How Efficient Rural Healthcare Centres Work in Iran?

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Abstract

The capital input scarcity and their late returns in health system together with other factors such as high cost of constructing new centers, expensive equipment, inadequate expert workforce and consequently slow development of healthcare facilities have always encouraged policy makers and decision-makers of health sector to make optimum use of resources and adopt proper management policies. To ensure the provision of the best and high quality, healthcare services require evaluation of health sector, as efficiency assessment is the first step in performance evaluation. Health education has been one of the most important and inspiring roles of rural healthcare centers and health workers. To evaluate the performance and efficiency of rural healthcare centers in Langarud County is the main objective of this study which can help to improve the efficiency of rural healthcare centers, and also help to make proper plans and strategies to reach those goals and develop such centers. There were 970 active rural healthcare centers in Guilan provinces in 2015, out of which 45 centers were in Langarud County. In this study, we have used CCR model to evaluate their technical efficiency, the results showed that 9 out of 45 rural healthcare centers with the efficiency score of 1, are efficient. Then using AP-CCR model, the units were ranked based on their efficiency. The rural healthcare centers in Garsak, Kuro-rudkhaneh and Malat got the best efficiency scores, respectively.

Keywords: Technical efficiency, Decision making units, Inputs, Outputs, Health services

Introduction

Efficiency is a concept that increases to enhance the quality of life, well-being, comfort and peace of mankind. These goals have always been the focus of attention of those involved in politics and economics. Due to its relation with the allocation and use of inputs, the efficiency has currently been very important.[1] Efficiency means that an organization properly uses its resources to produce the best performance at some point in time, so the efficiency is a measure of the performance in an organizational system. In other words, the efficiency is the use of resources to produce a certain amount of product.[2] Rural healthcare centers (in Iran known as Health Houses) are the most convenient and accessible health centers in rural areas. Each rural healthcare center, considering the geographical conditions, particularly communication facilities and the population, covers one or more villages. The staff trained to provide health service in these healthcare centers are known as health workers. Some tasks performed by rural healthcare centers include: conducting annual census and documentation of vital events such as deaths and births, community participation in health activities, parenatal and child care, health and nutrition education, taking care of students and school health,

dental health, monitoring the standards of occupational hygiene, public sanitation, screening, basic treatments and their follow-ups.[3]

Health has always been among the basic human needs.[4] Provision of health services for all people has been one of the goals of development plans in the Islamic Republic of Iran. For instance, article 29 of the Iranian Constitution noted the essential role of public and perfect health as the basic human needs and required the government to mobilize all of its resources, facilities and capacities to provide, maintain and promote the health of the people in the country.[5] The third development plan (2000-2005) stressed that government should take measures to enhance efficiency and develop health services in the country, facilitate public access to health services, develop rural health centers in areas where no investment is made by private sector to provide health services for rural people. The fourth development plan (2005-2009) emphasized on improving health and quality of life and protecting the environment for sustainable development through provision of equitable health services to the public and fair participation in financing the health sector.[6] Clearly, to fulfil this goal, it is essential to have proper facilities. As maintaining and improving the public health is among the country's priorities for development, those involved in the health sector are trying to take advantage of the resources at their disposal, and provide the best quality health services to the community.[7]

In recent decades, the high cost of medical services resulting from development of medical technology, and the heavy burden of such costs on most governments, have made policy makers admit that health is not just a social issue, and it should also be viewed from an economic perspective. Therefore, proper distribution of health facilities and their efficient use is of particular importance. Further, it seems inevitable to evaluate and improve the health system, and this would be possible only through further investigation of policies, increased efficiency, limiting the unnecessary costs and responding to needs of the society.[8]

Managers of health sector are always anxious to know if the units under their management are more efficient than other units, and how much efficient their unit is if there is any difference. These questions reflect the application of economic analysis in health units. One of the most important types of economic analysis is the efficiency analysis of the firms, which properly answer these questions and even more about the performance of such units. In fact, performance evaluation viewed as a source of feedback to the managers, can help them set priorities, compare the efficiency of various units, identify the reasons behind low or high efficiency, contribute to make more informed decisions as to continue or stop some activities or programs, and help optimally allocate resources to such units.[9] The performance evaluation of health service providers is now very important, and the use of assessment results, as an indispensable management tool has become popular among all executives at various levels of the health system.[10]

In this paper, we have used a credible and mathematically valid approach to evaluate the performance of rural health centers in Langarud County, which plays an important role in promoting national health in rural areas.

Materials and Methods

DEA is one of the widely used nonparametric methods of measurement. In this method, the efficient frontier curve is created by a set of points determined by linear programming. To find the points, one can use two assumptions of constant and variable returns to scale. Here the constant return to scale is used. As this model was proposed by “Charnes, Cooper and Rhodes”, it is known as CCR Model, which is formed from the

first letters of the name of these three people. It was introduced in 1978, in a paper titled "Measuring the Efficiency of Decision Making Units".[10] Returns to constant scale mean any multiplier from inputs would produce the same multiplier of the outputs. CRS return model to unit scale is assumed as constant. Therefore, small and large units are compared to each other. In this model, if a single unit changes in the inputs, the outputs will also change (increase or decrease) with a constant proportion. In fact, the slope of the production function in this model is constant.[11]

At relative measurement of the units, Farrell focused on balanced aggregate of units for building a virtual unit, and proposed the following relation as a common measurement tool for evaluating the technical efficiency:[12]

$$efficency = \frac{balanced\ \ aggregate\ \ outputs}{balanced\ \ aggregate\ \ inputs} \rightarrow (1)$$

If you seek to evaluate the efficiency of n units each of which has m inputs, and s outputs, the efficiency of the unit j (j=1,2,…,n) is calculated in the following way: to calculate the model of constant returns to scale for K production factor and M product that exists for each of the firms:[13]

$$Max\ Z_0 = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}$$

$$St: \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} < 1 \qquad \rightarrow (2)$$

$$U_r, v_i \geq 0$$

In the above equation, y represents the outputs of the model, and s represents the number of outputs. X is the inputs, and m is the number of inputs in the model. U and V represent the weight of variables in the weighted mean. In this equation, we seek to obtain the optimal values of U and V; in a way that ratio of the total weight of products to the total weight of production factors and each firm's efficiency is maximized.[14]

The problem with the above relation is that it has infinite optimal solutions. To avoid this problem, the constraint $\sum_{i=1}^{n} x_{ij0} v_i = 1$ could be added to the model, and change it into a linear programming format. As the method of linear programming for solving duality problem meant fewer constraints than the initial method, it is more appropriate to use the dual form:

$$Min\ y_0 = \theta$$

$$St: \sum_{j=1}^{n} \lambda_i y_{rj} \geq y_{r0}$$

$$\theta x_{i0} - \sum_{j=1}^{n} \lambda_i x_{ij} \geq 0 \qquad \rightarrow (3)$$

$$\theta, \lambda_j \geq 0$$

In fact, θ shows the optimal input proportions for gaining a definite value of products to the utilized proportion of the products. The numerical value of θ is between zero and one, and the more it is closer to one, the higher would be the levels of efficiency. Index i also represents the orientation of input in solving the duality problem.[15]

In the above models, the rural healthcare centers were divided into two groups: efficient and inefficient. Therefore, this model does not care about the ranking among efficient

centers, and efficient healthcare centers are marked by numerical value of one; to solve this problem, we will use Anderson-Peterson model.

Anderson–Peterson method

Anderson–Peterson in 1993 proposed a method for ranking efficient units, which made it possible to evaluate the most efficient units. In this method, the score of efficient centers could be higher than one; therefore, efficient units can be ranked the same as inefficient ones. This method consists of two steps: in the first step, we calculate efficiency the same as before. After identifying efficient centers, the constraints related to the same efficient center will be excluded from the model, so that efficiency could be estimated to be more than one.

$$Min\ Z = \sum_{r=1}^{s} y_{rj.\,ur}$$

$$St: \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \rightarrow (4)$$

$$\sum_{i=1\ ,\ i\neq j}^{n} v_i x_{ij\,.} = 1$$

$$U_r,\quad V_i \geq 0$$

X_{ij} is the i input for unit j (i:1,2, 3,…m)

Y_{rj} is the r output for unit j (i: 1, 2, 3,...,s)

U_r is the given weight to r output;

V_i is the given weight to the i input.

(4)

In the above equation, the constrain $\sum_{i=1}^{n} v_i x_{ij.} = 1$ is changed into $\sum_{i=1\ ,\ i\neq j}^{n} v_i x_{ij\,.} = 1$ and it is excluded from the constrains of the problem. As this constrain is excluded, the firm can achieve an efficiency of higher than one.

Results

The introduction of inputs and outputs

In this paper, the performances of 45 rural healthcare centers operating under supervision of Langarud Health Network have been evaluated. The number of health workers and expenditure of every health care center were taken as inputs, and Family Health patients, outpatients and patients who asked for wound dressing and injection were taken as outputs. Family Health patients include: clients of healthy pregnancy, child care and mothers-care, and outpatients included patients suffering from blood pressure, diabetes, or those who need help with mental health immunization, and other diseases. The inputs and outputs were for the period from 20 March 2015 to 20 March in 2016.

The results of CRS model

Based on the results of the CRS model, out of 45 healthcare centers that were evaluated, 9 healthcare centers of Garask, Kororoud Khaneh, Malat, Lower Leila Kouh, Kafsh Kan Mahaleh, Moridan, Ganjali Sara, Haji Sara and Dive-Shell were efficient (Table 1).

Reference rural healthcare centers in CRS Model

In order to improve the performance of inefficient rural healthcare centers, they should pursue some models. Based on the results, models used for each inefficient rural healthcare centers are summarized in the Table 2.

Ranking of efficient rural healthcare centers in CRS model

In order to rank rural healthcare centers in CCR model, the index of number of recurrences as a reference was taken into account. Accordingly, the ranking of efficient rural healthcare centers is summarized in the Table 3.

The results of the AP-CCR model

Anderson-Peterson model was used for ranking rural healthcare centers. Accordingly, rural healthcare center in Garask with the highest efficiency score was in the first place.

Discussion

According to the study results, 9 out of 45 rural healthcare centers in Langarud are efficient and the remaining ones are inefficient.

Among the efficient rural healthcare centers, the one in Garask ranked first, and the rural healthcare centers in Kororoud Khaneh, Malat, Lower Leila Kuh, Kafsh Kan Mahaleh, Moridan, Ganjali Sara, Hajji Sara, and Dive-shell were respectively ranked second to ninth. These findings are in consistent with Shoja et al. which evaluated the performance of rural healthcare centers in Firoozkooh. Based on the study results, 5 out of 18 rural healthcare centers in Firoozkooh were efficient and the remaining ones were inefficient. In ranking the rural healthcare centers, the one in Arjomand achieved the highest efficiency.

In this study which was conducted on Langarud County, the average efficiency of 36 rural healthcare centers was 61%, this suggests that potential average reduction of 39% has no effect on outputs.

The feasibility of DEA in this study showed that 80% of rural healthcare centers were inefficient and 20% were efficient, this is comparable to Marschall et al. study,[16] in which 30% of the rural healthcare centers in Burkina Faso were inefficient. Also, the study, in which 45 rural healthcare centers were evaluated using DEA, is in consistent with Caballer-Tarazona et al., on 22 hospitals in Valencia Association, in which 6 hospitals were effective and 16 were ineffective.

Hughes et al., evaluating 70 NSW hospitals, Lina evaluating 43 public hospitals in Finland, Webster et al., evaluating 301 private hospitals in Australia, and Sear and Chirikos evaluating 186 hospitals in Florida have all emphasized using DEA for evaluating the efficiency of hospitals. Meanwhile, Gannon evaluating 60 hospitals in Ireland[17] and Mortimer and Peacock on 38 public hospitals in Australia all used DEA to evaluate the relative efficiency of the hospitals.

The results provide authorities with a clear view of the capabilities of rural healthcare centres and managers of health sector, in a way that managers can use the results to evaluate the performance of rural healthcare centres, and make proper decision to

overcome the weaknesses. Therefore, we can identify the strengths and weaknesses through examining the results and rankings in this article, and accordingly, one can assess the realization of strategic goals of health sector, and define the future strategy for each unit.

Conclusion

Interpreting the efficiency score of rural healthcare centres, we found that some units have a performance score higher than others, and tend to be efficient. But some other units are known as the most inefficient units and require more time and endeavour to improve their efficiency.

In some units, some special administrative policies are adopted such as reducing the costs of consumables and reconsidering the allocation of funds for some units, in a way that the output is commensurate with its costs. In some other units, layoffs could be useful where there are a few clients, and one person can properly perform the tasks and be responsive to clients and provide the services. This way, the surplus workforce would be employed for units which do not have enough staff. The study also revealed that in some units, the total number of clients to the population is falsely too high or too low, which could be caused by various factors such as cultural view of the rural people towards going to rural healthcare centres, etc. If such factors are identified, they could be used to promote the efficiency of such centres. Besides, some inefficient centres can model the centres introduced in the table as referral model, and reduce the cost of inputs, or increase their total outputs for example through the number of patients, etc., to achieve higher efficiency.

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Table 1: Inputs and outputs used to analyze the efficiency of rural health centers in Langarud County.

code	Title of rural healthcare centers	outputs			inputs	
		wound dressing	outpatients	family health clients	costs (million Rials)	number of health workers
1	Daryasar	50	707	1984	107	3
2	Lower Salkoyeh	49	2376	378	118	2
3	Dive-Shell	79	2700	5689	230	3
4	Talesh Mahaleh	238	660	465	90	2
5	Lower Leila Kouh	45	1500	3806	100	2
6	Lower Nalekiya Shahr	20	240	480	35	2
7	Tazehabad	60	738	924	48	1
8	Sadat Mahaleh	20	1420	1349	70	1
9	Khalikyasar	26	1807	1569	128	2

10	Lower Popkiyadeh	40	1060	472	57	2
11	Upper Popkiyadeh	23	950	1218	82	2
12	Agha Ali Sara	24	332	516	43	1
13	Pour-Shokuh	38	1145	218	98	2
14	Haji Sara	48	2850	1856	80	2
15	Taleb Sara	15	990	1100	40	1
16	Golab Mahaleh	32	1880	1300	60	2
17	Liseh Roud	66	1680	1200	63	1
18	Moridan	200	3000	3500	121	3
19	Malat	40	2265	1500	69	1
20	Yaghobiyeh	68	1020	1574	88	2
21	Sigaroud	24	1599	721	55	2
22	Bipass Bagh	60	1080	980	69	1
23	Lower Shekar-kesh	40	1118	193	105	2
24	Pileh Mahaleh layl	50	918	219	57	1
25	Lower Parvaresh	90	1156	1020	65	2
26	Tazeh Abad Kurd-Sara Kouh	35	1815	820	102	2
27	Khorma	40	1020	600	53	1
28	Kororoud Khaneh	300	1005	450	105	2
29	Kafsh Kan Mahaleh	120	2350	1400	67	3
30	Sadaat Mahaleh Nalekiya Shahr	36	1652	184	70	2
31	Sadaat Mahaleh Koshalshad	7	1090	1400	90	1
32	Lowkalayeh	42	1982	1800	105	2

33	Miyan Mahaleh Koshal-shad	10	1211	240	73	2
34	Fatideh	42	1860	792	88	2
35	Gol Sephid	20	1369	373	71	2
36	Darya Kenar	50	1335	1060	89	2
37	Pir Poshteh	48	1508	264	56	2
38	Lat-leil	45	1207	947	70	2
39	Bolordakan	85	316	100	55	2
40	Sarleil	30	391	150	50	2
41	Lower Siyah Manaseh	63	741	173	65	2
42	Kohlestan	50	540	725	53/7	2
43	Kiya Gahan	32	598	1896	63	2
44	Garask	210	1010	300	52/5	2
45	Ganjali Sara	20	1800	1700	57	1

Table 2: Average of precision and recall facing the number of retrieved outputs.

Rows	rural healthcare centers	Performance score in CCR	Performance status	Row	rural healthcare centers	Performance score in CCR	Performance condition
1	Daryasar	0.533	Inefficient	24	Pileh Mahaleh layl	0.619	Inefficient
2	Lower Salkoyeh	0.61	Inefficient	25	Lower Parvaresh	0.678	Inefficient
3	Dive-Shell	1	Efficient	26	Tazeh Abad Kurd-Sara Kouh	0.525	Inefficient
4	Talesh Mahaleh	0.892	Inefficient	27	Khorma	0.632	Inefficient

5	Lower Leila Kouh	1	Efficient	28	Kororoud Khaneh	1	Efficient
6	Lower Nalekiya Shahr	0.435	Inefficient	29	Kafsh Kan Mahaleh	1	Efficient
7	Tazehabad	0.808	Inefficient	30	Sadaat Mahaleh Nalekiya Shahr	0.664	Inefficient
8	Sadat Mahaleh	0.8	Inefficient	31	Sadaat Mahaleh Koshalshad	0.783	Inefficient
9	Khalikyasar	0.477	Inefficient	32	Lowkalayeh	0.611	Inefficient
10	Lower Popkiyadeh	0.534	Inefficient	33	Miyan Mahaleh Koshal-shad	0.466	Inefficient
11	Upper Popkiyadeh	0.46	Inefficient	34	Fatideh	0.619	Inefficient
12	Agha Ali Sara	0.399	Inefficient	35	Gol Sephid	0.541	Inefficient
13	Pour-Shokuh	0.368	Inefficient	36	Darya Kenar	0.495	Inefficient
14	Haji Sara	1	Efficient	37	Pir Poshteh	0.761	Inefficient
15	Taleb Sara	0.878	Inefficient	38	Lat-leil	0.543	Inefficient
16	Golab Mahaleh	0.896	Inefficient	39	Bolordakan	0.397	Inefficient
17	Liseh Roud	0.993	Inefficient	40	Sarleil	0.258	Inefficient
18	Moridan	1	Efficient	41	Lower Siyah Manaseh	0.418	Inefficient
19th	Malat	1	Efficient	42	Kohlestan	0.502	Inefficient

20	Yaghobiyeh	0.588	Inefficient	43	Kiya Gahan	0.819	Inefficient
21	Sigaroud	0.816	Inefficient	44	Garask	1	Efficient
22	Bipass Bagh	0.826	Inefficient	45	Ganjali Sara	1	Efficient
23	Lower Shekar-kesh	0.343	Inefficient				

Table 3: Benchmarking for inefficient rural healthcare centers in CRS method.

Rows	Rural healthcare centers	Benchmark 1	Benchmark 2	Benchmark 3	Benchmark 4
1	Daryasar	Moridan	Lower Leila Kouh		
2	Lower Salkoyeh	Garask	Kafsh Kan Mahaleh	Malat	
3	Talesh Mahaleh	Moridan	Garask	Kororoud Khaneh	
4	Lower Nalekiya Shahr	Lower Leila Kouh	Moridan		
5	Tazehabad	Malat	Lower Leila Kouh	Moridan	Kororoud Khaneh
6	Sadat Mahaleh	Dive-Shell	Ganjali Sara	Malat	
7	Khalikyasar	Malat	Ganjali Sara	Dive-Shell	
8	Lower Popkiyadeh	Kafsh Kan Mahaleh	Malat	Hajji Sara	
9	Upper Popkiyadeh	Lower Leila Kouh	Moridan	Ganjali Serra	
10	Agha Ali Sara	Kororoud Khaneh	Moridan	Lower Leila Kouh	
11	Pour-Shokuh	Garask	Kafsh Kan Mahaleh	Mortar	

12	Taleb Sara	Lower Leila Kouh	Moridan	Ganjali Serr a	
13	Golab Mahaleh	Kafsh Kan Mahaleh	Ganjali Sara	Hajji Sara	
14	Liseh Roud	Lower Leila Kouh	Moridan	Mortar	Kororoud Khaneh
15	Yaghobiyeh	Kvrvrvdkhan h	Moridan	Lower Leila Kouh	
16	Sigaroud	Hajji Sara			
17	Bipass Bagh	Malat	Kororoud Khaneh	Divshal	
18	Lower Shekar-kesh	Garask	Kafsh Kan Mahaleh	Malat	
19	Pileh Mahaleh layl	Kororoud Khaneh	Garask	Malat	
20	Lower Parvaresh	Moridan	Malat	Garask	Kafsh Kan Mahaleh
21	Tazeh Abad Kurd-Sara Kouh	Malat	Hajji Sara	Kafsh Kan Mahaleh	
22	Khorma	Garask	Kafsh Kan Mahaleh	Malat	
23	Sadaat Mahaleh Nalekiya Shahr	Kafsh Kan Mahaleh	Hajji Sara		
24	Sadaat Mahaleh Koshalshad	Sara Ganjali	Divshal		
25	Lowkalayeh	Ganjali Sara	Moridan	Kafsh Kan Mahaleh	Malat
26	Miyan Mahaleh Koshal-shad	Hajji Sara			
27	Fatideh	Kafsh Kan Mahaleh	Hajji Sara	Malat	
28	Gol Sephid	Hajji Sara			

29	Darya Kenar	Malat	Moridan	Kafsh Kan Mahaleh	Garask
30	Pir Poshteh	Kafsh Kan Mahaleh	Hajji Sara		
31	Lat-leil	Moridan	Kafsh Kan Mahaleh	Sara Ganjali	Malat
32	Bolordakan	Garask	Kororoud Khaneh		
33	Sarleil	Mortar	Garask	Kafsh Kan Mahaleh	
34	Lower Siyah Manaseh	Garask	Kafsh Kan Mahaleh	Malat	
35	Kohlestan	Moridan	Garask		
36	Kiya Gahan	Lower Leila Kouh	Moridan		