushehr Persian Gulf Martyrs	Initial amounts	0	0	0	0	0	0	0	0
	Ideal amounts	45	1.9	5314	40	114	90	28	334
	Extra amounts	45	1.9	5314	40	114	90	28	334



**Table 5.** Mean and standard deviation of technical-managerial efficiency and scale of Bushehr province university hospitals

Year	Efficiency	Technical	Managerial	Scale
92	Mean	0.934	1	0.934
	Standard deviation	0.116	0	0.116
93	Mean	0.950	0.977	0.966
	Standard deviation	0.131	0.059	0.088

## Discussion

Considering the high importance of hospitals in providing health services and their great impact on the effectiveness of the health system of the country, using the data frontier analysis model by providing comparisons and ranking and modeling can be an important step for continuous improvement of hospital efficiency and especially the health sector of the country. In this research, the efficacy of hospitals affiliated with Bushehr University of Medical Sciences has been investigated before and after the implementation of health system development plan. After the establishment of health system development plan, the mean and standard deviation of technical, managerial and scale efficiency in hospitals of Bushehr University of Medical Sciences was  $0.141 \pm 0.950$ ,  $0.059 \pm 0.977$ , and  $0.088 \pm 0.966$ . As the results show, management efficiency has had the highest performance before and after the implementation of the development plan. However, comparison of mean and standard deviation of efficiency before and after implementation of the health system development plan showed that the average management efficiency decreased and other efficiencies increased. Based on the results of this study, the development plan has had positive effects in most hospitals during one year before and after the implementation, and has changed the efficiency indicators of those organizations. Comparing the results of this study with the study of Nabilou et al .(20), it was found that after the implementation of the development plan, the mean of technical, managerial and scale efficiency in the hospitals affiliated to Urmiah University of Medical Sciences significantly increased, which is similar to the results of the present study. Moreover, in a study by Joshan et al .(21), with the

aim of comparing the efficiency of training hospitals in Tehran before and after the implementation of the health development plan, the technical, managerial, and scale efficiency of the hospitals affiliated to the Tehran University of Medical Sciences after the implementation of the development plan has been increasing (0.959, 0.986 and 0.971) that are consistent with the results of this study. They also compared the efficacy of hospitals affiliated to Shahid Beheshti University of Medical Sciences, which showed an increase in the efficiency of hospitals after the implementation of the development plan (21) . One of the reasons for the consistency of the results of the above studies is the similarity between the input and output variables used in the study, which leads to the results of the study being closer to each other.

Based on the results of the study by Ghaderi and Yousefzadeh (22), the mean technical, managerial and scale efficiency of the hospitals covered by Uremia University of Medical Sciences. in 2009 was lower than the current study in 2014, which seems that one of the reasons for the increase in efficiency indicators of Bushehr University hospitals is changes in the health system of the country that have increased the hospital bed occupancy rate by reducing the payment of the patients and increasing their satisfaction from state hospitals, which leads to the use of surplus capacity of inputs in these centers. Furthermore, the average technical efficiency in US training hospitals in Harrison and Lambis study (23) in 2005 was 0.88, which is lower than the average technical efficiency of this study . The average technical, managerial and scale efficiency of Qom general hospitals in the study of Baroni et al .(24), during the years 2010 and 2011 was lower than the average technical, managerial and scale efficiency of Bushehr



University of Medical Sciences hospitals after the implementation of the development plan. The reason for these differences can be because most of the hospitals in the study of Barouni and colleagues were training- therapeutic hospitals, and because more inputs are used in medical training hospitals, the efficiency of these hospitals is lower than that of therapeutic hospitals. The efficiency of Lee and Yang (25) research in 116 general hospitals in Florida (0.638) was lower than the mean technical efficiency of Bushehr University hospitals . One of the important differences in this research with the present study is the number of sample volumes, and since the number of hospitals in the state of Florida is much higher than the number of hospitals surveyed in this study, this could be one of the factors reducing the mean efficiency of Florida hospitals (25).

Kazemi et al .(26), also reported the mean technical efficiency, managerial efficiency and scale efficiency of 11 hospitals during the years 2004-2008 by input minimization method equal to 0.880, 0.934 and 0.936, respectively, which is less than the average efficiency of hospitals in the current study in 2014 (26). Moreover, the technical and scale efficiency in the Kanderjio (27) study in psychiatric hospitals in Bulgaria in 2011 was 92.97% and 93.65% respectively .

Among the hospitals under investigation, two hospitals of Ahrom Imam Hossein and Borzjan Shahid Ganji were technically inefficient (less than one) and other hospitals had full technical efficiency (equal to one) before the implementation of the health system development plan, but after the implementation of the plan from among the 8 hospitals of Bushehr University of Medical Sciences, only 1 hospital was technically inefficient (12.5%) and 7 hospitals were efficient.

The results of Mahani et al .(28), study on 13 general hospitals of Kerman University of Medical Sciences in 2007 indicated that 7 hospitals had the maximum technical efficiency of 1, 4 hospitals had a mean technical efficiency between 0.8-1 and 2 hospitals had an efficiency of less than 0.8. Ajlouni et al .(29), in a study on Jordanian state hospitals, concluded that out of 15 hospitals, the number of

efficient hospitals increased from 7 hospitals in 2006 to 9 hospitals in 2007. Kontutimopoulos et al. (30), also achieved technical inefficiency in a number of hospitals and medical care facilities in Greece, 26.77% and 25.13% respectively . In a study conducted by Osei et al .(31), in 17 local state hospitals in Ghana, there were 9 efficient hospitals and 8 hospitals (technical efficiency average of 61%) were ineffective.

While the findings from the Masiye (32) study in Zambia hospitals showed that only 40% of hospitals were efficient, this study also found that hospital size was a major source of inefficiency . Lotfi et al. (33), research on Iran university of medical sciences hospitals showed that 43.5 percent of these hospitals had full technical efficacy, two hospitals with an average efficiency of 0.8 to 1 and seven other hospitals with a technical efficiency of less than 0.8 . Therefore, the number of efficient hospitals in Bushehr is more than the two above-mentioned studies. This may also be due to the existence of surplus in the variables of research in hospitals, which has led to a decrease in the efficiency of hospitals in Zambia and hospitals of Iran University of Medical Sciences. Based on the results of this study we can say that the development plan of health system has a positive effect on the efficiency of the hospitals and the health system development plan has been optimally implemented in most hospitals. However, research has shown that the inefficiency of some hospitals may be due to large numbers of manpower and expensive diagnostic equipment, a high proportion of staff costs, and components such as the expertise of hospitals, the location of hospitals, hospital type, and so on, which has not been studied in this study (19). Among the main constraints of this research and other researches that are done using the data frontier analysis method, the lack of consideration of the quality of care provided to patients and the satisfaction of patients from hospital services and the small sample of the study, as well as secondary data used, which confirmed the accuracy of data by the Department of Medical Education to reduce its adverse impact.



## Conclusion

In general, although the efficiency of the studied hospitals has been sufficient, it is imperative that managers and policymakers of the health sector take measures to increase their efficiency and increase the efficiency of utilization of resources. Considering that measure of standard efficiency to compare the utilization of available resources with standard criteria or indexes for assessing the performance of hospitals, university authorities can use their ranking of their efficiency in budgeting and financing hospitals. In addition to helping to better management of resources and reducing costs, this study can be used as a tool for better policy of the health system development plan. Performance evaluation makes hospitals identify their weaknesses and strengths and determine their optimal and potential use, as well as inefficient hospitals to compare their performance with well-functioning, efficient hospitals and promote themselves.

In order to promote the efficiency of health centers, it is suggested that in addition to the

hospitals affiliated with Bushehr University of Medical Sciences, hospitals covered by military and social centers are also supported in the development plan of the health system so that the burden of referrals to state hospitals be proportional to the amount of their input.

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## Conflicts of interest

Authors have no conflicts of interest to declare.

## Authors' Contributions

Kiani MM and Khanjankhani Kh designed research; Mosavi Rigi SA conducted research; Sepaseh F analyzed data; and Shiravani M, Naghdi B, and Karami H wrote the paper. Kiani MM and Khanjankhani Kh had primary responsibility for final content. All authors read and approved the final manuscript

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