

Assessing the efficiency of hospitals by using Pabon Lasso graphic model

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Abstract

One of the main issues in hospitals is assessment of their efficiency. Evaluation and comparison of hospitals is made possible through assessment of performance indicators. This study aimed to compare performance of hospitals through performance indicators using Pabon Lasso graphic model. Performance of seven hospitals affiliated to Bushehr University of Medical Sciences was evaluated from 2009 to 2011. Selected indicators of this comparison were analyzed using Pabon Lasso graphic model. According to study results, less than half of the hospitals were in zone 1 of the chart (the most inefficient zone), and only 20% were in zone 3 (the most efficient zone). Three hospitals: Zainabieh, Choromi, and Baqiyyatallah were in zone 1 in every one of three years, and Imam Khomeini Hospital in zone 2 (low bed occupancy rate, high bed turnover ratio). Fatemeh-Zahra Hospital was in zones 3, 4 and on the border of 3 and 4, respectively. 17 Shahrivar Hospital was in zone 2 in the first year, and moved to zone 3 for the next two years. Amiralmomenin Hospital was also in zones 2 and 3, and returned to zone 2. Considering inefficiency of hospitals in zone 1, adopting appropriate strategies to reduce services can be beneficial. Hospitals in zone 3 are advised to maintain status quo, and finally, hospitals in zones 2 and 4 can near efficient zone by proper management and improvement of their performance indicators.

Keywords: Hospital, Performance, Pabon Lasso, Indicators

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Introduction

Performance assessment has long been considered one of the most important factors of organizational success. Organizations have always tried to benefit from scientific and practical methods in organizational

performance assessment, and apply results in planning to address shortcomings and strengthen progress of the organization [1]. It is often said that health care institutions cannot be expected efficiency. Yet, there is an overwhelming inclination to assess efficiency

in hospitals. Use of efficiency indicators in hospitals to compare their relative performance to ensure the best use of resources is rarely emphasized [2]. Given that hospital, as an important health care providing institution, has a special importance in returning physical and mental health to patients, training health sector specialists, medical research, and ultimately, promoting community health, it uses up a major proportion of health system resources [3]. For optimal use of its existing resources, inevitably it has to use economic analysis and performance evaluation indicators. Accordingly, the most important and usual mechanism in hospital performance evaluation is efficiency [4]. For various reasons, including the complex nature of productivity and difficulty in measuring the desired outcomes in this sector, for instance improvement of health; it is difficult to measure efficiency in health care. This has become even more complicated by the fact that status of health is affected by many factors, most of which occur beyond health care domain [5]. It is difficult to comment on performance of hospitals on the basis of unit cost data, since quality of care varies across hospitals. Higher unit cost in a center may reflect higher quality, poorer efficiency, patients with more severe diseases, or a combination of these factors [6]. Efficiency of hospitals can be shown through use of ratios that mainly measure use of hospital capacity [7]. The most important and practical ones are the three indicators: Bed Occupancy Rate (BOR), Bed Turnover Ratio (BTR), and Average Length of Stay (ALS) of patients in hospitals [8]. Every one of these three indicators can provide useful information to describe performance of hospital services [6]. It should be emphasized that evaluation based on only one of the indicators of hospital capacity to utilize beds may be inadequate and misleading. For instance, despite unnecessarily high average length of stay, high BOR may be due to factors such as poor nursing care, wrong planning of diagnostic and medical interventions, and spread of nosocomial infections. Thus, although BOR may indicate good use of capacity, but in fact, it happens

because of poor or inefficient performance of hospitals. Therefore, to avoid such a misleading conclusion, and to have a better picture, concurrent use of all three indicators is needed [9]. Because of mathematical relationship between them, descriptive power of these indicators increases when combined. Graphical representation of combination of these indicators was compiled by Pabon Lasso for Colombia hospitals in 1986 for rapid identification of technically inefficient hospitals [6]. The chart of combined three indicators is a rectangle containing 4 zones with following characteristics:

Zone 1: Represents hospitals with lower than acceptable average BOR and BTO, which indicate surplus hospital beds in relation to existing demands. In this case, hospital lacks required efficiency and will not be able to continue under such circumstances.

Zone 2: Represents hospitals with high BTO and BOR, indicating unnecessary hospitalization and excessive supply of hospital beds. Zone 3: Includes hospitals with both high BOR and BTO, and enjoy good efficiency.

Zone 4: Shows hospitals with high BOR, but low BTO, indicating either providing services for patients with serious chronic diseases, or patients with unnecessarily long ALS. Accordingly, long term hospitalization, low utilization of existing resources and high costs are characteristics of these hospitals. Typically, psychiatric and geriatric medical centers are in this group [10].

The above technique has been used in many countries in performance evaluation of hospitals, such that Asbo *et al.* in studying efficiency of 40 hospitals in Malawi using Pabon Lasso technique showed that 27.5% of hospitals were in the efficient zone and nearly 50% in inefficient zone [9]. Motaghi *et al.* recommended use of main efficiency indicators to hospital managers, such as those in Pabon Lasso graphic model, as they provide a more comprehensive perspective on identifying, analyzing, and evaluation of hospital problems to improve efficiency [11].

Thus, this analytical technique is applicable for assessing performance of hospitals, and finding subsequent appropriate strategies to overcome hospital inefficiency [12]. Several studies have been conducted in this and other parts of the world using this model, and have obtained valuable results. The present study investigates technical efficiency of hospitals in Bushehr province, and also compares efficiency of hospitals in a given period. In this study, by implementing economical concepts, the role of each of the three indicators has carefully been examined. Furthermore, because few hospitals were studied, it was possible to separately analyze each center and its movement process in the 4 zones of the chart. This study was designed with the aim to assess performance of hospitals affiliated to Bushehr University of Medical Sciences using Pabon Lasso graphic model, so that hospital managers and planners could be encouraged to endeavor to improve performance indicators for more effective and efficient hospital activities.

Method

The present descriptive cross-sectional study was conducted in 2012 to investigate performance of hospitals affiliated to Bushehr University of Medical Sciences including Fatemeh-Zahra Bushehr, 17 Shahrivar Borazjan, Zainabieh Khormuj, Imam Khomeini Kangan, Choromi and Amiralmomenin Genaveh, and Baqiyatallah Dailam, during 2009-2011, using Pabon Lasso model. For performance assessment of hospitals according to this model, three indicators of BOR, ALS, and BTO are required. This model is based on rectangular coordinates with BOR on the X-axis and BTO on the Y-axis. It can be seen in figure 1 that when mean BOR and BTO are placed on these two axes, parallel lines to vertical and horizontal axes, divide the above rectangle into 4 zone [13]. Coordinates of these two indicators show location of each hospital on the diagram. Line passing through origin is a function of hospital. Inverse slope of this line equals average patient stay in that hospital, and is specified at the end of this line.

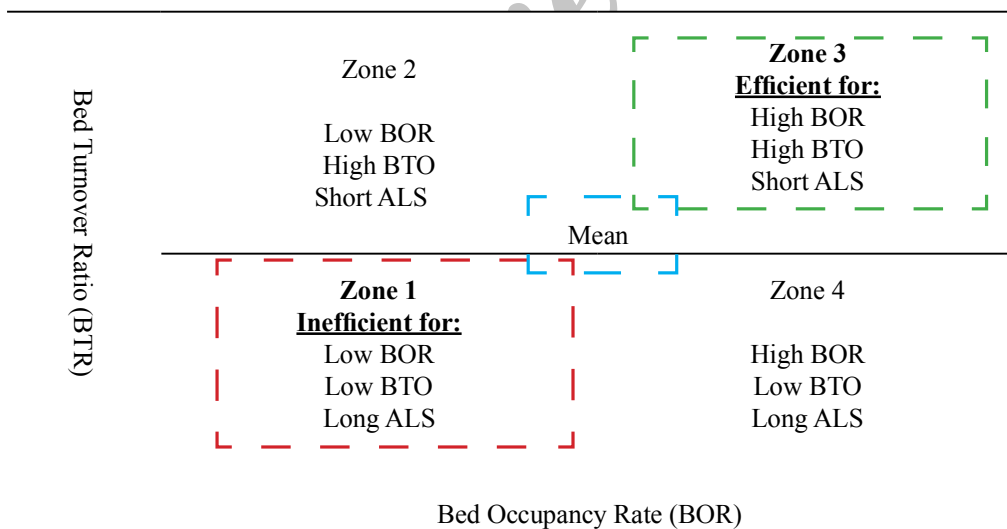


Figure 1 Position of hospital efficiency indicators on the 4 zones of Pabon Lasso model

Data required for the study were extracted from statistical yearbooks of Bushehr University of Medical Sciences, with collaboration of the university statistics office. Once rigor of data was assured, each year's chart was plotted using Excel software, and analysis was performed according to the model's manual.

Results

A total of 7 hospitals affiliated to Bushehr University of Medical Sciences entered the study, of which, Fatemeh-Zahra was a teaching hospital, choromi was an accidents and Burns single-specialty hospital, and the rest were general hospitals. Table 1 presents information about hospitals affiliated to

Table 1 Information about hospitals affiliated to Bushehr University of Medical Sciences from 2009 to 2011

No	Hospital name	Bed Occupancy Rate (BOR)			Bed Turnover Ratio (BTR)			Average Length of Stay (ALS)		
		2009	2010	2011	2009	2010	2011	2009	2010	2011
1	Fatemeh zahra	70	68	67	3	3	3	7/84	9/80	7/81
2	17 sahrivar	52	65	62	2	3	6/2	1/85	2/94	86
3	Zeinabieh	35	47	44	2	2	2	3/62	3/75	2/78
4	Imam khomeini	52	46	51	2	2	2	8/94	2/86	2/92
5	Choromi	20	18	17	10	10	1/7	2/7	2/6	1/9
6	Amiralmomenin	44	63	55	1	2	8/1	116	123	109
7	Baqiyetallah	23	23	21	2	2	2	7/34	36	38
Total		53	58	56	2	2	5/2	4/83	1/84	7/81

Bushehr University of Medical Sciences from 2009 to 2011. According to data presented in Table 1, the highest BOR and BTO were in 2009, and the longest stay was in 2011. The highest BOR (70) belonged to Fatemeh-Zahra Hospital in 2009, and the lowest (17) belonged to Choromi

Genaveh in 2011. Choromi Genaveh had the highest ALS, followed by Fatemeh-Zahra in Bushehr by three days during 2009-2011, and the lowest ALS (1) was in Dailam Baqiyatallah Hospital in 2009. The highest BTO (109) in 2011 was in Genaveh Amiralmomenin hospital and the lowest (6.2) was in 2009 in

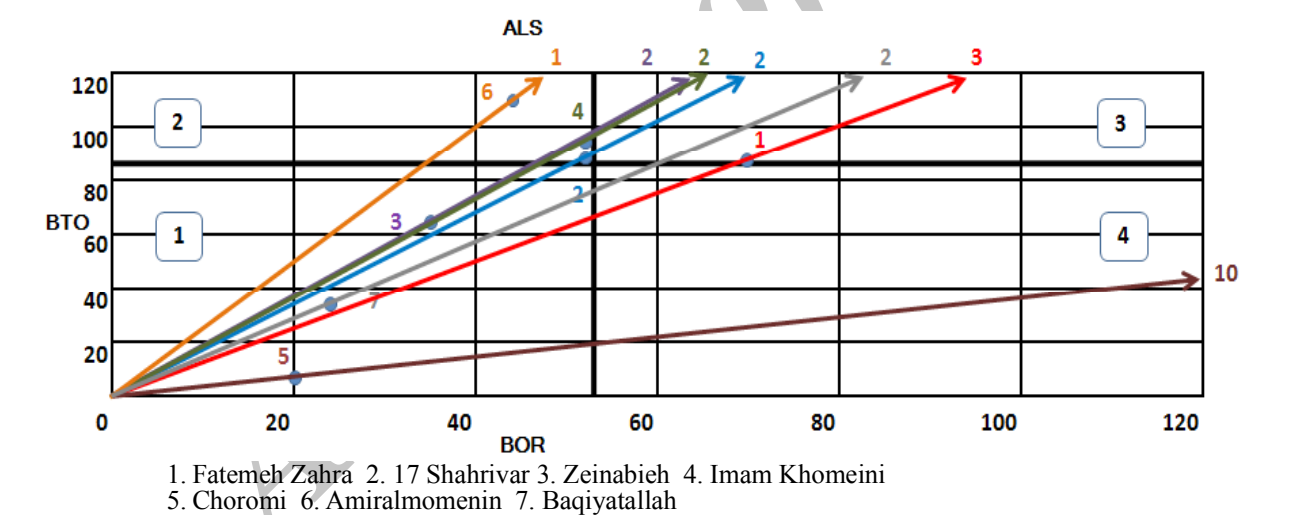


Figure 2 Performance of hospitals affiliated to Bushehr University of Medical Sciences according to Pabon Lasso model in 2009

Genaveh Choromi Hospital. It can be seen from figure 2 that in 2009, only Fatemeh-Zahra was in zone 3, despite being almost on the border with zone 4, and none of the hospitals were in zone 4. 17 Shahrivar was located on 3 and 4 borderzone, Kangan Imam Khomeini was on border of zone 3, and of Genaveh Amiralmomenin was in zone 2. Finally, Zainabieh Khormuj, choromi Genaveh and Baqiyatallah Dailam were in zone 1. According to Figure 3, Fatemeh-Zahra was in zone 4. 17 Shahrivar in Borazjan and

Amiralmomenin in Genaveh were in zone 4, Imam Khomai in Kangan in zone 2 (bordering to zone 1), and Zainabieh in Khormuj, Choromi in Genaveh, and Baqiyatallah in Dailam in zone 1. According to results in figure 4, in 2011, Fatemeh-Zahra Hospital was on the border of zones 3 and 4. 17 Shahrivar was in zone 3 close to 4. Amiralmomenin was in proximity of zone 3, and Imam Khomeini was in zone 3. Finally, Zainabieh, Choromi and Baqiyatallah were in zone 1.

Comparing these three figure reveals that Zainabieh, Choromi, and Baqiyatallah hospitals were consistently in zone 1 all three years, and Imam Khomeini hospital was in zone 2 all three years. Fatemeh-Zahra was in zones 3, 4 and on

the border of 3 and 4 during the three years, respectively. 17 Shahrivar was in zone 2 in the first year, and transferred to zone 3 the following years. Amirmomenin moved from zone 2 to 3, and finally back to 2.

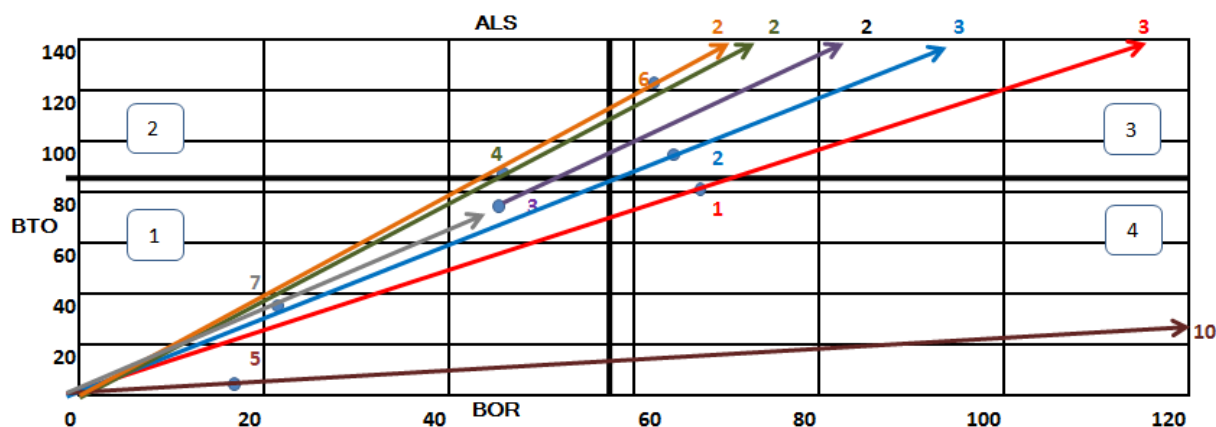
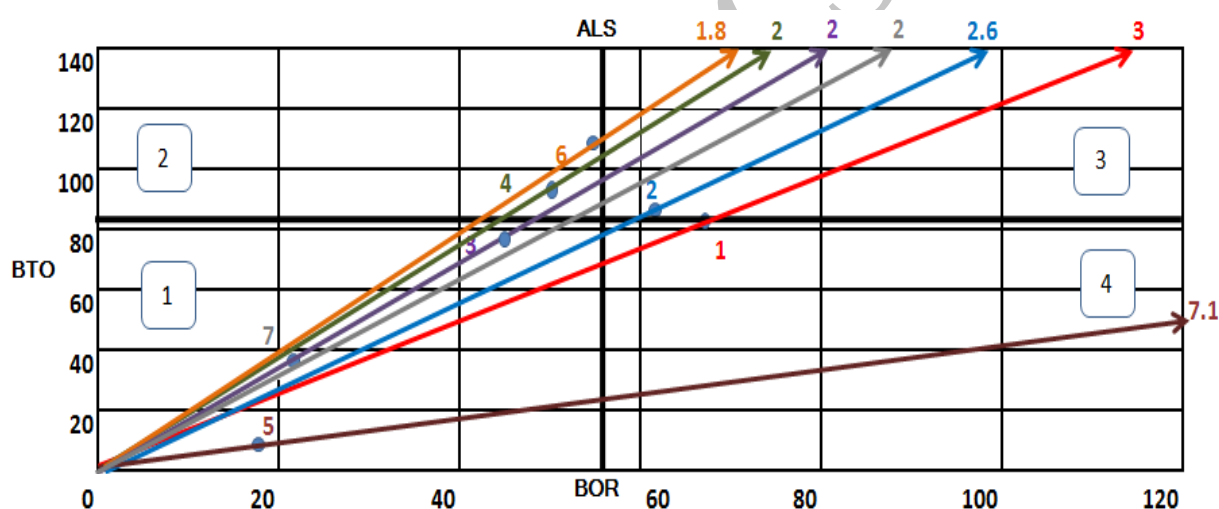


Figure 3 Performance of hospitals affiliated to Bushehr University of Medical Sciences according to Pabon Lasso model in 2010



3. Fatemeh Zahra 2. 17 Shahrivar 3. Zeinabieh 4. Imam Khomeini
7. Choromi 6. Amirmomenin 7. Baqiyatallah

Figure 4 Performance of hospitals affiliated to Bushehr University of Medical Sciences according to Pabon Lasso model in 2011

Discussion

According to study results, less than half of the hospitals were in zone 1 Pabon Lasso model (the most inefficient zone), and only 20% were in zone 3 (the most efficient zone). Three hospitals: Zainabieh, Choromi, and Baqiyatallah were in zone 1 in all three years, and Imam Khomeini Hospital in zone 2 (low occupancy, high bed turnover ratio). Fatemeh-Zahra Hospital was in zones, 3, 4 (high occupancy, low bed turnover ratio) and on the border of 3 and 4, respectively. 17 Shahrivar Hospital was in zone 2 in the first

year, and moved to zone 3 the next two years. Amirmomenin Hospital was also in zones 2 and 3, and returned to zone 2.

In this study, 3 hospitals (42.8%) were in zone 1 during the three years. In studies by Bahadori [14] in West Azarbaijan 26%, Goshtasbi [15] in Kohgiluyeh and Boyer-Ahmad 33.3%, Sajadi [16] in Isfahan in 2005 and 2006 10% and 6% respectively, Zairi [17] in Khuzestan 7.6%, Barati [18] in Tehran 26.6%, Kavousi [19], in Lorestan 28.6%, Pabon Lasso in Colombia in 1977 and 1980 35% and 33% respectively,

and Absu in Malawi in 2005 and 2006 47.5% and 65% respectively, of hospitals were in zone 1. In Nekoe-Moghadam study [10] in Kerman and Shiraz, none of the hospitals was in zone 1. In hospitals located in this zone, low performance in hospital efficiency indicators (low BOR, low BTO, and long ALS) is clear. Placement in this zone means there is excess supply of available beds, low demands compared to approved capacity and potential demand, which is indicative of patient's going to rival hospitals. In such circumstances, merger of wards or transfer of services to associated clinics may be cost-effective. A general solution for such hospitals is not to increase number of beds. When demand is low for hospitalization services, people conspire against hospital to reach better hospitals. Improving quality of services and referral system (for instance, allocation of more specialists' staff) may be appropriate to alter people's preferences. If this is not practical, it may be better to limit hospitalization services through depletion of services and descent of hospital ranking.

Imam Khomeini Hospital in all three years, 17 Shahrivar in 2009, Amirmomenin in 2009 and 2011 were in zone 2. In other words, in 2009, 2010, and 2011, 42.8%, 14.3% and 28.6% of hospitals respectively were in this zone. Percentage of hospitals in this zone in various studies was as follows: Bahadori [14] 8.7%, Sajadi [16], in 2005 and 2006 39% and 45% respectively, Zahiri [17] 26.9%, Barati [18] 13.3%, Kavoosi [19], 21.4%, Nekoe-Moghadam [10] 25%, Pabon Lasso [20] in 1977 and 1980 17% and 9% respectively, and Asbu [9] in 2005 and 2006 7.5% and 22.5% respectively. In Goshtasbi study [15] no hospital was in zone 2.

Surplus available beds, unnecessary hospitalization or use of beds for purposes such as monitoring patients lead to prolonged patient stay. Hospitalization of patients who have no serious problems may be seen in these hospitals. Activating specialist and outpatient clinics is recommended for these hospitals.

17 Shahrivar Hospital in 2010 and 2011, Fatemeh-Zahra Hospital in 2009, and

Amirmomenin Hospital in 2010 were in zone 3, so that in 2009, 2010 and 2011, 14.3%, 28.6%, and 14.3% of hospitals were in this zone. Percentage of hospitals in this zone in various studies was as follows: Bahadori [14] in 34.8%, Goshtasbi [15] 33.3%, Sajadi [16] in 2005 and 2006 45% and 43% respectively, Zahiri [17] 38.4%, Barati [18] 26.6%, Kavoosi [19], 35.7%, Nekoe-Moghadam [10] 50% Pabon Lasso in Colombia in 1977 and 1980 27% and 34% respectively, and Absu in Malawi in 2005 and 2006 27.5% and 12.5% respectively.

This is an acceptable zone in terms of efficiency, which leads to reduction in unused capacity. However, this does not mean adequacy of effort for the two hospitals in the present study, as improvement of efficiency has no ultimate limit. Thus, continued move toward improving hospital efficiency should take priority for managers.

Only Fatemeh-Zahra Hospital in 2010 and 2011 (14.3%) was in zone 4. In studies by Bahadori [14] in 30.4%, Goshtasbi [15] 16.6%, Sajadi [16] in 2005 and 2006 6% in both, Zahiri [17] 26.9%, Barati [18] 33.3%, Kavoosi [19], 14.3%, Nekoe-Moghadam [10] 25% Pabon Lasso in Colombia in 1977 and 1980 21% and 24% respectively, and Absu in Malawi in 2005 17.5% of hospitals were in zone 4.

Zone 4 contains hospitals that have high BOR, low BTO, and long ALS. In such hospitals, there may be high rate of patient services, admission of chronic patients, and unnecessary long stay. Proper planning and use of modern management techniques, or providing new services and use of advanced medical technologies and equipment are recommended for these hospitals to improve their low performance.

Choromi, Zainabieh, and Baqiyatallah hospitals were in zone 1 (the worst performing zone) all three years. Choromi hospital was in the worst possible position. Given the operational nature of burns hospitals, high ALS, and consequently low BTO are commonplace. Still, low BOR could be associated with several

factors, including low patient rate, shortage of facilities and equipment, lack of necessary specialties (including surgical and infection), and finally improper management. Through proper planning, improvement of performance indicators and move toward higher performance zones can be achieved. This situation was found in Zainabieh and Baqiyatallah hospitals. Even though Zainabieh Hospital was in a better position and close to zone 2, it did not show much improvement over the three years.

Imam Khomeini Hospital in Kangan was in zone 2 in all three years, which was not a good performance. Yet it showed a descending performance, such that in the first year it was bordering zone 3, but fell into the center of zone 2 in the following two years (even nearing are 1). Given BTO, and proximity of hospital to industrial zones, it is recommended that admission of new patients should increase, through adopting appropriate measures.

During the three-year period, Fatemeh-Zahra Hospital was in zone 3 (bordering or close to zone 4) or in zone 4. Considering that this hospital is the only teaching hospital in the province with many patient referrals, it is expected to have higher BOR to be able to transfer to zone 3. Improving quality of services, creating full specialty and subspecialty services and deployment of advanced equipment as well as proper management can help realization of this goal. Amir Hospital in Genaveh moved from zone 2 to 3, and back to 2. In this hospital, high BOR is observed, with low BTO. This hospital can make huge improvements through appropriate strategies and better use of capacities, and given that the area receives a lot of travelers, by attracting and admitting new patients. Finally, 17 Shahrivar Hospital in Borazjan, the best performing hospital in the province, was in zone 2 in the first year, but moved to zone 3 in the following two years, despite getting close to zone 4 in the last year. Given the extensive coverage area and existing facilities, it has the potential to maintain its position and even improve further. Officials' support and increased specialist services and facilities can also be beneficial.

Conclusion

This study aimed to evaluate performance of hospitals affiliated to Bushehr University of Medical Sciences using Pabon Lasso graphic model. According to study results, less than half of the hospitals were in zone 1 (the most inefficient zone), and only 20% were in zone 3 (the most efficient zone). Thus, to improve their technical efficiency, hospitals in zone 1 should adopt appropriate strategies such as removal or merger of activities, hospitals in zone 2 should activate specialist clinics, and hospitals in zone 4 should use modern management techniques or provide new services and use advanced medical technologies and equipments, in order to create the context to move to the efficient zone (zone 3). It should be noted that, using three specific indicators, this model can only assess utilization rates of hospital beds. As such, it cannot provide indications of efficacy and quality of services. Furthermore, in this study, hospitals had different sizes (number of beds), while in performance evaluation of hospitals, inefficiency due to non-optimal hospital size (outside manager's control), should also be considered. Therefore, care should be taken in using this model and extending results obtained. Accordingly, to account for inefficiency associated with size, uses of efficiency measures such as Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA), which contain productivity and cost functions, are recommended.

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Contributions

Study design: SI, SMKF, MA

Data collection and analysis: SG, AH, NF

Manuscript preparation: MA, SG, SI

Conflict of interest

"The authors declare that they have no competing interests."

References

1. Soroush F. Survey of personnel evaluation effect in improving the manpower's performance, from employee's perspective in the hospitals of Kermanshah [dissertation]. Ms Dissertation in health services management: Iran University of medical science2002; 87 [In Persian]
2. Jacobs R. "Alternative methods to examine hospital efficiency: data envelopment analysis and stochastic frontier analysis. *Health Care Manag Sci*2001; 4(2): 103-115.
3. Pour Reza A. Hospital cost analysis: guideline for managers. Tehran, Institute for Social Research 2003. [In Persian]
4. Pour Reza A, Goudarzi R, Azadi H. Technical efficiency of Tehran University Hospitals using data envelopment analysis(DEA). *Journal of the School of Public Health and Institute of Public Health Research*2009; 7(4): 86-79. [In Persian]
5. World Health Organization. "Technical Efficiency of district hospitals in Malawi (An exploratory assessment using data envelopment analysis 2008. Available at URL: www.medcol.mw/commhealth/publication/hm
6. Tanner, M. Urban health in developing countries: progress and prospects. Routledge2014.
7. Smith P, Mayston D. Measuring efficiency in the public sector. *Omega*1987; 15(3): 181-9.
8. Asefzadeh S. Hospital Research Management. Ghazvin, Hadise Emrooz; 2006. [Book in Persian].
9. Asbu E, Walker O, Kirigia J, et al. Assessing the efficiency of hospitals in Malawi: An application of the Pabón Lasso technique. *African Health Monitor*2012; 14(1): 28-33.
10. McKee, M., & Healy, J. The role of the hospital in a changing environment. *Bull World Health Organ*2000; 78(6), 803-10.
11. Motaghi M, Gholizadeh L, Ahmad AM, et al. Comparison of Efficiency in Kashan Medical Science University Hospitals, Using Indicators of Hospital Efficiency: 2010-2011. *Journal of Basic and Applied Scientific Research* 2012; 2(12): 12417-12425
12. Motaghi M, Gholizade, L, Ahmadi, AM., Delgoshaei B. Comparison of efficiency in kashan medical science university hospitals, using indicators of hospital efficiency: 2010-2011. *J Basic Appl Sci Res*2012, 2, 12417-25.
13. Forster DP, Frost B, Kamberska Z, et al. Supply, utilization and outcome in hospital systems: an Anglo-Czech comparison. *Health Policy*1999; 48: 171-8.
14. Nekoei-Moghadam M, Rooholamini A, Yazdi-Feizabadi V, et al. Comparing Performance of Selected Teaching Hospitals in Kerman and Shiraz Universities of Medical Sciences, Iran, Using Pabon-Lasso Chart. *Journal of Health & Development*2012; 1(1): 11-21. [In Persian]
15. Bahadori M, Sadeghifar J, Hamouzadeh P, Hakimzadeh SM, Nejati M. Combining multiple indicators to assess hospital performance in Iran using the Pabon Lasso Model. *AMJ*2011;4(4):175-9.
16. Goshtasebi A, Vahdaninia M, Gorgipour R, et al. Assessing Hospital Performance by the Pabon Lasso Model. *Iranian Journal of Public Health*2009; 38(2): 119-24.
17. Sajjadi H, Sajjadi Z, Hadi M. Is There any Method to Compare Key Indicators of Hospital Performance Simultaneity? *Journal of Health Information Management*2011; 8(1). 71-81. [In Persian]
18. Zahiri M, Keliddar I. Performance evaluating in hospitals affiliated in Ahwaz University of Medical Sciences based on PABON LASSO model. *Hospital Journal*2012; 11(3):37-44. [In Persian]
19. Barati Marnani A, Sadeghifar J, Pourmohammadi K, et al. Performance assessment indicators: How DEA and Pabon Lasso describe Iranian hospitals' performance. *Health Med*2012; 6(3): 791-6.
20. Kavosi Z, Goodarzi S, Almasiankia A. Performance Evaluation In Hospitals Of Lorestan University Of Medical Sciences Using Pabon-Lasso Model. *Payavard Salamat Journal*2012; 5 (6): 365-75. [In Persian]
21. Pabon Lasso H. Evaluating hospital performance through simultaneous application of several indicators. *Bull Pan Am Health Organ*1986; 20(4): 341-57.