Muthanna Journal of Administrative and Economics Sciences
مجلة المثنى للعلوم الادارية والاقتصادية

Comparative Analysis for Performance Assessment of Health Organization in Thi Qar Province Using CRS and VRS Models

Ahmed Noori Yousef[*a] , Rasheed Al-Salih[b] & Muaamar Aqeel Obaid[c]

a. University of Sumer/ College of Administration and Economics.
b. University of Sumer/ College of Administration and Economics.
c. University of Sumer/ College of Administration and Economics.

Abstract

Data envelopment analysis is an important tool that used to measure the relative efficiency for different organizations such as in banking, in education, and in health organizations. In this paper, we present a comparative study between two types of data envelopment models.

First, we calculate the relative efficiency using constant return to scale (CRS) model. Second, the relative efficiency and scale efficiency have calculated using variable return to scale (VRS) model. We have used a case study consists of eight hospitals with four inputs and three outputs for two years period i.e., 2020 and 2021. The study shows that most of the hospital get high score efficiency using VRS data envelopment model compared with CRS model, because most of the health organizations did not work in static environment and therefore it is better to deal with VRS model. Also, based on the VRS model we can calculate the scale efficiency for health organizations.

Information

Received:1 /3/2024
Revised: 20/3/2024
Accepted: 1/4/ 2024
Published: 6/7/2024

Introduction

Performance evaluation is a crucial component of the broader performance management process. It is the practice of observing and evaluating, providing feedback, and implementing changes within an organization. It involves both a quantitative assessment and a very emotional experience. Primarily, it is a somewhat precise human procedure. When examining the motivation of work, there is a well-established principle that tasks that receive a bonus are more likely to be completed successfully. Consequently, managers possess many alternatives. The performance assessment process can prioritize either short-term or long-term targets, or a combination of both. Short-term goals, such as the final results of the current quarter, serve as confirmation. The long-term aims encompass objectives such as achieving a higher market share and securing regular business insurance from consumers. In order for strategic management to effectively evaluate performance, the strategies employed by the Organization or Strategic Business Unit must be linked to a competitive advantage, such as innovation, speed of innovation, improved quality, or cost control. Management by objectives (MBO), which is a common evaluation approach in the United States, but less prevalent in other countries like Japan and France. MBO primarily emphasizes outcomes rather than the methods employed to reach those outcomes. It typically has a limited time frame, although this is not always the case. In Japan, there is a stronger emphasis on evaluating performance based on psychological and behavioral factors rather than solely on tangible outcomes. Consequently, employees are categorized based on their level of effort, integrity, and loyalty. The essence of collaboration; the caliber of its client service. Alternatively, the non-parametric linear programming method called data envelopment analysis (DEA) is utilized to assess the relative efficiency of decision-making units based on their input and output. For further information on new formulations and

* Corresponding author : E-mail addresses: ahmed.mba@uos.edu.iq.
2024 AL – Muthanna University . DOI:10.52113/6/2024-S-1/1014-1018

applications of linear programming and DEA models, please refer to examples provided in references [1], [2], [3], [4], [5], [6], and [7]. This study employs a comparison between two types of DEA models, namely CRS and VRS, to assess the relative efficiency and scale efficiency of eight hospitals in Thiqar province. The assessment is based on four inputs and three outputs.

1. The methodology of the research

1.1 The problem of the research

The uncertainty of determine the most suitable data envelopment models based on constant return to scale (CRS) and variable return to scale (VRS) models to assess the performance of the health organizations in ThiQar province. Also, the decision maker has not been understanding the factors influencing the relative efficiency scores in health care in ThiQar province including the scale efficiency.

1.2 The aim of the research

The aims of the research are to assess the performance of the health organizations in ThiQar province using some qualitative approaches. Also, calculating both relative efficiency and scale efficiency using constant return to scale (CRS) and variable return to scale (VRS) models. Moreover, comparing the efficiency scores in both static and dynamic environments.

1.3 The importance of the research

Determining the efficiency scores of the health organizations will help the decision maker to improve the resources allocation. In addition, qualitative approaches will determine the most influencing factors in both static and dynamic environments which addresses the need for tailored evaluation methods that account for the dynamic nature of healthcare environments.

2. DEA models

There are two types of the data envelopment analysis the first one known as constant return to scale (CRS) and the second one known as variable return to scale (VRS) as in [11],[12],[13],[14]. The formulation of these two model are described as follows.

The constant return to scale (CRS) as follows:

Max $\theta_\pi = \sum_{r=1}^{s} u_r y_{r\pi}$

s.t.

$$\sum_{i=1}^{m} v_r x_{i\pi} = 1 \quad i = 1, \dots, m$$

$\sum_{r=1}^{s} u_r y_{rj} \le \sum_{i=1}^{m} v_r x_{ij} \quad r = 1, \dots, s$

$u_r, v_r \ge 0$ j=1,….,n

The variable returns to scale (VRT) has the following

Min$_\lambda$ z_o

s.t.

$\sum_{j=1}^{n} \lambda_j x_{ij0} \le z o x_{ij0}$ i=1,2,…,nr,

$\sum_{j=1}^{n} \lambda_j y_{rj0} \le y_{rj0}$ r=1,2,…,t:

λj ≥ 0 j=1,2,….,ir,

$\sum_{j=1}^{n} \lambda_j = 1$

3. Comparison between CRS and VRS models

To calculate the relative efficiency based on CRS ad VRS, we consider eight hospitals in Thiqar province as follows for each hospital, we choose four inputs and three outputs as in Table 1and Table 2, Table 3, and Table 4 respectively. The data collected for 2020 and 2021.

3.1 DMUs Input and output data

2, Table 3, and Table 4 respectively. The data collected for 2020 and 2021.

3.1 DMUs Input and output data

Table 1: Input data for 2020

No.	Name	Input1	Input2	Input3	Input4
1	Unit1	5102	530	3076	400
2	Unit2	1800	105	688	124
3	Unit3	1990	194	597	124
4	Unit4	2153	125	1093	154
5	Unit5	1202	37	257	133
6	Unit6	533	104	360	169
7	Unit7	1809	98	1353	169
8	Unit8	1920	102	688	285

Table 2: Output data for 2020

No.	Name	Output1	Output2	Output3
1	Unit1	460215	10405	12948
2	Unit2	75163	4562	8351
3	Unit3	65714	7087	52638
4	Unit4	35465	7087	42638
5	Unit5	130757	9330	17615
6	Unit6	140778	10988	128323
7	Unit7	164015	12768	120482
8	Unit8	130691	6071	84119

Table 3: Input data for 2021

No.	Name	Input1	Input2	Input3	Input4
1	Unit1	5089	563	3200	220
2	Unit2	1606	112	680	124
3	Unit3	2006	199	542	124
4	Unit4	2164	132	1102	154
5	Unit5	1249	35	259	133
6	Unit6	608	110	400	154
7	Unit7	2222	89	1213	160
8	Unit8	1961	105	600	222

Table 4: Output data for 2021

No.	Name	Output1	Output2	Output3
1	Unit1	602676	10915	25356
2	Unit2	132602	6322	17430
3	Unit3	57952	10490	71439
4	Unit4	40663	11012	51445
5	Unit5	83960	2713	23977
6	Unit6	138876	14910	141431
7	Unit7	172658	10564	105353
8	Unit8	127601	6322	87453

3.2. Results discussion

The relative efficiency and scale efficiency calculated using constant return to scale and variable return to scale are given in the tables below:

Table 5: 2020 Hospitals Efficiency

DMUs	**CRS** -Efficiency	**VRS** –Efficiency	**Scale** Efficiency
Unit1	1	1	1
Unit2	0.60	1	0.60
Unit3	0.80	1	0.80
Unit4	0.62	0.86	0.71
Unit5	1	1	1
Unit6	1	1	1
Unit7	1	1	1
Unit8	0.73	0.76	0.97
Average of efficiency	0.84	0.95	0.97

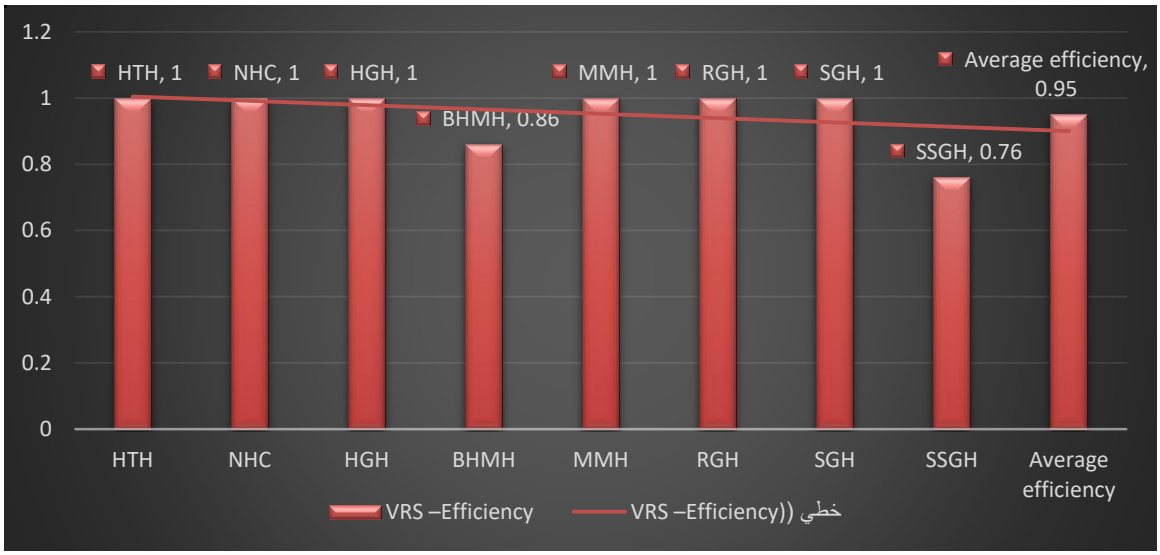

Figure 1: 2020 Hospitals Efficiency

Table 6: 2021 Hospitals Efficiency

DMUs	**CRS-** Eficifency	**VRS-** Efficiency	**Scale** Efficiency
HTH (Unit1)	1	1	1
NHC(Unit2)	0.89	1	0.89
HGH(Unit3)	0.87	1	0.87
BHMH(Unit4)	0.70	0.80	0.80
MMH(Unit5)	1	1	1
RGH(Unit6)	1	1	1
SGH(Unit7)	1	1	1
SSGH(Unit8)	0.75	0.80	0.93
Average of efficiency	**0.90**	**0.96**	**0.94**

Figure 2: 2021 Hospitals Efficiency

Conclusions

a comparative study for performance evaluation of health organizations in Thi Qar Province using two types of data envelopment analysis models have been presented. The study shows that six hospitals reach full efficiency during 2020 as well as 2021 using variables return to scale model while only four hospitals reach full efficiency using constant return to scale model. Also, the efficiency averages using VRS are 0.95 during 2020 and 0.96 during 2021 while the efficiency averages using CRS are 0.84 during 2020 and 0.90 during 2021. In addition, we conclude that variables return to scale model is more reliable than constant return to scale model since most the health organization work in dynamic environment which mean that did not work using optimal size.

References

Al-Salih, R., & Bohner, M. (2018). Linear programming problems on time scales. *Applicable Analysis and Discrete Mathematics*, *12*(1), 192-204.

Al-Salih, R., & Bohner, M. (2019). Linear fractional programming problems on time scales. *Journal of Numerical Mathematics and Stochastics*, *11*(1), 1-18.

Al-Salih, R., & Bohner, M. J. (2020). Separated and state-constrained separated linear programming problems on time scales. *Boletim da Sociedade Paranaense de Matemática*, *38*(4), 181-195.

Al-Salih, R., Habeeb, A., & Laith, W. (2019). A quantum calculus analogue of dynamic leontief production model with quadratic objective function. *Journal of Engineering and Applied Sciences*, *14*(17), 6415-6418.

Battal, Ahmad et al. (2017). Data envelopment analysis: theory and applications. Noor

Bhattacharyya, A., & Chakraborty, S. (2014). A DEA-TOPSIS-based approach for performance evaluation of Indian technical institutes. *Decision science letters*, *3*(3), 397-410

efficiency and ranking operating rooms: a case study. *Int J Res Ind Eng*, *10*(1), 67-86.

Ghasemi, S., Aghsami, A., & Rabbani, M. (2020). Data envelopment analysis for estimate

Hamed, Q. A., Al-Salih, R., & Laith, W. (2020, May). The analogue of regional economic models in quantum calculus. In *Journal of Physics: Conference Series* (Vol. 1530, No. 1, p. 012075). IOP Publishing.

Hameed, M. L., Makttoof, N. A., & Al-Salih, R. (2023). Measuring the efficiency of banking performance using the data envelope analysis (bcc) model. *Alkut university college journal*, *2023*(The 6th Scientific Conference), 161-174.

Hameed, M. L., Makttoof, N. A., & Al-Salih, R. An efficient computational approach for solving multi criteria decision making problems. In *AIP Conference Proceedings* (Vol. 3036, No. 1). (2024, March), AIP Publishing

Lafta, M. H., Sulaiman, A. A., & Al-Salih, R. (2021, May). A Computational Procedure Using Robust Ranking Method to Formulate and Solve Fuzzy DEA Models. In *Journal of Physics: Conference Series* (Vol. 1879, No. 3, p. 032006). IOP Publishing.

Peng, C., Feng, D., & Guo, S. (2021). Material selection in green design: a method combining DEA and TOPSIS. *Sustainability*, *13*(10), 5497.

Publishing.

Rakhshan, S. A. (2017). Efficiency ranking of decision making units in data envelopment analysis by using TOPSIS-DEA method. *Journal of the Operational Research Society*, *68*(8), 906-918.

Yousef, A. N., Al-Salih, R., & Obaid, M. A. (2023). Performance Assessment of Health Organization in Thi Qar Province Using CCR Model. *Alkut university college journal*, *2023*(The 6th Scientific Conference), 249-253.