Presenting a model to evaluate efficiency and improve step by step in the health care networks of Ahvaz Jundishapur University of Medical Sciences

Soliman Kamaei
PhD student in Accounting, Science & Research Branch, Islamic Azad University, Tehran, Iran.

HamidrezaVakilifard
Associate Professor, Science & Research Branch, Islamic Azad University, Tehran, Iran.(corresponding Author)
vakilifard_phd@yahoo.com

Submit: 23/01/2021 Accept: 07/02/2021

ABSTRACT

Health networks operate as a subset of universities of medical sciences and health services with the aim of providing health care through the generalization and expansion of health, medical and educational services. In this article, we present a model to evaluate the efficiency and step by step improvement in the health care networks of Ahvaz Jundishapur University of Medical Sciences. At first, using previous studies, performance evaluation criteria in the field of health care network were identified, then, by interviewing experts, the evaluation criteria were finalized. The results showed that out of 18 health care networks of Ahvaz Jundishapur University of Medical Sciences, 9 health care networks are inefficient and using the model presented as a model, in order to improve the health care network step by step Was taken

Keywords:

Performance evaluation, step by step improvement, Health Network, Ahvaz Jundishapur University of Medical Sciences.

1. Introduction

Health care networks in different societies are the foundation of physical and mental health of individuals and prerequisites for sustainable development. Due to the relationship with community health, these organizations need to use efficient methods in providing services to improve quality, low health costs and timely meet the needs of clients, which is only in the shadow of using new methods of information management and allocating appropriate time to the matter. Knowledge management is possible (Mirghfouri et al., 2009).

Evaluate the performance of the health care system to form a common vision of prioritization to strengthen health care systems, provide a platform for dialogue between programs and between different departments, and establish a common understanding to communicate activities that have implications. In addition, evaluating the performance of health care systems helps health decision makers and politicians to be accountable for their decisions so that they can make better decisions to improve their actions (Nasrullah Poor Shirvani and Tahmasebi, 2016). Data envelopment analysis is a nonparametric method based on mathematical programming to evaluate the performance of a set of decision units (DMUs) with multiple inputs and outputs. Farrell (1957) first proposed non-parametric methods for determining efficiency. His work was generalized in 1978 by Charans, Cooper, and Rhodes to the Data Envelopment Analysis (DEA), leading to the CCR paper. Generalized. In 1984, the BCC paper was published by Bunker, Charans, and Cooper. In addition to the models presented in CCR and BCC papers, other basic models such as collective models and SBM were proposed (Ton, 2001).

The use of data envelopment analysis in the field of health has had a growing trend in recent years, for example, Nazari (1998) in a study to evaluate the performance of managers at different levels of the health network system in Semnan and Mazandaran provinces descriptively -Analytical payment. The statistical population includes 158 managers and 472 employees working in urban health centers of the two provinces (28 centers), 63 managers and 947 employees working in the hospitals of the two provinces (25 hospitals) and 900 adult patients (20 years and older). He was hospitalized in the mentioned hospitals. The results of their research show that there was a significant difference between employee evaluation scores of health care network managers, self-evaluation scores of health care network managers and also between employee evaluation scores of hospital managers performance in two provinces. Dargahi and Droudy (2015) in a study evaluated the performance of health centers in the south of Tehran health network. The results of their research show that the performance of all health centers studied was lower than the average (56.1) and the highest mean score was related to the continuity of care (64.2) and the lowest average score (0.81) was related to the comprehensiveness index. It was care. Junidi Jafari et al. (2015) in a study evaluated the safety and risk of health centers under the auspices of Iran University of Medical Sciences in 1994. To conduct the study, they used disaster risk assessment guidelines in the health care network system and completed the forms of threat hazard identification, functional readiness assessment, structural and non-structural vulnerability assessment at the level of 214 health units under the auspices of Iran University of Medical Sciences. According to the results of the study of health centers of Iran University of Medical Sciences, the level of functional readiness is 23%, the level of safety of non-structural elements, structural and total safety is 27, 20 and 22%, respectively. The disaster safety index was also estimated at 3 out of 10. Zare Ahmadabadi et al. (2015) in a study used a quasi-experimental method based on mathematical modeling to identify and investigate the behavior of variables that explain the efficiency of health centers. After identifying the research variables from the data envelopment analysis model and Lingo software, they evaluated the efficiency of health centers. Their findings indicate different and sometimes thought-provoking levels of efficiency among health centers in Yazd. Most health centers have a combined score between 0.6 and 0.9 and only two health centers, Cotton Farmers and Akbari Safaieh, are located on the Kara border. Nasrollahpour *et al*. (2016) studied the performance evaluation models of health systems during 1998 to 2012 and discussed the experiences of some countries in performance evaluation in the health sector.

Evaluating the performance of health centers shows how to implement the planned programs in these centers and identifies the shortcomings that have occurred. But the evaluation of health centers by scientific and citation models is important (Sherman and Sherman, 2000).

In this research, at first, the important criteria for evaluating the efficiency in the field of health care network are identified and finalized according to the information contained in the financial statements of health care networks. In the next step, we evaluate the efficiency of the health care network using data envelopment analysis models. This study, for the first time, presents a step-by-step improvement process for inefficient health care networks and models for improving their efficiency.

2. The concept of improvement potential in data envelopment analysis

The potential for improvement and how to calculate it was first introduced by Bogtoft and Hoggard in 1999. Bogtoft and Hoggard (2004) developed a model of hyperfunction to measure the potential for improvement. He used the potential for improvement as a practical example for Danish elderly care, which we will introduce in the following concept of the potential for improvement for data envelopment analysis.

Suppose that: we have n health networks, which we call DMUs. We show the inputs and outputs of this DMU with X and Y, respectively. To evaluate the efficiency of a health care network, for example o (o = 1,…, n), we use the following model:

$$\theta^* = min\frac{1}{m}\sum_{i=1}^{m}\theta_i$$

$$\sum_{j=1}^{n}\lambda_j x_{ij} \leq \theta_i x_{io} \qquad i = 1, ...,$$

$$\sum_{j=1}^{n}\lambda_j y_{rj} \geq y_{ro} \qquad r = 1, \dots, s$$

$$\lambda_j \geq o \qquad (j = 1, \dots, n)$$

In fact, the purpose of this model is to create a non-negative combination of inputs and outputs of the health care network, which can be compared to each of the inputs and outputs of the health care network under evaluation according to this negative combination. If the optimal value of this model is θ equal to 1, it indicates that the health care network is inefficient, and if it is less than 1, it indicates the inefficiency of the health care network in using the inputs to generate output. Using this model, not only can the efficiency of each health care network be obtained, but also it can be used to rank these centers. To measure the degree of inefficiency in each health care network, we use the index introduced by Bogftoft and Hoggard (1999). This index is as follows:

$$E^{NR}(\mathbf{x}) = \sum_{i=1}^{m}\frac{(1-\theta_i^*)x_i}{x_i^+ - x_i^-}$$

$E^{NR}(\mathbf{x})$ The recovery potential index is called the inefficiency index. For an efficient health care network, this value is zero, and for inefficient centers, this value is positive. The higher the value, the worse the health care network is.

2.1. The potential for step-by-step improvement

Health policymakers are always looking for answers to the question of what policies should be implemented for an inefficient health care network to improve their performance. $E^{NR}(\mathbf{x})$ indicates the potential for improving the level of inefficiency of the health network, but two things are discussed here. First, having the potential index for improving a health network, how to change its inputs and outputs so that we can have a health network be efficient. To achieve this goal, we propose the concept of potential for step-by-step improvement. If we want to improve E' the potential improvement index of a health care network as it is $E' \leq E^{NR}(\mathbf{x})$.

$$\min = \sum_i \alpha_i$$

$$s.t \quad \sum\frac{(1-\alpha_i)x_i}{x_i^+ - x_i^-} = E' \leq E^{NR}(\mathbf{x})$$

$$0 < \theta_i^* \leq \alpha_i \leq 1$$

$$i = 1, \dots, m$$

Considering the inputs as the amount of reduction in the inputs in order to achieve the potential for improvement is provided. According to the policy of Ahwaz Jundishapur University of Medical Sciences, it is not possible to reduce the inputs of the health care network to improve their performance at once. So it has to improve part of the performance step by step. To do this, do a $\left[0, E^{NR}(\mathbf{x})\right]$ split in the interval and move on $E^{NR}(\mathbf{x})$ to zero and the health network efficiency and each time provide an improvement $(\alpha_i x_i)$ pattern for network and health care inputs.

3. Evaluating the efficiency and improving the health care networks of Ahvaz Jundishapur University of Medical Sciences step by step

Network and Health Names of Ahwaz University of Medical Sciences showed in table (1):

No.	Health care networks	No.	Health care networks
1	Dashte Azadegan	10	Masjdisoleiman
2	LaLi	11	Andimeshk
3	Omidieh	12	Haftgel
4	Izeh	13	Hamidieh
5	Baghmalek	14	Dehdez
6	Bavi	15	Ramshir
7	Hendijan	16	Andika
8	Karoon	17	Ramhormoz
9	Hoveyzeh	18	Mahshahr

In order to evaluate the efficiency of the network and health care using the proposed model, some items should be considered as evaluation criteria. To do this, the financial evaluation criteria of this health network are used in their financial statements. These criteria are listed in Table (2) below.

Table (2): Criteria for evaluating the efficiency of the health network

Performance evaluation criteria	Input or output type
Dedicated income	Output
Staff salaries	Input
Use of goods and services	Input
Sale of goods and services	Output
Total assets	Input
Health materials and supplies	Input

In addition, to evaluate the performance using data envelopment analysis models, we must divide these criteria into two categories of input and output, which are given for these criteria in the third column of Table (2) of this category. If the criterion for reducing it is to improve the efficiency of the health care network, it is referred to as input, and if its increase indicates an improvement in the efficiency of the health care network, it is referred to as output.

After determining the performance evaluation criteria, we collected information about these criteria in Ahvaz Jundishapur Medical Sciences Health Network. This information is extracted from the financial statements of the health network and is given in Table (3) below.

Table (3): Input and output information related to health care networks of Ahvaz Jundishapur University of Medical Sciences

Health Network	Health materials and supplies	Total assets	Sale of goods and services	Use of goods and services	Staff salaries	Dedicated income
Dashte Azadegan	1393061494.00	59112336211	54035486997.00	52236127628.00	106670453974.00	56368677846.00
Lali	402,621,081	28,059,031,924	41933017699.00	39,762,840,944	87,089,785,216	40,772,164,982
Omidieh	448,558,427	37,717,580,974	36,542,512,380	33,360,454,595	80,955,313,186	43,404,835,132
Izeh	2,481,772,227	110,205,904,398	73,793,557,660	80,076,292,724	139,568,165,063	81,867,455,753
Baghmalek	1,525,017,813	70,618,583,674	93,144,699,568	64,834,895,823	143,881,381,345	100,133,627,584
Bavi	387,149,053	37,152,743,397	81,857,652,890	58,650,133,915	96,064,928,548	76,870,134,820
Andika	443,657,987	38,445,388,930	67,548,016,333	76,739,104,554	72,909,497,811	81,041,871,918
Ramhormoz	439,500,966	50,635,831,617	52,250,473,755	57,503,562,610	97,825,074,821	54,083,281,147
Mahshahr	824,048,431	145,419,494,171	47,960,426,192	54,568,918,963	90,580,723,528	48,486,705,680
Masjedsolieman	416,836,227	48,008,367,962	27,910,473,925	33,046,682,322	99,421,525,897	32,639,741,951
Andimeshk	1,363,059,915	242,807,394,173	49,173,950,128	27,706,591,809	286,525,887,147	52,618,369,309
Haftgel	602,493,699	39,740,615,150	33,620,231,277	33,827,339,380	57,172,778,367	34,625,744,194
Hamidieh	343,636,560	22,073,705,094	52,251,352,475	54,545,078,901	42,834,744,772	54,726,193,034

Health Network	Health materials and supplies	Total assets	Sale of goods and services	Use of goods and services	Staff salaries	Dedicated income
Dehdez	272,228,771	32,499,034,379	25,893,544,794	19,856,867,255	66,682,084,679	33,065,729,446
Ramshir	566,695,938	35,580,925,160	44,520,442,922	29,250,685,192	51,410,285,662	37,038,385,335
Hendijan	155,334,504	69,783,267,763	34,721,991,067	27,119,586,269	55,121,383,941	32,966,226,921
Karoon	205,144,290	23,438,809,215	49,923,378,662	37,326,850,854	93,151,083,848	54,213,426,372
Hoveizeh	184,440,415	40,418,817,661	48,552,200,788	38,055,885,363	68,288,195,285	49,081,017,255

After determining the criteria for evaluating the efficiency of the health care network and collecting its information, we will evaluate the efficiency, we also want to calculate the potential for their improvement, we also use Lingo software. The results of the implementation of these models are given in Table (4) below.

According to the results, half of the health care network was efficient and the other half were inefficient. For an efficient health care network, the potential for improvement is zero, because it does not need to be improved in terms of its criteria. Among this network, Izeh Health has the greatest potential for improvement. In fact, this healthcare network makes the worst use of its inputs and has the potential for high improvement to achieve efficiency.

There are two questions here that will be answered below.

Question 1: For an inefficient health care network, how much should they reduce their inputs in order to achieve efficiency?

To answer this question, it is enough to put it in the formula: $E^{'} = E^{NR}(\mathbf{x})$ and by implementing it for the inefficient health care network, the amount of inputs of this health care network in order to make them efficient is given in Table (5) below.

In order for these 9 health care networks to be efficient, their input consumption must be reduced to the values given in Table (5). Also, in table (6) below, in order to compare the reduction ratio of inputs for Izeh health network, it is given.

Table (4): Amount of efficiency and improvement potential for the health care network

Health Network	$E^{NR}(\mathbf{x})$	$\boldsymbol{\theta}^{*}$
Dashte Azadegan	1.44	0.53
Lali	0.76	0.64
Omidieh	0.36	0.67
Izeh	2.29	0.49
Baghmalek	0	1
Bavi	0	1
Andika	0	1
Ramhormoz	0.72	0.63
Mahshahr	1.58	0.45
Masjedsolieman	1.11	0.45
Andimeshk	0	1
Haftgel	0.71	0.55
Hamidieh	0	1
Dehdez	0	1
Ramshir	0	1
Hendijan	0.43	0.74
Karoon	0	1
Hoveizeh	0	1

Table 5: Inputs related to inefficient health care networks in order to be efficient

Health Network	Health materials and supplies	Total assets	Use of goods and services	Staff salaries
Dashte Azadegan	139306100	5911234000	12487440000	106670500000
Lali	40262110	2805903000	10265100000	87089790000
Omidieh	44855840	3771758000	31392150000	80955310000
Izeh	248177200	11020590000	27049240000	139,568,165,063
Ramhormoz	43950100	5063583000	36817130000	97825070000
Mahshahr	82404840	14541950000	14324870000	90580720000
Masjedsolieman	41683620	4800837000	3304668000	82374460000
Haftgel	60249370	3974062000	14865090000	57172780000
Hendijan	15533450	6978327000	21978080000	55121380000

Table (5): The ratio of reduced inputs for the efficiency of the health network and in Izeh

Health materials and supplies	Total assets	Use of goods and services	Staff salaries	
2,481,772,227	110,205,904,398	80,076,292,724	139,568,165,063	Main input
248177200	11020590000	27049240000	139,568,165,063	Reduced inputs for efficiency
0.10	0.10	0.33	1	Reduction ratio

This reduction ratio states that in order to achieve the desired level of efficiency, the Izeh Health Network must increase the input of employees' salaries unchanged, the use of goods and services by 33%, the total assets by 10%, and materials and supplies. Reduce health consumption by 10%. But the problem here is that the Izeh Health Network cannot have this reduction in input all at once. To solve this problem, we use the potential for step-by-step improvement.

Another question that arises:

Question 2: How much should they reduce their inputs for the inefficient health care network in order to achieve a step-by-step improvement?

Consider the Izeh Health Network, which has the highest potential for improvement compared to other health care networks. Its improvement potential is 2.29. In a step-by-step improvement process, we want to improve this performance potential in four steps.

Consider the Izeh Health Network, which has the highest potential for improvement compared to other health care networks. Its improvement potential is 2.29. In a step-by-step improvement process, we want to improve this performance potential in four steps. The improvement potential for the first stage of improvement is 0.58, for the second stage of improvement is equal to 1.15, for the third stage of improvement is equal to 1.72 and for the fourth stage of improvement (efficiency) is calculated to be 2.29. The results are given in Table (6) below.

Table (6): Step-by-step improvement potential for Izeh Health Network

Health materials and supplies	Total assets	Use of goods and services	Staff salaries	
2,481,772,227	110,205,904,398	80,076,292,724	139,568,165,063	Main input
2177809000	11020590000	80,076,292,724	139,568,165,063	First stage improvement inputs (reduction ratio)
0.87	0.10	1	1	Reduction ratio in step 1
851739200	11020590000	80,076,292,724	139,568,165,063	Second stage improvement inputs (reduction ratio)
0.34	0.10	1	1	Reduction ratio in stage 2
248177200	11020590000	61374310000	139,568,165,063	Third stage improvement inputs (reduction ratio)
0.10	0.10	0.76	1	Reduction ratio in stage3
248177200	11020590000	27049240000	139,568,165,063	Fourth stage improvement inputs (reduction ratio)
0.10	0.10	0.33	1	Reduction ratio in stage 4

As you can see in Table 6, a 10 percent reduction in total asset inflows and an 87 percent reduction in health supplies and supplies can result in a quarter of an improvement in the efficiency of the Izeh Health Network. Similarly, according to the second stage, with a 10% reduction in the total input of assets and 34% in health and medical supplies and materials, half of the inefficiency of the Izeh health network will be improved. In the third stage, with a 76 percent reduction in the use of goods and services and a 10 percent reduction in total assets and a 10 percent reduction in healthcare materials and supplies, only 25 percent of the inefficiency for the Izeh health care network remains. Finally, to be effective, the Izeh Health Network must have a 33 percent reduction in the use of goods and services, a 10 percent reduction in total assets, and a 10 percent reduction in health and medical supplies and supplies.

A similar analysis can be made for other inefficient health care networks. In fact, this model can provide a step-by-step improvement for other inefficient health care networks.

4. Discussion and conclusion

In this article, we presented a new concept for evaluating the efficiency and improving the health care network of Ahvaz Jundishapur University of Medical Sciences step by step. To do this, in the first stage: identifying the criteria for evaluating the efficiency of medical centers, and then, using the model presented in this study, we evaluated the efficiency and improved the inefficient health network step by step. Perhaps one of the weaknesses of data envelopment analysis models is the provision of improvement models that can not be implemented due to the conditions of the units under evaluation. For example, the inefficient Izeh health care network that we examined in this study, in order to be effective, must reduce the criterion of "health supplies and materials" by 90%, and a one-time reduction of 90% for the health network. And treatment is not possible.

According to the model presented in this paper, four stages of improvement were considered in order to make the Izeh health care network efficient. Step-by-step reduction seems more logical.

The idea presented in this article can be used in different areas of the Ministry of Health to evaluate the efficiency and improve step by step hospitals or medical universities and other statistical communities in the field of health.

References

1) Junidi Jafari Ahmad, Baba Massoud, Dolati Mohsen. Risk assessment of health centers under the auspices of Iran University of Medical Sciences in functional, non-structural and structural dimensions in 1994. Occupational health in Iran. 1397; 15 (1): 76-85.
2) Dargahi Hossein, Darroudi Alireza. Evaluating the performance of health centers in the south of Tehran health network. Management strategies in the health system. 1397; 3 (4): 264-275.
3) Farmer Ahmadabadi Habib, Masoudian Sepideh, Farmer Bandakoki Mohammad Reza. Evaluation of technical efficiency of health centers using a combined model of data envelopment analysis and game theory: A case study of health centers in Yazd. Scientific Journal of Shahid Sadoughi University of Medical Sciences, Yazd. 1397; 26 (8): 717-732.
4) Mirghfouri, Seyed Habibollah, Farhangnejad Mohammad Ali, Sadeghi Arani, Zahra. (1388). Evaluating the performance of the health department of Yazd city in applying the knowledge management process. Health Management, 13 (39).
5) Nasrollahpour Shirvani Seyed Davood, Tahmasebi Bahram. A review of models for evaluating the performance of health care systems. Clinical Excellence. 1395; 5 (2): 98-116.
6) Nazari Ali Akbar. Evaluate the performance of health network managers in Semnan and Mazandaran provinces and provide an appropriate model. Scientific Journal of Qazvin University of Medical Sciences. 1377; 2 (4): 48-57
7) Banker, R.D., Charnes, A., Cooper, W.W.(1984). "Some Models for estimating technical and scale inefficiencies in data envelopment analysis", Management science, Vol. 32 No.7,pp. 18-70
8) Bogetoft, P.andJ. L.Hougaard. (1999). "Efficiency Evaluations Based on Potential (Non-Proportional) Improvements." Journal of Productivity Analysis 12, 231–245.
9) Charnes,A. ,W.W.Cooper and E.Rhodes. (1978). "Measuring theEfficiency of Decision Making

Units.” European Journal of Operational Research 2, 429–444.

10) Emrouznejad, A., Yang, G.: A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016, Socio-Economic Planning Sciences, Vol. 51, 2017, pp. 152-164
11) Farrell, M. J. (1957). “The Measurement of Productive Efficiency.” Journal of the Royal Statistical Society, Series A, III, 253–290.
12) Sherman SG, Sherman CV. Total customer satisfaction: a comprehensive approach for health care providers. Journal of Healthc are Quality 2000; 22(5): 46. doi: 10.1111/j.1945-1474.2000.tb00154.
13) Tone, K., (2001), A slacks-based measure of efficiency in data envelopment analysis, European Journal of Operational Research;130(3):498–509.