Performance Analysis of Hospitals Departments by Using Data Envelopment Analysis

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Abstract

This study uses the Data Envelopment Analysis method to examine the health sector's performance efficiency. The study measures the efficiency of three departments of 6 public and 5 private hospitals in Kuwait health sector. Data Envelopment Analysis (DEA) method with Constant return to Scale (CRS), Variable return to Scale (VRS), and scale efficiency were used to estimate public and private hospitals' technical and managerial efficiency regarding staff, doctors, health services, and the number of patients indicators.

Keywords:
Data Envelopment Analysis, efficiency, health sectors, performance measurement

Introduction

Public and private medical institutes are often considered essential components of a country's healthcare system. Healthcare is often seen as a critical determinant in fostering people's overall physical, mental, and social well-being. In addition, proper management and organization of healthcare systems may contribute significantly to a country's economy, development, and industrialization when done successfully.
This study used DEA models to analyze the efficiency of three selected health departments in Kuwait hospitals. In addition, efficiency measurements of different public and private hospitals' surgical, orthopedic, and dermatology departments were done.

The total population of Kuwait increased from about 1.9 million in 2000 to 4.3 million in 2020 (worldmeter 2023), and an increasing trend followed in the total life expectancy at birth from 76 to 80 for the same years (wrldbank.org 2023). However, while the total population and life expectancy at birth factors increase, demand in the healthcare sector also increases (Alsabah et al. 2020).

Increased demand for health services makes the health system more challenging in Kuwait. That is why efficiency and performance measurement of the Kuwait hospitals is crucial for getting information about the strong and weak points of the inefficient departments. This way, improvement analysis, and future projections can make the system more stable and efficient.

DEA models were used to measure and compare the technical and managerial performances of selected departments of Kuwait hospitals. It is identifying ways of best practice with accurate available data.
The DEA method, also called frontier analysis, was first proposed by Charnes&Cooper (1978). The DEA technique is a practical benchmarking tool that suggests using a reference group of "efficient" DMUs as a standard against which to measure the "inefficient" ones. As a result, managers of organizations (in this case, hospital administrators) may quickly do projection analysis to determine the strengths and weaknesses of their organizations. Also, it is the most effective and practical methodology that can be used for examining organizational efficiencies of any sector like healthcare (see, e.g., Kohl & Fügener (2019)), finance (see,

e.g., Satrio & Wijaya (2023)), manufacturing (see, e.g., Wang (2023)), logistics (see, e.g., Sharma, P. et al.,. (2023))., etc. DEA allows for using several inputs and outputs without imposing a functional shape on the data or making inefficient expectations.

1.1 Problem Statement and Objectives

With the massive increase in the population of Kuwait, the demand for hospitals is increasing day by day. Therefore, it is of great importance that patients have access to accurate and reliable information about hospital performance.

The related indicators data for the Surgical, Orthopedic, and Dermatology departments were collected, and the efficiency of selected 6 public and 5 private hospitals were analyzed using DEA methodology. The objectives of the study are listed as follows:

Determination of the efficient and inefficient health departments in Kuwait hospitals.
Identifying the slack and surplus analysis of input and output indicators.
Making peer analysis to get information about how to make inefficient hospitals efficient

2. Literature review

One of the most widely used efficiency assessment techniques is DEA, created by Banker et al. (1984) and Charnes et al. (1978). DEA can be used to measure the relative efficiency performance of decision-making units that involve many inputs and numerous outputs. As a result, it has been widely used in many different fields for efficiency measurement, including healthcare (De Jorge-Moreno & Martin Meana (2022); logistics (Quan et al. (2022); manufacturing (Im, C. H., & Cho (2021); finance (Kwon & Lee (2015)), etc.

This part summarizes the literature about the efficiency measurement analysis of the health sector using the DEA method.

Pirani N. et al. (2018) measured the efficiency of the hospital in Southwest Iran and compared the performance of hospitals before and after the health sector evolution plan by using DEA-Panel Data. DEA variable-return-to-scale (VRS) model and Regression analysis method were used to determine hospitals' strengths and weaknesses. Using the analysis results, several improvement strategies and future projections are made for the inefficient ones. While the number of hospital admissions, nurses, and available beds indicators are input, the average length of stay (LOS) and bed-turnover interval indicator data are used as output.

Ahmed Set al. (2019) measured the health systems efficiencies of countries in Asia by using a two-stages DEA efficiency analysis with cross-sectional data. First, they used regression analysis and a bootstrap method to identify the indicators significantly affecting the health system's efficiency measurement. Next, they used the DEA method to evaluate the country's efficiency scores. WHO data repository and World development indicators (WDI) wereused. The importance of having as many countries as possible so that theycan study technical efficiency using the DEA VRS method. While the health expenditure per capita indicator was selected as an input, the health life expectations at birth (HALE) andinfant mortality per thousand live births indicators were selected as output. The Tobit model was used in regression to transform the VRS technical efficiency scores to VRS inefficiency scores, leaving the censor at zero. The study has shown that measuring the scale efficiency is to help them see if the health system of Asian countries is working at their optimum capacity. The results point to three high-income and one lower-middle-income country that efficiently used the healthcare systems resources. This study also proved that they could improve the health output by using the currentlevel of per-capita health outflow.

Gonçalves et al. (2007) used the DEA constant-return-to-scale (CRS) methodology to evaluate the performance of Brazilian public hospitals in terms of clinical medical admissions. The hospital efficiency studies showed that circulatory disease is most prevalent in admissions and mortality rates between a couple of state capitals. They analyzed the efficiency of hospital networks using SUS hospitals in Brazilian state capitals. The CRS model defines efficiency as a ratio of the weighted sum of the inputs and outputs. This method aims to maximize the ratios for every decision-making unit. They first used a canonical correlation analysis for the input and output indicators to identify the restriction intervals and the weights for those variables needed for DEA analysis. The Brazilian public hospitals were paid through HAAs. The most important showcase of the methodology presented in this study is to compare efficiencies while considering actual functional conditions.

3. Methodology

DEA is a nonparametric method in operations research and economics for estimating production frontiers. It is a linear programming model that could be used as a nonparametric method for measuring the relative efficiency of a group of control units (Banker, 1991). The DEA applications used control units to estimate the performance of different entities such as companies, schools, clinics, universities, shops, bank branches, etc. (Cooper, W. et al. 2011).

DEA model can be subdivided into the input-oriented model, which minimizes inputs while satisfying at least the givenoutput levels, and the output-oriented model, which maximizes outputs without requiring more of any of the observed input values.

DEA models can also be subdivided regarding Returns to Scale by adding weight constraints. Initially, the efficiency measurement of the control units for constant returns to Scale (CRS) where all control units are operating at their optimal scale. Also, the variable returns to Scale (VRS)efficiency measurement model allow the breakdown of efficiency into technical and scale efficiencies in DEA.

3.1. DEA Mathematical Models

Let there be 'a' number of input and '*b*' number of output indicators for each control unit, and X_{ij} and Y_{sj} show the input and output, respectively. Then, the ratio of the sum of the total weights of outputs and inputs is defined as efficiency. The mathematical model for the efficiency calculation of the control unit is as below:

$$\text{Max } z = \frac{\sum_{s=1}^{b} u_s Y_{so}}{\sum_{i=1}^{a} v_i X_{io}} \tag{1}$$

subject to

$$\frac{\sum_{s=1}^{b} u_s Y_{so}}{\sum_{i=1}^{a} v_i X_{io}} \leq 1. \qquad \forall\, j = 1, 2, 3, \dots, k \tag{2}$$

$$u_s\,,\ v_i \geq 0 \quad \forall\, s = 1, 2, 3, \dots\dots, b\ ;\ \forall\, i = 1, 2, 3, \dots\dots, a \tag{3}$$

where v_i and u_s variables are the weights of indicators. Constraint (3) guarantee that all efficiency scores are not more than 1. The mathematical model shown in equations (1)-(3) is not linear. The transformed DEA model is as below.

The proposed new model is shown below:

$$\text{Max } \phi_o + \varepsilon\left[\sum_{s=1}^{b} s_s^{+} + \sum_{i=1}^{a} s_s^{-}\right] \tag{4}$$

subject to

$$\sum_{j=1}^{k} \beta_j X_{ij} + s_i^- = X_{io} \qquad \forall\ i = 1, 2, 3, \dots, a\ \ \&\ \ j = 1, 2, 3, \dots, k \tag{5}$$

$$\sum_{j=1}^{k} \beta_j Y_{sj} + s_s^- = \phi_o Y_{so} \qquad \forall\ s = 1, 2, 3, \dots, b\ \ \&\ \ j = 1, 2, 3, \dots, k \tag{6}$$

$$\sum_{j=1}^{k} \beta_j = 1 \quad \text{(VRS)} \tag{7}$$

$$\sum_{j=1}^{k} \beta_j \geq 1 \quad \text{(CRS)} \tag{8}$$

$$\beta_j, s_i^-, s_r^+ \geq 0 \qquad \forall\ i, j, r \qquad \phi_o \ \text{ free} \tag{9}$$

s_r^+ and s_i^- parameters are changeable variables to obtain efficiency. If $s_r^+ + s_i^- = 0$, then output unit *o* is classified as "*strongly efficient*". If not, classified as "*weakly efficient"* (González-Garay, 2019).

4. Results and Analysis

The following steps show DEA analysis for each selected health department of 6 public and 5 private hospitals.

4.1 DEA Efficiency Analysis of Surgical Department of Hospitals

4.1.1 Efficiency Analysis of the Surgical Department

Table A.1 and Table A.2 show the input and output indicators data and DEA efficiency analysis results for the surgical department to be used in the DEA analysis and determine the efficient and inefficient hospitals. The Constant return to Scale (CRS), Variable return to Scale (VRS), and Scale efficiency scores were determined and used in the analysis.

Technical "CRS", pure technical "VRS", and Scale "CRS/VRS" efficiency analysis results for the surgical department of the selected hospitals are calculated as shown in Table 1 and Figure 1, along with the return-to-scale results.

Table 1. Efficiency analysis results for the surgical department

	Efficiency Scores			Return to Scale		
	CRS	**VRS**	**Scale**	**IRS**	**DRS**	**CRS**
All Hospitals (n=11)						
Average	0.938	0.984	0.953			
SD	0.122	0.052	0.106			
Median	1	1	1			
Range (Min-Max)	0.648 - 1	0.827 - 1	0.648 - 1	1	2	
Full efficient	73% (8/11)	91% (10/11)	73% (8/11)			
Public Hospitals (n=6)						
Average	0.986	1.000	0.986			
SD	0.033	0.000	0.033		1	
Median	1	1	1			

Range (Min-Max)	0.918 - 1	1 - 1	0.918 - 1			
Full efficient	83% (5/6)	100% (6/6)	83% (5/6)			
Private Hospitals (n=5)						
Average	0.881	0.965	0.913			
SD	0.167	0.077	0.152			
Median	1	1	1	1	1	
Range (Min-Max)	0.648 - 1	0.827 - 1	0.648 - 1			
Full efficient	60% (3/5)	80% (4/5)	60% (3/5)			

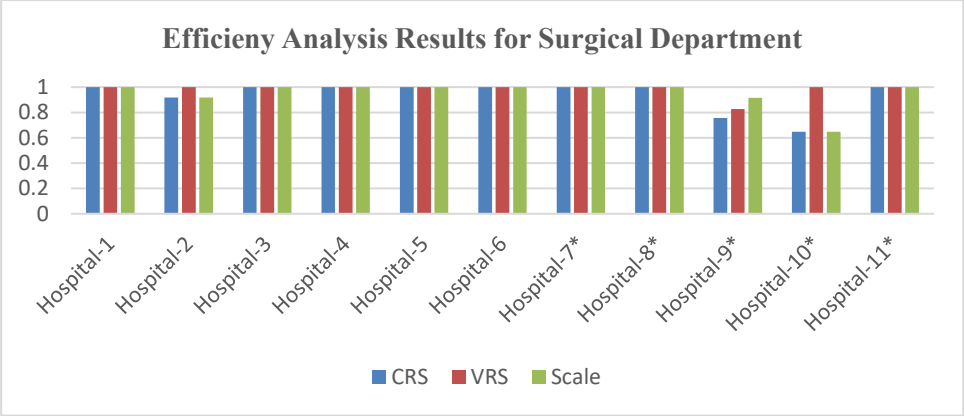

Figure 1. Graph of DEA efficiency scores for the Surgical Department

According to the analysis results in Figure 1, most of the hospitals are fully efficient; that no need to make any improvement strategy for increasing efficiency. However, Hospital-2, Hospital-9*, and Hospital-10* are inefficient and have an efficiency score of less than 1. Therefore, these inefficient hospitals must improve their input or output indicators to make their process efficient. According to the VRS efficiency analysis results in Table 1, the average efficiency score of all selected hospitals is 0.984 with a standard deviation of 0.052. The efficiency performance of public hospitals is better than private hospitals' surgical departments. While all selected public hospitals' efficiency scores equal 1, 80%, 4 of 5 selected private hospitals are efficient.

Returns-to-scale (RTS) analysis results prove that two of the inefficient hospitals, Hospital-2 and Hospital-9*, have a decreasing-return-to-scale (DRS), and Hospital-10* has an increasing-return-to-scale (IRS) mode. If a hospital's return-to-scale mode is DRS, that means that every one-unit increase in input resources will not increase output resources by one unit, increasing rate will follow a decreasing trend. But the IRS return-to-scale mode is the opposite; one unit increase will reflect more output rises.

4.1.2 Analysis of Input and Output Indicators for the Surgical Department

Table 2 shows the original and targeted indicator values for the surgical department for all hospitals. Output indicator O3, the number of periscope operations, is the most significant indicator affecting hospitals' efficiency score with a 17% potential change ratio. To increase the efficiency score of their department, management should focus on increasing firstly "number of periscope operations", secondly "number of patients", and lastly "number of open surgeries" indicators.

Table 2. Surgical department original vs. target indicators analysis

Output Indicators	Original Value (Avg.)	Target Value (Avg.)	% Potential Change *(min_max)*
O_1	5171	5336	3% (0% _ 23%) & (2/11)
O_2	161755	177327	12% (0% _ 98%) & (2/11)
O_3	574	638	17% (0% _ 93%) & (2/11)
Input Indicators			
I_1	65455834	64722326	-1% (0% _ -11%) & (1/11)
I_2	23	23	0% (0% _0%) & (0/11)
I_3	113	113	0% (0% _0%) & (0/11)
I_4	10	10	0% (0% _0%) & (0/11)
I_5	10	11	0% (0% _0%) & (0/11)
I_6	4	3	-3% (0% _ -36%) & (1/11)

O1: # of open surgeries, O2: # of patients, O3: # of periscope operations, I1: Total Investment (KWD), I2: # of Doctors I3: # of Assistants, I4: # of X-rays Machines, I5: # of operation Rooms, I6: # of Periscope

According to the input indicators analysis results shown in Table 2, approximately all hospitals are using their input resources efficiently. On average, hospitals should make a 1% decrease in their "total investment" and 3% in the "number of periscopes" indicators. Although even analytical analysis results advise decreasing the input resources, it is better to act and focus on the strategies for increasing the number of outputs to increase the department's efficiency.

4.1.3 Peer Hospital Analysis Surgical Department

Most hospitals are efficient for VRS analysis; only Hospital-2, Hospital-9*, and Hospital-10* are inefficient. Hospital-1, Hospital-4, Hospital-6, and Hospital-7* are the peer hospitals for these inefficient ones. Therefore, inefficient hospitals should follow what these efficient peer hospitals apply to their management process and apply similar changes to make their department efficient.

4.2 DEA Efficiency Analysis of Orthopedic Department of Hospitals

4.2.1 Efficiency Analysis of the Orthopedic Department

Table A.3 and Table A.4 show the input and output indicators data and DEA efficiency analysis results for the orthopedic department to be used in the DEA analysis and determine the efficient and inefficient hospitals. The Constant return to Scale (CRS), Variable return to Scale (VRS), and Scale efficiency scores were determined and used in the analysis.

Technical "CRS", pure technical "VRS", and Scale "CRS/VRS" efficiency analysis results for the surgical department of the selected hospitals are calculated as shown in Table 3 and Figure 2, along with the return-to-scale results.

Table 3. Efficiency analysis results for the orthopedic department

	Efficiency Scores			Return to Scale		
	CRS	VRS	Scale	IRS	DRS	CRS
All Hospitals (n=11)						
Average	0.940	0.972	0.965	3	1	
SD	0.115	0.076	0.069			

Median	1	1	1			
Range (Min-Max)	0.649 - 1	0.747 - 1	0.794 - 1			
Full efficient	63% (7/11)	82% (9/11)	63% (7/11)			
Public Hospitals (n=6)						
Average	0.942	0.958	0.978			
SD	0.143	0.103	0.054			
Median	1	1	1		1	
Range (Min-Max)	0.649 - 1	0.747 - 1	0.868 - 1			
Full efficient	83% (5/6)	83% (5/6)	83% (5/6)			
Private Hospitals (n=5)						
Average	0.938	1	0.949			
SD	0.085	0	0.088			
Median	0.964	1	0.987	3		
Range (Min-Max)	0.794 - 1	0.945 - 1	0.794 - 1			
Full efficient	40% (2/5)	60% (3/5)	40% (2/5)			

According to the VRS efficiency analysis results in Table 3, the average efficiency score of all selected hospitals is 0.958, with a standard deviation of 0.103. The efficiency performance of public hospitals is better than private hospitals' surgical departments except for Hospital-2. While 83% of selected public hospitals are efficient, only 60% of private hospitals are efficient.

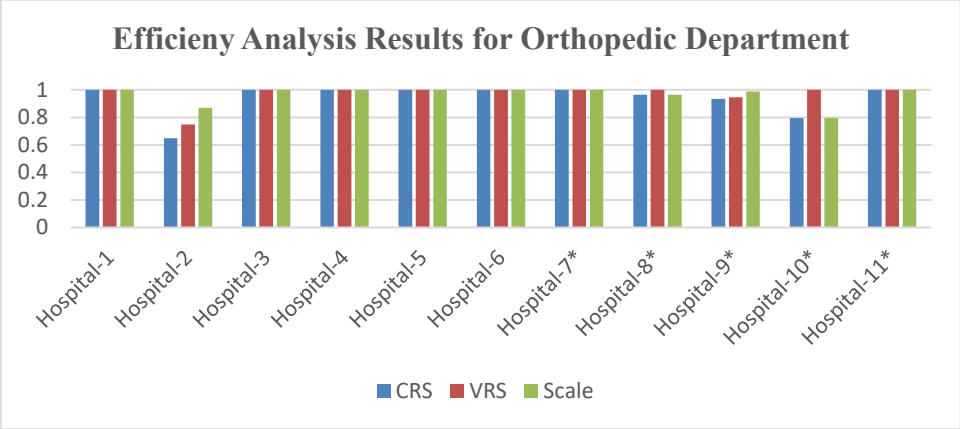

Figure 2 . Graph of DEA efficiency scores for the Orthopedic Department

As seen in Figure 2, most hospitals are fully efficient, so there is no need to make any improvement strategy for increasing efficiency. However, Hospital-2, Hospital-8*, Hospital-9*, and Hospital-10* are inefficient and have an efficiency score of less than 1. Even though Hospital-8* and Hospital-10* are efficient for DEA-VRS results, they were found ineffective for DEA-CRS results. Hospital-2 is the worst one compared to other inefficient hospitals. These inefficient hospitals must improve their input or output indicators to make their process efficient.

Returns-to-scale (RTS) analysis results prove that one of the inefficient hospitals, Hospital-2, has a decreasing-return-to-scale (DRS) and the others, Hospital-8*, Hospital-9*, and Hospital-10*, has increasing-return-to-scale (IRS) mode. If a hospital's return-to-scale mode is DRS, that means that every one-unit increase in input resources will not increase output resources by one unit, increasing

rate will follow a decreasing trend. But IRS return-to-scale mode is the opposite; one unit increase will reflect more output increases. The return-to-scale results show that private hospitals have considerable potential for making their process efficient because if they make a correct improvement strategy, they will get the results directly.

4.2.2 Analysis of Input and Output Indicators for the Orthopedic Department

Table 4 shows the original and targeted indicator values for the orthopedic department for all hospitals. Generally, most hospitals efficiently use their sources. According to the efficiency analysis results, only one hospital, Hospital-2, is the most problematic hospital. As seen in the output indicators results, the needed average potential increasing rate of O1 (number of surgeries) is 54%, and the range is between 0% and 585%. But this is only up to Hospital -2, and the other hospitals have no problem regarding the O1 indicator. Therefore, at most, only two hospitals need to improve their output indicators to make their process efficient, but the others have no problem with them.

According to the input indicators analysis results shown in Table 3, approximately all hospitals are using their input resources efficiently. Therefore, on average, hospitals should make between 2% to 5% decrease in their input indicators to make their process efficient. Although even analytical analysis results advise decreasing the input resources, it is better to act and focus on the strategies for increasing the number of outputs to increase the department's efficiency.

Table 4 Orthopedic department original vs. target indicators analysis

Output Indicators	Original Value (Avg.)	Target Value (Avg.)	% Potential Change *(min_max)*
O_1	4898	5542	54% (0% _ 585%) & (1/11)
O_2	166712	192451	31% (0% _297%) & (2/11)
O_3	546	591	13% (0% _ 111%) & (2/11)
Input Indicators			
I_1	57500685	55432638	-3% (0% _ -32%) & (1/11)
I_2	10	9	-5% (0% _-53%) & (1/11)
I_3	6	6	-5% (0% _-29%) & (2/11)
I_4	60	58	-2% (0% _-18%) & (2/11)
I_5	4	3	-3% (0% _-20%) & (2/11)

O_1: # of surgeries, O_2: # of patients, O_3: # of natural therapy, I_1: Total Investment (KWD), I_2: # of X-rays machine, I_3: # of doctors, I_4: # of assistants, I_5: # of casting room

As a result, hospitals should focus on increasing their output indicators, especially the "number of surgeries" and "number of patients," so they can use their input resources more efficiently and increase their efficiency rates.

4.2.3 Peer Hospital Analysis Orthopedic Department

According to the efficiency results in Table 3, Hospital-2, Hospital-8*, Hospital-9*, and Hospital-10* are considered inefficient according to efficiency scores. Hospital-1 and Hospital-5 are the peer hospitals for the inefficient Hospital-2. Hospital-5, Hospital-7*, and Hospital-11* can be peer hospitals for the other inefficient ones. Therefore, inefficient hospitals should follow what these

efficient peer hospitals apply to their management process and apply similar changes to make their department efficient.

4.3 DEA Efficiency Analysis of Dermatology Department of Hospitals

4.3.1 Efficiency Analysis of the Dermatology Department

Table A.5 and Table A.6 show the input and output indicators data and DEA efficiency analysis results for the dermatology department to be used in the DEA analysis and determine the efficient and inefficient hospitals. The Constant return to Scale (CRS), Variable return to Scale (VRS), and Scale efficiency scores were determined and used in the analysis.

Technical "CRS", pure technical "VRS", and Scale "CRS/VRS" efficiency analysis results for the surgical department of the selected hospitals are calculated as shown in Table 5 and Figure 3, along with the return-to-scale results.

According to the VRS efficiency analysis results in Table 5, the average efficiency score of all selected hospitals is 0.976, with a standard deviation of 0.11. The efficiency performance of private hospitals' dermatology departments is better than public hospitals. According to DEA-VRS results, while all selected private hospitals' efficiency scores equal 1, 83%, 5 of 6 selected public hospitals are efficient.

Table 5. Efficiency analysis results for the dermatology department

	Efficiency Scores			Return to Scale		
	CRS	**VRS**	**Scale**	**IRS**	**DRS**	**CRS**
All Hospitals (n=11)						
Average	0.934	0.976	0.955			
SD	0.137	0.081	0.095			
Median	1	1	1	2	1	
Range (Min-Max)	0.618 - 1	0.731 - 1	0.707 - 1			
Full efficient	73% (8/11)	91% (10/11)	73% (8/11)			
Public Hospitals (n=6)						
Average	0.888	0.955	0.926			
SD	0.177	0.110	0.124			
Median	1	1	1	1	1	
Range (Min-Max)	0.618 - 1	0.731 - 1	0.707 - 1			
Full efficient	67% (4/6)	83% (5/6)	67% (4/6)			
Private Hospitals (n=5)						
Average	0.990	1.000	0.990			
SD	0.022	0.000	0.022			
Median	1	1	1	1		
Range (Min-Max)	0.951 - 1	1 - 1	0.951 - 1			
Full efficient	80% (4/5)	100% (5/5)	80% (4/5)			

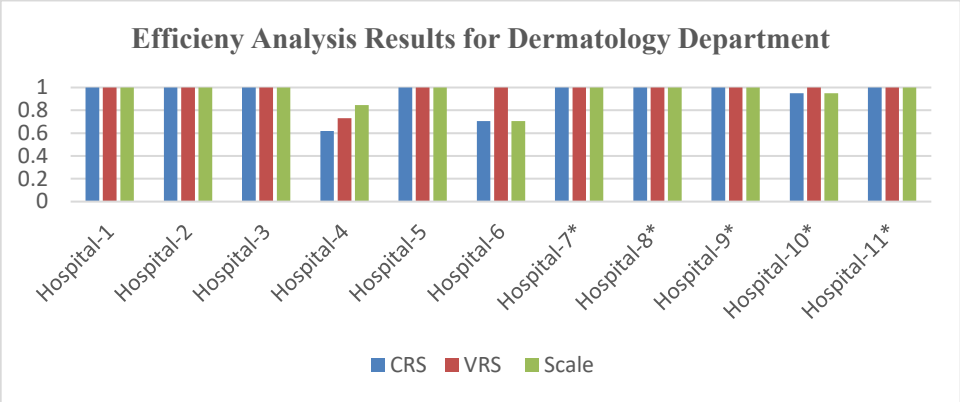

Figure 3. Graph of DEA efficiency scores for the dermatology department

According to the analysis results in Figure 3, most of the hospitals are fully efficient; that no need to make any improvement strategy for increasing efficiency. However, Hospital-4, Hospital-6, and Hospital-10* are inefficient and have an efficiency score of less than 1. Hospital-4 and Hospital-6 are the worst compared to other inefficient Hospital-10*. These inefficient hospitals must improve their input or output indicators to make their process efficient.

Returns-to-scale (RTS) analysis results prove that two of the inefficient hospitals, Hospital-4 have a decreasing-return-to-scale (DRS), and Hospital-6 and Hospital-10* have an increasing-return-to-scale (IRS) mode. The return-to-scale results show that two inefficient hospitals, Hospital-6 and Hospital-10*, have considerable potential for making their process efficient. They will get the results directly if they make a correct improvement strategy.

4.3.2 Analysis of Input and Output Indicators for the Dermatology Department

Table 6 shows all hospitals' original and targeted indicator values for the dermatology department. Generally, most hospitals efficiently use their sources. According to the efficiency analysis results, only one hospital, Hospital-4, is the most problematic hospital. As seen in the output indicators results, the needed average potential increasing rate of O1 (number of patients getting treated for dandruff) is 44%, and the range is between 0% and 479%. But this is only up to Hospital-4; the other hospitals have no problem regarding the O1 indicator. Therefore, only one hospital needs to improve its output indicators to make its process efficient, but the others have no problem with them.

Table 6. Dermatology department original vs. target indicators analysis

Output Indicators	Original Value (Avg.)	Target Value (Avg.)	% Potential Change *(min_max)*
O_1	588	710	44% (0% _ 479%) & (1/11)
O_2	359	374	3% (0% _37%) & (1/11)
O_3	23560	24353	3% (0% _37%) & (1/11)
Input Indicators			
I_1	23926476	20378469	-5% (0% _ -60%) & (1/11)
I_2	19	18	-4% (0% _-42%) & (1/11)
I_3	23	22	-3% (0% _-31%) & (1/11)
I_4	12	12	-2% (0% _-26%) & (1/11)

I_5	8	8	-1% (0% _-13%) & (1/11)
I_6	1233	1233	-0% (0% _ 0%) & (1/11)

O_1: # of patients getting treated for dandruff, O_2: # of patients treated for eczema, O_3: # of outpatient visits, I_1: Total Investment (KWD), I_2: # of doctors, I_3: # of assistants, I_4: # of lasers machines, I_5: of Dermatascope machines, I_6: # of dermal cutter tools

According to the input indicators analysis results shown in Table 6, approximately all hospitals are using their input resources efficiently. In average, hospitals should make between 1% to 5% decrease in their input indicators to make their process efficient. Although even analytical analysis results advise decreasing the input resources, it is better to act and focus on the strategies for increasing the number of outputs to increase the department's efficiency.

4.3.3 Peer Hospital Analysis Dermatology Department

According to the efficiency results in Table 6, Hospital-4, Hospital-6, and Hospital-10* are considered inefficient according to efficiency scores. Hospital-2 and Hospital-8 are the peer hospitals for the inefficient hospitals. Therefore, inefficient hospitals should follow what these efficient peer hospitals apply to their management process and apply similar changes to make their department efficient.

5. Conclusion

In this study, the efficiency analysis of selected 3 departments of 11 hospitals was done using the DEA method. The analysis results give us a realistic ranking of hospital departments based on selected indicators.
Analysis results showed that:

No specific hospital is/are inefficient in all departments. For example, while Hospital-4's dermatology department is inefficient, the orthopedic and surgical department of the same hospital is fully efficient. Moreover, while the orthopedic and surgical departments of Hospital-10* are inefficient, the dermatology department is fully efficient.
The efficiency performance of private hospitals' dermatology departments is better than public hospitals.

Public hospital surgery departments are fully efficient, showing that patients mostly prefer service from public hospital surgery-related operations.

No standard efficiency problem is detected related to all public or private hospitals.

Private hospitals use their input indicators more efficiently, like the number of doctors, assistants, etc., than public hospitals.

The return-to-scale results show that private hospitals have considerable potential for making their process efficient because if they make a correct improvement strategy, they will get the results directly.

To sum up, this study showed that the efficiency measurement of big organizations like hospitals, universities, big companies, etc., could not be done by considering the whole organization. Department-by-department measurement of efficiency is meaningful and usable.

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APPENDIX Note: * sign indicates private hospitals. *All others are public.*

Table A.1 Original values of the surgical department

Hospitals	Output Indicators			Input Indicators					
	# of open surgeries	# of patients	# of periscope operations	Total Investment (KWD)	# of Doctors	# of Assistants	# of X-rays Machines	# of operation Rooms	# of Periscope
Hospital-1	7500	150765	800	79,494,495	20	100	25	10	3
Hospital-2	1162	90678	760	80,566,789	15	75	10	15	4
Hospital-3	7016	250764	450	90,576,700	52	260	15	7	2
Hospital-4	7644	80761	623	60,456,666	40	200	8	6	3
Hospital-5	7920	372657	868	70,543,456	60	300	12	19	5
Hospital-6	6600	320675	790	85,780,980	18	90	8	28	7
Hospital-7*	4000	170880	570	60,786,766	5	25	4	4	2
Hospital-8*	3202	90266	455	50,345,256	8	40	4	3	3
Hospital-9*	4362	95354	327	70,654,765	16	80	6	6	4
Hospital-10*	2400	70764	243	40,543,325	9	45	8	8	2
Hospital-11*	5070	85742	423	30,264,972	8	32	12	9	4

Table A.2 DEA Efficiency Analysis Results for Surgical Department

Efficiency Analysis Summary (Surgical Department)				
Hospitals	**CRS**	**VRS**	**Scale**	**Return to Scale**
Hospital-1	1	1	1	-
Hospital-2	0.918	1	0.918	drs
Hospital-3	1	1	1	-
Hospital-4	1	1	1	-
Hospital-5	1	1	1	-
Hospital-6	1	1	1	-
Hospital-7*	1	1	1	-
Hospital-8*	1	1	1	-
Hospital-9*	0.757	0.827	0.915	drs
Hospital-10*	0.648	1	0.648	irs
Hospital-11*	1	1	1	-

Table A.3 Original values of the orthopedic department

Hospitals	Output Indicators			Input Indicators				
	# of surgeries	# of patients	# of natural therapy	Total Investment (KWD)	# of X-rays machine	# of Doctors	# of assistants	# of casting room
Hospital-1	7000	120750	700	35,000,000	20	4	120	3
Hospital-2	1170	80670	650	80,522,760	15	7	110	5
Hospital-3	8020	350740	550	7,000,000	20	6	80	4
Hospital-4	7550	80730	680	70,450,777	10	4	100	3
Hospital-5	8020	320450	870	80,530,430	7	5	90	4
Hospital-6	5500	372650	790	85,870,980	8	6	75	5
Hospital-7*	3000	170770	510	60,786,766	5	5	15	3
Hospital-8*	2200	90220	320	60,785,770	6	4	10	3
Hospital-9*	4060	95350	240	70,653,760	7	9	20	4
Hospital-10*	2300	70760	250	50,543,320	5	11	20	2
Hospital-11*	5060	80740	450	30,362,973	9	8	15	4

Table A.4 DEA Efficiency Analysis Results for Orthopedic Department

Efficiency Analysis Summary (Orthopedic Department)				
Hospitals	CRS	VRS	Scale	Return to Scale
Hospital-1	1	1	1	-
Hospital-2	0.649	0.747	0.868	drs
Hospital-3	1	1	1	-
Hospital-4	1	1	1	-
Hospital-5	1	1	1	-
Hospital-6	1	1	1	-
Hospital-7*	1	1	1	-
Hospital-8*	0.964	1	0.964	irs
Hospital-9*	0.933	0.945	0.987	irs
Hospital-10*	0.794	1	0.794	irs
Hospital-11*	1	1	1	-

Table A.5 Original values of the dermatology department

Hospitals	Output Indicators	Input Indicators

	# of patients getting treated for dandruff	# of patients treated for eczema	# of outpatient visits	Total Investment (KWD)	# of doctors	# of assistants	# of lasers machines	# of Dermatascope machines	# of dermal cutter tools
Hospital-1	280	500	1,286	9,066,830	20	31	2	10	500
Hospital-2	507	430	70,477	5,355,300	25	73	15	7	2300
Hospital-3	110	320	59,454	5,677,895	30	10	6	4	1500
Hospital-4	280	465	23,654	65,453,679	20	30	17	8	670
Hospital-5	500	222	26,543	2,390,455	22	42	16	11	4000
Hospital-6	113	356	16,754	80,540,222	14	23	8	6	700
Hospital-7*	59	98	19,925	5,023,400	50	5	6	3	200
Hospital-8*	1846	678	24,675	30,680,134	9	10	12	7	340
Hospital-9*	1672	345	2,467	7,667,890	8	10	19	12	1300
Hospital-10*	496	209	7,830	40,678,099	3	7	23	14	450
Hospital-11*	604	321	6,098	10,657,336	5	14	7	5	1600

Table A.6 DEA Efficiency Analysis Results for Dermatology Department

Efficiency Analysis Summary (Dermatology Department)				
Hospitals	**CRS**	**VRS**	**Scale**	**Return to Scale**
Hospital-1	1	1	1	-
Hospital-2	1	1	1	-
Hospital-3	1	1	1	-
Hospital-4	0.618	0.731	0.846	drs
Hospital-5	1	1	1	-
Hospital-6	0.707	1	0.707	irs
Hospital-7*	1	1	1	-
Hospital-8*	1	1	1	-
Hospital-9*	1	1	1	-
Hospital-10*	0.951	1	0.951	irs
Hospital-11*	1	1	1	-