

An Empirical Comparison on the Efficiency of Healthcare Companies in Malaysia with Data Envelopment Analysis Model

Lam Weng Siew^{1,2,3,*}, Liew Kah Fai^{1,2}, Lam Weng Hoe^{1,2,3}

¹Department of Physical and Mathematical Science, Faculty of Science, UniversitiTunku Abdul Rahman, Kampar Campus, Kampar, Perak, Malaysia

²Centre for Mathematical Sciences, UniversitiTunku Abdul Rahman, Kampar Campus, Kampar, Perak, Malaysia

³Centre for Business and Management, UniversitiTunku Abdul Rahman, Kampar Campus, Kampar, Perak, Malaysia

Email address

lamws@utar.edu.my (L. W. Siew), liewkf@utar.edu.my (L. K. Fai), whlam@utar.edu.my (L. W. Hoe)

*Corresponding author

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Abstract

Performance measurement of the company is significantly depends on their operational efficiency. The efficiency evaluation is an assessment for the company to determine their capability to maximize the outcomes with minimal level of inputs. The objective of this paper is to apply Data Envelopment Analysis (DEA) model to evaluate and compare the relative efficiency of the healthcare sector companies in Malaysia. In DEA model, the efficiency of the companies is determined as the ratio of sum-weighted outputs to sum-weighted inputs. In this study, the data consists of 12 companies from the healthcare sector in Malaysia from year 2011 to 2015. The results of this study show that ADVENTA, AHEALTH and KOTRA are ranked as efficient companies. This implies that these companies are in optimal control of their resources or inputs to generate maximum outputs. Therefore, these efficient companies can serve as the benchmark to other inefficient companies for further improvement. This study is significant because the DEA model can help to identify the efficient companies from the healthcare sector in Malaysia based on multiple outputs and inputs.

Keywords

Healthcare Company, Data Envelopment Analysis, Efficiency, Linear Programming Model

1. Introduction

There is an increasing trend in comparing the efficiency of healthcare systems rather than just healthcare expenditure. The public nowadays is very concern on the efficiency of the healthcare systems, this is because they wish to obtain an efficient and effective service from the healthcare system. Inefficient healthcare system will lead to many negative consequences to the community as well as the country. The inefficient healthcare system tends to discourage people from using health care services when or before they need them. No doubt, healthcare system plays a dominant role in a country and also is a source of income of a country. The efficiency of

the healthcare system refers to the extent to which healthcare systems achieve their objectives by produce the maximum outputs or outcomes given the resources available. The economics literature refers to objectives as outputs and to resources as inputs. Efficiency involves the allocation of available resource inputs in a way that provides the best outcomes for the community. In other words, efficiency is attained when the community's well-being is maximized, given the resources available. Although measuring efficiency in the healthcare system is fraught with difficulty. However, Data Envelopment Analysis (DEA) is a well-

known model that can utilize to evaluate the relative efficiency of the companies by using multiple inputs and outputs simultaneously.

Data Envelopment Analysis (DEA) model was originally introduced by [1], which is known as CCR model. Subsequently, the CCR model was further improved to become BCC model [2]. The BCC model allows more flexibility than the CCR model by providing a variable return to scale DEA formulation. BCC model is assumed that not all DMUs operate on an optimal scale. DEA is a mathematical linear programming model which is utilized to measure the relative efficiency of a set of decision making units (DMUs). DEA model is occasionally called frontier analysis, which can handle multiple outputs and inputs simultaneously. The organization unit is identified as an efficient unit if and only if the efficiency score is 1 (100.00%), otherwise, the organization unit will be determined as inefficient unit [1, 2]. The objective of this paper is to evaluate and compare the efficiency of the companies from the healthcare sector in Malaysia stock market with DEA model. The rest of the paper is organized as follows. The next section describes the literature review of DEA model in the evaluation on the efficiency of the company. Section 3 discusses about the data and methodology of the study. Section 4 presents the empirical results of this study. Section 5 concludes the paper.

2. Literature Review

Reference [3] has applied the DEA model to investigate the efficiency of King Khalid University Hospital departments. The study period was just covered in year 2010. There were total of nine hospital departments evaluated in this study such as accident and emergency department, medicine department, obstetrics and gynecology department, orthopedic department, pediatrics department, primary care department, psychology department, specialty department, and surgery department. The results of this study showed that only psychology department and primary care departments managed to achieve an overall efficiency score of 100.00% in year 2010. The other hospital departments such as accident and emergency department, medicine department, obstetrics and gynecology department, orthopedic department, pediatrics department, specialty department, and surgery department were not efficient hospital department units since these departments were not able to obtain 100.00% efficiency.

Reference [4] have evaluated the relative efficiency of 55 private sector hospitals in India by using DEA model. The data used in this study were collected from the PROWESS database of Centre for Monitoring Indian Economy from year 2009 until 2010. The inputs that considered in this study were energy expenses, net fixed assets, wages and salaries, whereas the operating income was the only output that involved in the evaluation. The major findings of this study showed that 10 out of 55 private sector hospitals were efficient. The remaining 45

hospitals were treated as inefficient units since these hospitals failed to achieve 100.00% efficiency due to poor utilization of the resources.

Reference [5] have applied the DEA model to examine the efficiency of 34 health posts in rural Guatemala from year 2008 to 2009. The source of the data was obtained from the regional health office of Alta Verapaz for 34 health posts from the 19 districts comprising the health region. Based on the results, there were total of 10 health posts recorded as efficient units in year 2008. However, the number of efficient health posts dropped to 8 units in year 2009. The overall efficiency score was approximate 0.78 and 0.75 in year 2008 and 2009 respectively.

Reference [6] have assessed the performance of 34 Chinese life insurance companies from year 2006 until 2010 with DEA model. The input variables were debt capital, equity capital, and labor and business service. On the other hand, investment profits and incurred benefits plus additions to reserves were treated as outputs in this study. The major findings of this study showed that the mean efficiency scores of life insurers were relatively stable over the five-year period from 0.905 to 0.973. The overall efficiency score obtained by 34 Chinese life insurance companies for the year 2006 to 2010 were 0.963, 0.973, 0.930, 0.912 and 0.905, respectively.

Based on the past research, DEA model is able to evaluate the efficiency of the companies based on multiple inputs and outputs in various countries. However, this model has not been studied actively in Malaysia. Therefore, this paper aims to fill the research gap by evaluating the efficiency of the healthcare companies in Malaysia by using DEA model.

3. Data and Methodology

3.1. Data

In this study, the data consists of 12 companies from the healthcare sector listed in Malaysia stock Market which is presented in Table 1.

Table 1. Healthcare Companies in Malaysia Stock Market.

CompanyName	Abbreviations	Code
AdventaBerhad	ADVENTA	7191
Apex Healthcare Berhad	AHEALTH	7090
Berjaya Corporation Berhad	BJCORP	3395
DKSH Holdings (Malaysia) Berhad	DKSH	5908
Hai-O Enterprise Berhad	HAIO	7668
HovidBerhad	HOVID	7213
IHH Healthcare Berhad	IHH	5225
Kotra Industries Berhad	KOTRA	0002
KPJ Healthcare Berhad	KPJ	5878
PharmaniagaBerhad	PHARMA	7081
PeterLabs Holdings Berhad	PLABS	0171
Y.S.P. Southeast Asia Holding Berhad	YSPSAH	7178

Source: [7]

Due to the importance of the financial ratio analysis, many researchers have conducted their study by utilizing the financial ratio analysis [8-11]. The financial ratio is defined as a relationship between two individual quantitative financial information connected with each other in the logical manner [12]. The financial ratio such as debt to assets ratio, debt to equity ratio, return on asset (ROA) and return on equity (ROE) are employed in this study since these financial ratios are the most common and significant indicator to determine the performance of the companies. The data are collected from their respective companies' financial annual report on Bursa Malaysia from year 2011 to 2015 [7].

In this study, debt to assets ratio and debt to equity ratio are the inputs to measure the efficiency of the companies. Output that considered in this study are return on asset (ROA) and return on equity (ROE). Debt to assets ratio is a measure of financial leverage defined as debt divided by total assets, whereas debt to equity ratio is the relative proportion of shareholders' equity and debt used to finance a company's assets [13]. Return on asset (ROA) is defined as how productively a company uses its assets to yield profits [14]. Return on equity (ROE) is the measures a company's efficiency at generating profits from every unit of shareholders' equity [15].

Table 2 presents the formula for the financial ratios used in the evaluation on the company performance.

Table 2. Formula for the Financial Ratio.

Financial Ratio	Formula
Debt to assets ratio	$\frac{\text{Total liabilities}}{\text{Total assets}}$
Debt to equity ratio	$\frac{\text{Total liabilities}}{\text{Total shareholders' equity}}$
Return on asset (ROA)	$\frac{\text{Net profit}}{\text{Total assets}} \times 100\%$
Return on equity (ROE)	$\frac{\text{Net profit}}{\text{Total shareholders' equity}} \times 100\%$

3.2. Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a mathematical linear programming model which widely used for comparing the outputs and inputs of the organizational units by measuring their relative efficiency. DEA model provides a comparative efficiency indicator of the units to evaluate. DEA model allows each organizational unit to choose the vectors of input and output weights which maximize its own ratio of weighted output to weighted input. The inputs and outputs can be expressed in any unit of measurement if homogeneity is maintained. The organization unit is identified as an efficient unit if and only if the efficiency score is 1 (100%), otherwise, the organization unit will be determined as inefficient unit [1, 2]. The formulation of the DEA model is presented as follows [2].

$$\text{Maximize } h_k = \frac{\sum_{r=1}^s t_r y_{rk} + \alpha}{\sum_{i=1}^m w_i x_{ik}} \quad (1)$$

Subject to

$$\frac{\sum_{r=1}^s t_r y_{rj} + \alpha}{\sum_{i=1}^m w_i x_{ij}} \leq 1, j = 1, 2, 3, \dots, n \quad (2)$$

$$t_r \geq \varepsilon, r = 1, 2, 3, \dots, s \quad (3)$$

$$w_i \geq \varepsilon, i = 1, 2, 3, \dots, m \quad (4)$$

where

h_k is the relative efficiency of DMU_k

s is the number of outputs

t_r is the weights to be determined for output r

y_{rj} is the observed magnitude of r -type output for entity j

m is the number of inputs

w_i is the weights to be determined for input i

x_{ij} is the observed magnitude of i -type input for entity j

n is the number of entities

ε is the positive value

α is the free variable

Equation (1) is an objective function which maximizes the efficiency for k -decision-making unit (DMU). Constraint (2) ensures that the efficiency is $0 < h_k \leq 1$ for each DMU. The weights t_r and w_i and show the importance of each output and input in maximizing the efficiency which are determined by the model. The model above is a nonlinear with a linear and fractional objective function as well as the constraints. The model above can be converted to linear programming form by setting the denominator to 1 and maximizing the numerator [1, 16].

$$\text{Maximize } h_k = \sum_{r=1}^s t_r y_{rk} + \alpha \quad (5)$$

Subject to

$$\sum_{i=1}^m w_i x_{ij} - \sum_{r=1}^s t_r y_{rj} - \alpha \geq 0, j = 1, 2, 3, \dots, n \quad (6)$$

$$\sum_{r=1}^m w_i x_{ik} = 1 \quad (7)$$

$$t_r \geq \varepsilon, r = 1, 2, 3, \dots, s \quad (8)$$

$$w_i \geq \varepsilon, i = 1, 2, 3, \dots, m \quad (9)$$

4. Empirical Results

Table 3 presents the optimal control of input and output weights (%) in maximizing the efficiency by using DEA model.

Table 3. Optimal Control of Input and Output Weights (%) in Maximizing the Efficiency.

DMUs	Debt to assets ratio (Input 1)	Debt to equity ratio (Input 2)	ROA (Output 1)	ROE (Output 2)	Efficiency (%)
ADVENTA	100.00	0.00	0.47	99.53	100.00
AHEALTH	100.00	0.00	99.82	0.18	100.00
BJCORP	100.00	0.00	1.48	98.52	1.52
DKSH	100.00	0.00	2.65	97.35	5.73
HAIO	0.00	100.00	0.23	99.77	23.54
HOVID	100.00	0.00	4.01	95.99	3.27
IHH	0.00	100.00	99.98	0.02	98.44
KOTRA	0.00	100.00	0.01	99.99	100.00
KPJ	99.99	0.01	6.19	93.81	2.57
PHARMA	99.99	0.01	1.27	98.73	9.21
PLABS	100.00	0.00	99.87	0.13	42.51
YSPSAH	100.00	0.00	0.39	99.61	20.70
Average	75.00	25.00	26.36	73.64	42.29

As shown in Table 3, DEA model provides the optimal control of input and output weights in maximizing the efficiency for each healthcare company. The efficient companies with 100.00% efficiency consist of ADVENTA, AHEALTH and KOTRA. In this study, the overall input weights in the maximization of efficiency is mostly contributed by debt to assets ratio (75.00%), followed by debt to equity ratio (25.00%). On the other hand, the overall

output weights in the maximization of efficiency is mostly contributed by ROE (73.64%), followed by ROA (26.36%). Debt to assets ratio has plays a critical role in contributing to the maximization of the efficiency of the companies.

The empirical results for the efficiency and ranking of the companies from the healthcare sector in Malaysia over a five-year period from 2011 to 2015 are presented in Figure 1 and Table 4 respectively.

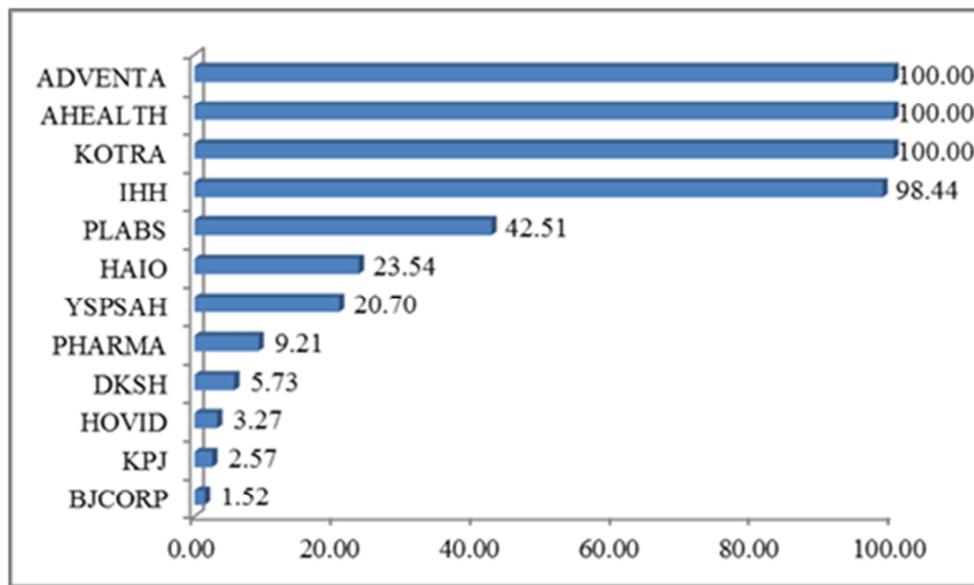


Figure 1. Efficiency of Healthcare Companies.

Table 4. Ranking of Healthcare Companies.

DMUs	Efficiency (%)	Rank
ADVENTA	100.00	1
AHEALTH	100.00	1
BJCORP	1.52	12
DKSH	5.73	9
HAIO	23.54	6
HOVID	3.27	10
IHH	98.44	4
KOTRA	100.00	1
KPJ	2.57	11
PHARMA	9.21	8
PLABS	42.51	5
YSPSAH	20.70	7

Figure 1 and Table 4 showed the relative efficiency and the ranking of the companies. The companies with an efficiency score of 100.00% are fully efficient. Therefore, it can be clearly observed that there are total of three companies found to be efficient because these companies manage to achieve 100.00% efficiency. Thus, the efficiency scores from the analysis clearly indicate that ADVENTA, AHEALTH and KOTRA are classified as efficient companies in this study. This implies that these companies are in optimal control of their inputs or resources to generate maximum outputs or outcomes. Therefore, these three companies achieve the first ranking since they obtain an efficiency score of 100.00%.

On the other hand, BJCORP, DKSH, HAI0, HOVID, IHH, KPJ, PHARMA, PLABS and YSPSAH are identified as inefficient companies since these companies are not able to achieve 100.00% efficiency. This indicates that these companies are not able to manage well their allocation of inputs to generate maximum outcomes during the study period. Based on Figure 1, IHH achieves maximum 98.44% efficiency. Thus, IHH obtain the fourth ranking in this study. On the other hand, PHARMA, DKSH, HOVID, KPJ and BJCORP obtain the efficiency scores of 9.21%, 5.73%, 3.27%, 2.57% and 2.57% respectively which are below 10.00%. This implies that PHARMA, DKSH, HOVID, KPJ and BJCORP do not perform well in terms of efficiency as compared to other companies. Therefore, these five inefficient companies are ranked in the unfavorable ranking, which are from eighth to twelfth ranking. As a result, PHARMA, DKSH, HOVID, KPJ and BJCORP obtained the eighth, ninth, tenth, eleventh and twelfth ranking, respectively in this study. In summary, ADVENTA, AHEALTH and KOTRA are ranked as efficient companies among the companies from the healthcare sector in Malaysia. Therefore, other inefficient companies can enhance their efficiency by taking these efficient companies as a benchmark in order to achieve optimal efficiency.

5. Conclusion

DEA is a mathematical linear programming model which is utilized to evaluate the relative efficiency of a set of organizational units. This study is carried out to evaluate and compare the efficiency of the healthcare sector companies in Malaysia by using DEA model. The important finding of this result shows that ADVENTA, AHEALTH and KOTRA are ranked as efficient companies since these companies are able to achieve an efficiency score of 100.00%. This implies that these efficient companies have fully utilized the inputs in generating maximum outputs or outcomes. Therefore, these efficient companies can serve as benchmark to other inefficient companies for further improvement on the efficiency. This study is significant because the DEA model is able to identify the efficient companies from the healthcare sector in Malaysia based on multiple outputs and inputs. Besides that, DEA model provides the optimal control of input and output weights in maximizing the efficiency for each healthcare company.

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