



EVALUATION ON THE EFFICIENCY OF HEALTHCARE COMPANIES IN MALAYSIA WITH DATA ENVELOPMENT ANALYSIS MODEL

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Abstract

Healthcare industry plays an important role in the society and attracts the attention of the public nowadays. Healthcare industry has played a vital role in this world to provide goods and services to enhance quality of life, life expectancy, diagnostic and treatment options as well as the efficiency and cost effectiveness of the healthcare system. The objective of this study is to evaluate and compare the performance efficiency of the healthcare companies in Malaysia with Data Envelopment Analysis (DEA) model. The performance efficiency of the companies is defined as the ratio of sum weighted outputs to sum weighted inputs. In this study, the data consists of 12 healthcare companies in Malaysia from year 2011 to 2015. The results of this study show that ADVENTA and AHEALTH are ranked as efficient healthcare companies and therefore serve as

benchmark to other inefficient healthcare companies. The efficiency of the healthcare companies in Malaysia can be determined by using DEA model. This study is significant because it helps to determine the efficient healthcare companies based on multiple inputs and outputs with DEA model.

Key words: Healthcare Company, Data Envelopment Analysis, Efficiency, Linear Programming Model

1. Introduction

Healthcare industry plays an important role in the society and attracts the attention of the public nowadays. According to Omachonu and Einspruch [1], healthcare industry has played a vital role in this world to provide goods and services to enhance the quality of life, life expectancy, diagnostic and treatment options, efficiency and cost effectiveness of the healthcare system. The goods and services that provided by the healthcare industry are in the form of regulation and management of health service delivery, education and training of health professionals, provision of traditional and complementary medicines as well as administration of health insurance, by Hernandez et al. [2]. Efficiency is used to describe how well an organizational unit is performing in utilizing resources to generate outputs or outcomes. In the field of healthcare industry, Nunamaker and Lewin [3] were the first team in measuring the routine nursing service efficiency by using Data Envelopment Analysis (DEA) model. After they have done their experiment successfully by using the DEA model, many researchers found that the DEA model can be well applied in the field of healthcare industry. Therefore, DEA model has been applied extensively in the evaluation of the performance efficiency of hospitals. Sherman [4] was the pioneer in applying DEA model for the evaluation of the overall hospital efficiency. Based on the opinion from Feroz et al. [5], DEA model is considered as an improved alternative to the traditional ratio analysis when evaluating the performance of the entities. DEA model was developed by Charnes et al. [6] to measure the performance efficiency of the organizational units such as companies, hospitals and so forth. DEA is a mathematical linear programming model based on non-parametric approach. DEA model has been widely applied in various fields such as banks (Kamil and Ong [7]), hospitals (Al-Shayea

[8]), healthcare industry (Asandului [9]), universities (Ulucan [10]), employees' performance (Zbranek [11]) and so forth. DEA model defines the performance of the unit as the ratio of sum weighted outputs to sum weighted inputs. The measure of performance is expressed in the form of efficiency score. The DEA model evaluates and assigns all units with an efficiency score, which is varied between 0 and 1 (0% and 100%). The units that achieve an efficiency score of 100% are considered as efficient units which manage to fully utilize their resources in generating maximum outcomes or outputs. On the other hand, the units that failed to reach 100% efficiency will be classified as inefficient units. The objective of this paper is to evaluate and compare the performance efficiency of the healthcare companies in Malaysia 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 of companies' performance efficiency. Section 3 discusses about the data and methodology used in this study. Section 4 presents the empirical results of this study. Section 5 concludes the paper.

2. Literature Review

Benneyan et al. [12] have examined the relative efficiencies of national healthcare systems of ten countries. The data were collected from the WHO website. Canada, China, India, Jamaica, Japan, Pakistan, Russian Federation, Turkey, USA, and Venezuela were ten countries assessed in this study. The findings of the study showed that the performance efficiency score of 100% was only achieved by Jamaica and Japan. However, the remaining countries such as Canada, China, India, Pakistan, Russian Federation, Turkey, USA, and Venezuela were identified as inefficient in term of their healthcare system.

Akazili et al. [13] have evaluated the performance efficiency of the healthcare industry in Ghana by using the DEA model. The efficiency assessment of 89 public healthcare centres were assessed and examined thoroughly. Based on the results, 35% of the health centers were efficient, whereas the other 65% of the health centres were found inefficient.

Al-Shayea [8] has assessed the efficiency of King Khalid University Hospital departments with a DEA model 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 primary care departments and psychology department managed to achieve an overall efficiency score of 100% in year 2010.

Mogha et al. [14] have analyzed the performance efficiency of 55 private sector hospitals in India by using DEA model. The data of the study were extracted from the PROWESS database of Centre for Monitoring Indian Economy from year 2009 to 2010. Net fixed assets, energy expenses, wages and salaries were treated as inputs, whereas the operating income was treated as output in their study. The results of this study showed that 10 out of 55 private sector hospitals were efficient. The remaining 45 hospitals were inefficient since these hospitals failed to achieve 100% efficiency due to poor utilization of the resources.

Asandului et al. [9] have evaluated the efficiency of 30 public healthcare systems in Europe with DEA model in year 2010. There were total of 30 European states evaluated in their study such as Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. The results of this study showed that some developing countries and developed countries were efficient in transforming their inputs into outputs effectively.

In addition, DEA model can also be applied in the banking sector to determine the performance efficiency. Kamil and Ong [7] have analyzed the efficiency of 20 listed Malaysia's companies in year 2003, which are ACP Industries Berhad (ACPI), Autoindustries Corporation (AIC) Berhad, AKN Technology Bhd (AKN), ASTRO All Asia Networks plc (Astro), Berjaya Group Berhad (Bjgroup), Genting Berhad, Globetronic Technology Bhd (GTRONIC), HeiTech Padu Berhad (Heitech), KOBAY Technology Bhd, LITYAN Holding Bhd, LKT Industrial Bhd, Maxis Communications Berhad, Malaysia Mining Corporation Berhad (MMC), MSNIAGA Berhad, Patimas Computers Bhd, PLB Engineering Berhad, Tenaga Nasional Berhad (TNB) Berhad, Unisem (M) Bhd , WCT Engineering Berhad and YLI Holding Berhad. In this study, current assets, current liabilities, total assets and total expenses were treated as inputs whereas net income after taxes was identified as output. The results of this study showed that Maxis, Genting and YLI achieved 100% efficiency in year 2003. The companies

other than Maxis, Genting and YLI were identified as inefficient companies because their efficiency scores were less than 100%.

Varias and Sofianopoulou [15] have examined the efficiency of Greek commercial banks with DEA model. The data was obtained from the income statements, balance sheets and the annual report of 19 commercial banks in year 2009. The commercial banks identified in this study were Alpha Bank, ATE Bank, Attica Bank, CitiBank Europe, EFG Eurobank Ergasias, Emporiki Bank, FBBank, Geniki Bank, Hellenic Bank, Hellenic Postbank, HSBC, Marfin Egnatia Bank, Millenium Bank, National Bank of Greece, Panellinia Bank, Piraeus Bank, PRO Bank, Proton Bank and T Bank. In this study, the outputs were loans, deposits and other earning assets. On the other hand, the ratio interest expenses/deposits, personnel expenses/total assets and other overhead expenses/fixed assets were considered as inputs. Based on the result, only ATE Bank, EFG Eurobank Ergasias, HSBC, National Bank of Greece and Piraeus Bank managed to achieve an efficiency score of 100%. Emporiki Bank was ranked at the lowest due to lowest efficiency score among the commercial banks. In conclusion, the researchers suggested that the inefficient commercial banks should take improvement action to in managerial aspect. The inefficient commercial banks can achieve optimal efficiency by increasing their outputs.

Zamani et al. [16] have evaluated the performance efficiency of 43 investment companies in India by using DEA model. The inputs that used in their study were debt to equity ratio and beta risk whereas net profit margin, return on capital employment, return on equity and earnings per share were considered as outputs. As a result, there were 18 out of 43 companies managed to achieve the optimal efficiency.

Based on the past research, DEA model is able to evaluate the performance efficiency of the companies in various countries. However, to the best of our understanding, DEA model has not been studied on the healthcare companies in Malaysia. Therefore, this paper aims to fill the research gap by evaluating and comparing the performance efficiency of the healthcare companies in Malaysia by using DEA model.

3.Data and Methodology

3.1Data

In this study, the data consists of 12 healthcare companies listed in Malaysia stock market as shown in Table 1.

Table 1: Healthcare Companies in Malaysia Stock Market

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

Source: (Bursa Malaysia [17])

The inputs identified in this study are total asset and total liability. On the other hand, net income is identified as output. Total asset is the sum of current asset and non-current asset. Sullivan and Sheffrin [18] defined the total asset as the value of ownership that can be converted into cash. According to Mousa [19], total liability is the year-end total amount of current liabilities and non-current liabilities from the balance sheet. Net income is defined as the residual of all incomes and revenues over all expenses and losses for the period, by Stickney et al. [20]. The data of this study is obtained from the companies' financial annual report from year 2011 to 2015.

3.2Data Envelopment Analysis (DEA)

Data envelopment analysis (DEA) model was developed by Charnes et al. [6]. DEA is a mathematical linear programming model based on non-parametric approach which is

utilized for measuring the performance efficiency of the organizational units. Efficiency is used to describe how well an organizational unit is performing in utilizing resources to generate outputs or outcomes. In DEA model, the performance of the unit is calculated as the ratio of the sum-weighted outputs to sum-weighted inputs. DEA model is a frontier analysis, which is able to deal with the multi-dimensional nature of inputs/outputs. The main idea of the frontier analysis is to show that the efficient unit will form the efficiency frontier, whereas the unit that is not on the efficiency frontier is identified as inefficient unit. The DEA model is formulated as follows:

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

Subject to

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

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

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

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

m is the number of inputs

w_i is the weights to be determined for input i

ε is the positive value

n is the number of entities

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 w_i and t_r show the importance of each input and output 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 reduced to linear programming form by setting the denominator to 1 and maximizing the numerator (Charnes et al. [6]; Martić et al. [21]).

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

Subject to

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

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

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

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

4. Results and Discussions

The empirical results for the performance efficiency and ranking of the healthcare companies are presented in Figure 1 and Table 2 respectively.

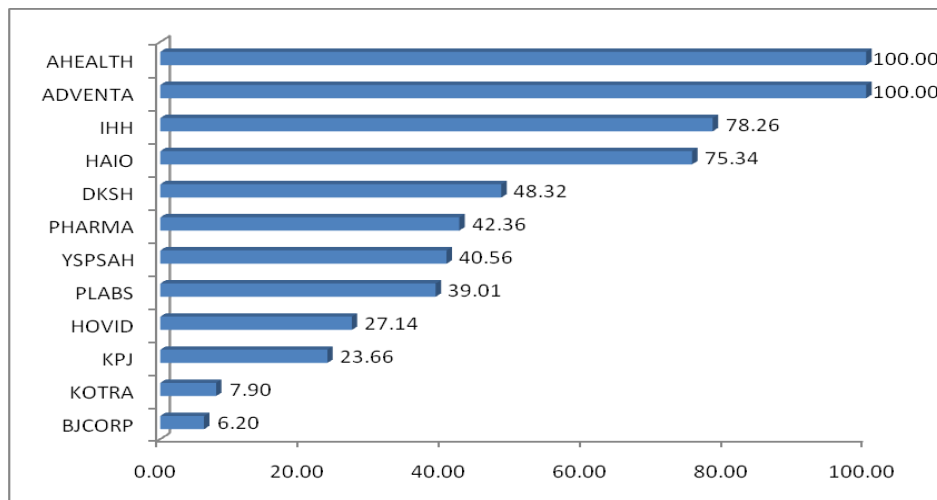


Figure 1: Performance Efficiency of Healthcare Companies

Table 2: Ranking of Healthcare Companies

DMU	Efficiency (%)	Rank
ADVENTA	100.00	1
AHEALTH	100.00	1
BJCORP	6.20	12
DKSH	48.32	5
HAIO	75.34	4
HOVID	27.14	9
IHH	78.26	3
KOTRA	7.90	11
KPJ	23.66	10
PHARMA	42.36	6
PLABS	39.01	8
YSPSAH	40.56	7

As shown in Figure 1 and Table 2, there are two efficient companies which manage to achieve 100.00% efficiency, which are ADVENTA and AHEALTH. This implies that both ADVENTA and AHEALTH have fully utilized the inputs of total asset and total liability in maximizing the net income as output. BJCORP, DKSH, HAIO, HOVID, IHH, KOTRA, KPJ, PHARMA, PLABS, and YSPSAH are treated as inefficient companies since their performance efficiencies are less than 100.00%. IHH and HAIO achieve 78.26% and 75.34% performance efficiency respectively. Therefore, IHH and HAIO obtain the third and fourth ranking respectively in this study. On the other hand, BJCORP and KOTRA obtain the efficiency scores of 6.20% and 7.90% respectively which are below 10.00%. This implies that BJCORP and KOPTRA do not perform well in terms of efficiency as compared to other companies. In summary, ADVENTA and AHEALTH are ranked as efficient companies among the healthcare companies in Malaysia and therefore both companies can serve as benchmark to other inefficient companies to achieve optimal efficiency.

5. Conclusions

DEA is a mathematical linear programming model which aims to measure the performance efficiency of the healthcare companies in this study. DEA model can provide useful information to the public and society in analyzing the performance efficiency of the healthcare companies. The results of this study show that ADVENTA and AHEALTH are ranked as efficient companies as compared to the other healthcare companies. Both ADVENTA and AHEALTH have fully utilized the total asset and total liability in maximizing the net income as measured in performance efficiency. This study is significant because it is able to identify the efficient companies from the healthcare companies in Malaysia with DEA model.

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