TECHNICAL AND SCALE EFFICIENCY OF DISTRICT HOSPITALS IN PERAK USING DATA ENVELOPMENT ANALYSIS

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Dis 2013

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Project Paper Submitted to

Othman Yeop Abdullah Graduate School of Business,

Universiti Utara Malaysia,

in Fulfillment of the Requirement for the Master's Degree

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ABSTRACT

In the recent years, the developed and developing countries has been debate's about increasing healthcare costs. The Ministry of Health in Malaysia has been implementing various health care sector reforms such as expansion and upgrading of public health facilities in a bid to improve efficiency in health care. In monitoring performance, efficiency study is vital for health care institutions. The purpose of the study is to investigate how well resources have been allocate in producing outputs, thus to measure technical and scale efficiencies of public hospitals in Perak, Malaysia.

Data were obtained from ten publics hospital in Perak, as the Decision-Making Units (DMUs), for the year 2008 to 2010. The data were pooled which consist of 30 DMUs altogether with the technique of Data Envelopment Analysis (DEA). The number of doctors, nurses and beds represents the inputs, while the number of outpatients, inpatients, surgeries and delivery represents the outputs.

There are three hospitals in year 2009 and 2010 with increasing return to scale (IRS). While in 2008, only two hospitals were faces IRS. Then, for decreasing return to scale (DRS), three hospitals were identified as DRS in year 2009, and one hospital in 2008 and 2010.

The findings motivate an examination of the policy implications of these comparative analysis of efficiency in the production of health care. Finally, the hospitals that are more economical in the allocation of resources to health care should be a benchmarking to inefficienct hospitals.

Keyword: data envelopment analysis, hospital efficiency, technical efficiency and scale efficiency

ABSTRAK

Kebelakangan ini, negara- negara maju dan membangun hangat membahaskan mengenai isu-isu dasar yang telah meningkatkan kos penjagaan kesihatan yang semakin meningkat. Kementerian Kesihatan Malaysia telah melaksanakan pelbagai reformasi sektor penjagaan kesihatan seperti pengembangan dan menaik taraf kemudahan kesihatan awam dalam usaha untuk meningkatkan kecekapan dalam penjagaan kesihatan. Dalam pemantauan prestasi, kajian kecekapan adalah penting bagi institusi penjagaan kesihatan. Tujuan kajian ini adalah untuk mengkaji bagaimana sumber telah diperuntukkan dalam menghasilkan output untuk mengukur kecekapan teknikal dan skala hospital awam di Perak, Malaysia.

Data diperolehi daripada sepuluh hospital awam di Perak sebagai Unit Pembuat Keputusan (DMUs), bagi tahun 2008 hingga 2010. Data yang dikumpulkan telah digunakan yang terdiri daripada 30 DMUs dan diuji dengan menggunakan teknik Data Envelopment Analysis (DEA). Bilangan doktor, jururawat dan katil mewakili input, manakala bilangan pesakit luar, pesakit, pembedahan dan bersalin mewakili output.

Hasil kajian menunjukkan bahawa tiga hospital pada tahun 2009 dan 2010 mencapai pulangan meningkat mengikut skala. Manakala pada tahun 2008, dua hospital mencapai pulangan meningkat mengikut skala. Sementara itu, tiga hospital dikenalpasti mencapai pulangan berkurangan mengikut skala pada tahun 2009. Manakala pada tahun 2008 dan 2010, hanya satu hospital mencapai pulangan berkurangan mengikut skala.

Hasil dari kajian ini, implikasi dasar memberi kesan dalam penjagaan kesihatan. Akhir skali, hospital yang cekap dalam menggunakan sumber menjadi tanda aras kepada hospital yang tidak cekap dalam menggunakan sumber.

Kata kunci: data envelopment analysis, kecekapan hospital, kecekapan teknikal dan kecekapan skala

ACKNOWLEDGEMENT

I take this opportunity to express my profound gratitude and deep regards to my supervisor, Dr Shri Dewi A/P Applanaidu for her exemplary guidance, monitoring and constant encouragement through the course of these project paper. The blessing and guidance given by her time to time shall carry me a long way in the journey of life on which I am about to embark.

Then, I would like to thank my family for continued encouragement throughout the course of my study. I really appreciate for their understanding, encouragement and finishing my master's program. Without their encouragement and understanding it would have been impossible for me to complete this work.

Finally, thanks to my fellow friends for reading and providing comments on the draft of my project paper. Also special thanks to all my lecturers of the University Utara Malaysia for their information, help and guidance. I remain deeply appreciative to everyone involved who has given inspirations and guidance whether directly or indirectly during my study.

TABLE OF CONTENTS

Pages

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AE	Allocative Efficiency
BOR	Bed Occupancy Rate
CRS	Constant Return to Scale
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
EE	Economic Efficiency
EMS	Efficiency Measurement System
GSO	General Statistics Office
ICU	Intensive Care Unit
IRS	Increasing Return to Scale
MPSS	Most Productive Scale Size
MoH	Ministry of Health
NIRS	Non-increasing Return to Scale
SE	Scale Efficiency
TE	Total Efficiency
TFP	Total Factor Productivity

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

In the era of global competition in a borderless world, productivity growth is the path for sustained economic growth and enhanced living standards. Traditionally, productivity has been defined as the efficiency of transforming input into output (Bitran & Chang, 1984; Stoner et al., 1995; Parken, 1992). The measurement of efficiency is usually the first step in auditing individual performance of production unit in health care systems (Hossein, Syed, & Rahmah, 2010).

Efficiency is an important term especially in health care because it may transform the delivery of health care system. The transformation can be in term of increasing quality, capacity and coverage of the health care infrastructure, shifting towards wellness and disease prevention rather than treatment and increasing the quality of human resource for health.

Since independence, Malaysia is a vibrant and dynamic country enjoying continued economic growth and political stability. Today, Malaysian are generally healthier, live longer, and are better disposed to be more productive. The health plan for Malaysia has been detailed out in the 10th Malaysia Plan (2011-2015). This plan is to ensure that good health enables Malaysian to lead productive and fulfilling lives and contributes to increased prosperity and social stability.

According to Ministry of Health (MoH) Malaysia, this plan is based on the concept of 1 Care for 1 Malaysia. This is a restructured national health system that is responsive and provides choice of quality health care, ensuring universal coverage for health care needs of population based on solidarity and equity. The concept for 1 Care for 1 Malaysia is to create an effective, efficient, fair and high technology system of health care as well as responsive and can further improve access to various levels of appropriate health care to all Malaysians.

According to MoH, the percentage of health budget allocation to total national budget has increased from 6.94 percent in 2009 to 8.02 percent in 2010 (Table 1.1). While Health budget which consist operating and development also increased around ninety one hundred billion.

Table 1.1: Percentage of Health Budget Allocation to Total National Budget, Malaysia
2009 and 2010

	2009	2010
Percentage of Health Budget Allocation to National Budget	6.94	8.02
National Budget (Operating & Development)	RM 207 million	RM 191 million
Health Budget (Operating & Development)	RM 14 million	RM 15 million

Source : Finance Division - Ministry of Health Malaysia, 2009 and 2010

MoH continues to actively persue public health promotion through health education such as training, research and development (see Table 1.2). Thus, the table clearly shows that government increased the allocation in health project from year to year. For example, government increased their budget allocation in training to encourage staffs to became more efficient and productive.

Besides training, the allocation to build new hospitals increased from RM 344 million in 2009 to RM 682 million in 2010. Similarly with expenditure equipments and transport, government has increased their budget from RM 277 million (2009) to RM 599 million (2010).

Table 1.2: Actual Development Allocation and Expenditure by Project Details, Malaysia, 2009 and 2010

DETAIL PROJECT	TITLE	ALLOCATION (RM)	
		2009	2010
00100	Training	289,531,701	354,877,332
00200	Public Health	609,772,124	586,030,953
00300	Hospital Facilities	743,456,380	778,967,368
00400	New Hospitals	344,808,043	682,227,698
00500	Research & Development	33,415,110	29,025,105
00600	Renovation, Upgrading and Repairs	50,660,826	157,536,480
00700	Procurement and Land Maintanances	5,732,950	56,810,954
00800	Information Technologyand Communication Facilities	87,103,877	163,253,193
00900	Staff Facilities	118,018,092	175,047,700
001000	Health Promotion	6,600,000	1,368,466
001100	Equipments and Transport	277,496,187	599,118,771
	TOTAL	2,566,596,130	3,584,264,010

Source : Finance Division - Ministry of Health Malaysia, 2009 and 2010

Table 1.3 presents the distribution of hospital and bed strength by sector and state in Malaysia. Malaysia have two types of hospitals which is public hospitals and private hospitals. Sabah and Sarawak recorded the highest number of hospitals with 23 and 22 respectively. While Perlis, Wilayah Persekutuan Putrajaya and Wilayah Persekutuan Labuan recorded only one hospital in the state. Perak showed the highest number total of beds (5,670 beds) under MoH. Overall, Malaysia have 137 hospitals with 37,793 number of total beds under MoH.

Table 1.3: Distribution of Hospital and Bed Strength by Sector and State, Malaysia,2010

STATE	GOVERNMENT HOSPITALS				PRIVATE HOSPITALS	
	MoH		Non MoH			
	Number of hospitals	Beds	Number of hospitals	Beds	Number of hospitals	Beds
Perlis	1	404	0	0	1	2
Kedah	9	2263	0	0	10	524
Pulau Pinang	6	1930	1	747	26	2053
Perak	15	5670	1	147	15	906
Selangor	11	4688	2	1220	65	3321
W.P Kuala Lumpur	2	2347	2	1408	45	3121
W.P Putrajaya	1	278	0	0	0	0
Negeri Sembilan	6	1527	0	0	9	439
Melaka	3	1006	1	144	5	819
Johor	12	4917	1	24	37	1110
Pahang	10	1907	0	0	9	213
Terengganu	6	1372	0	0	3	31
Kelantan	9	1652	0	0	5	173
Sabah	23	4155	0	0	7	277
W.P Labuan	1	109	0	0	0	0
Sarawak	22	3568	0	0	17	587
MALAYSIA	137	37793	8	3690	254	13578

Includes Private Hospital, Private Maternity Home, Private Nursing Home and Private Hospice

Source:Health Informatics Centre , Ministry of Health Malaysia, 2010

According to Malaysian Medical Council (see Table 1.4), presents the number of doctors and nurses by state in year 2010. Selangor recorded the highest number of doctors (3,190) and nurses (5,447). While Wilayah Persekutuan Labuan recorded only 27 number of doctors and 136 number of nurses. Malaysian have 19,429 doctors and 43,439 nurses in public sector under MoH.

Table 1.4 : Number of Doctors and Nurses by State, Malaysia, 2010

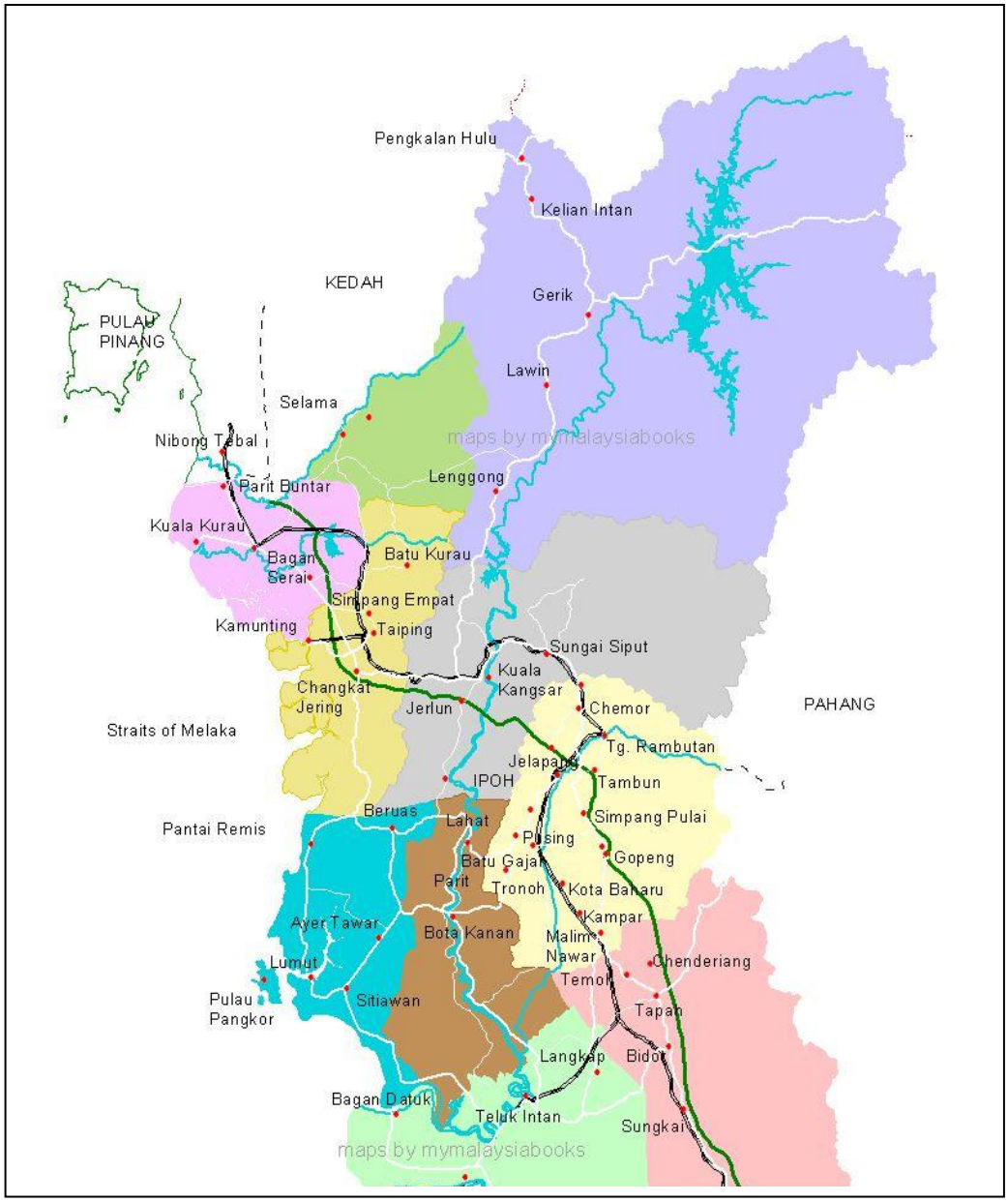
STATE	NUMBER OF DOCTORS AND NURSES BY STATE IN MoH	
	DOCTORS	NURSES
Perlis	251	716
Kedah	1276	3428
Pulau Pinang	1281	2461
Perak	1898	4099
Selangor	3190	5447
W.P Kuala Lumpur[1]	2788	4153
W.P Putrajaya	240	0
W.P Labuan	27	136
Negeri Sembilan	1007	1781
Melaka	729	1489
Johor	1646	4689
Pahang	1023	3033
Terengganu	672	2195
Kelantan	858	2431
Sabah	1339	4263
Sarawak	1254	3118
MALAYSIA	19429	43439

Data from Human Resource Division, MoH, 2010

[1] *Includes W.P Putrajaya*

1.2 A Glimpse of Health Care Services in Perak

Perak is one of the 13 states in Malaysia and is the second largest state in Peninsular Malaysia. Figure 1.1 shows the Perak state map.



Source : Google map

Figure 1.1: Map of Perak

There are 15 public hospitals in Perak (Table 1.5). Also, there are two types of public hospitals namely with specialist and non-specialist. This study discusses only 10 hospitals in Perak. Hospital Tanjung Rambutan was not included because of different category which is called as mental hospital. Remaining for four hospitals were not included in this study because of data limitation and no cooperation from particular hospitals.

Table 1.5: Hospitals in Perak State

	Hospital
1	Hospital Bahagia Tanjung Rambutan
2	Hospital Ipoh
3	Hospital Teluk Intan
4	Hospital Slim River
5	Hospital Changkat Melintang
6	Hospital Kuala Kaangsar
7	Hospital Batu Gajah
8	Hospital Gerik
9	Hospital Kampar
10	Hospital Parit Buntar
11	Hospital Selama
12	Hospital Seri manjung
13	Hospital Sungai Siput
14	Hospital Tapah
15	Hospital Taiping

This study utilises the Data Envolopment Analysis (DEA) which is a method for mathematically comparing different decision-making unit (DMUs) efficiency based on multiple inputs and outputs.

1.3 Problem Statement

In recent years, rising cost of health care services and inefficiency in using resources has been increasingly considered by health policy makers in Malaysia. Thus, MoH has been implementing various health care reforms such as expansion and upgrading of public health facilities and all this action involves cost in a bid to improve efficiency in health care. The aims of the Tenth Malaysia Plan (2011-2015) to transform the health sector towards a more efficient and effective health system in ensuring universal access to health care. So, the planed was created an interest to do this study and to investigate how well resources has been allocated in producing outputs.

This research is very vital in health care instituition especially in Perak state to monitoring performance and reduces the cost. Its will identify inefficient hospital and efficient hospitals. Then, inefficiency hospital can become efficient wheather to increase or decrease the input or both.

Publics hospitals are not expected to be efficient had been argued by some people. This is because they are not profit oriented, but given the large amount of resources that go towards funding them. This statement growing interest in examining their efficiency.

1.4 Objective

The main objective of this study is to estimate technical efficiency and scale efficiency of public hospitals in Perak state using Data Envelopment Analysis (DEA). The specific objectives are:

i. to estimate the technical efficiency (TE) of public hospitals in Perak;
ii. to estimate scale efficiency scale efficiency (SE) of public hospitals in Perak; and
iii. to estimate the ideal resources available with the less efficient hospitals which need to be relocated to improve efficiency of the hospitals.

1.5 Organization of The Study

This paper is structured as follows: chapter 2 is the literature review, chapter 3 the methodology used to calculate efficiency score, results in the chapter four, and final chapter provides some conclusion and policy implications.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews efficiency measurement concept. The concept of hospitals efficiency, review of hospital efficiency studies and followed by review of others studies using Data Envelopment Analysis (DEA).

2.2 Efficiency Measurement Concept

Efficiency measurement begins with Farrell (1957) who drew upon the work of Debreu and Koopmas (1951). They define a simple measure of firm efficiency which could account for multiple inputs. The efficiency of a firm consist of two components proposed by Farrell (1957). First, technical efficiency which reflects the ability of a firms to obtain maximal output from a given set of inputs. Allocative efficiency which reflects the ability of a firm to use the inputs in optimal proportions, given their respectives prices and the production technology was a second compenent. If combined technical efficiency and allocative efficiency, its provide a measure of total economic efficiency.

2.3 The Concept of Hospital Efficiency

Efficiency is the success of the hospital in using its resources to produce output. The recent history of microeconomics efficiency began in 1950 with Koopmans, who was the first formally defined technical efficiency. Debru (1951) first measured efficiency whereas Farrell (1957) who defined a simple measure of firm efficiency that could account for multiple inputs within the context of technical, allocative and productive efficiency. Beside that, he also described technical efficiency as the ratio of the firms observed output and the maximum obtainable output on the frontier given observed factor utilization. The concept of technical efficiency refers to the capacity of the decision-making unit (DMUs) efficiency based on multiple input and output.

In the Farrell (1957) framework, a hospital is judged to be technically efficient if it is operating on the best practice production frontier in its hospital industry. In the original Farrell framework, the entire observations on given sample is assumed to have accessed to same technology.

Measuring technical efficiency allows us to compare hospitals in terms of their real use of inputs and outputs rather than costs or profits (Magnussen, 1996). If an increase in an output requires a decrease in at least one other output, or an increase in at least one input, a hospital is said to be technically efficient.

Furthermore, a reduction in any input must require an increase in at least one other input or a decrease in at least one output. On the other hand allocative efficiency occurs when inputs or outputs are put to their best possible uses in the economy so that no further gains in output or welfare are possible.

2.4 Review of Hospital Efficiency Studies

Sherman (1984) wrote one of the founding articles on efficiency utilizing the DEA methodology in United States (U.S.) hospitals. He examined teaching hospitals and included nurses and interns trained as well as patient days as outputs. When he compared the results of traditional ratio and regression analysis as well as DEA, he found that DEA is a useful tool for the evaluation of resources among health care organizations. DEA also can lead toward improved hospital efficiency and reductions in health care costs. Sherman suggested the DEA technique can overcome limitations of traditional and regression analysis and provide a more comprehensive measure of hospital efficiency.

The first DEA in military hospitals was conducted by Charnes et al., (1985). He investigated the efficiency of 24 army military hospitals. Personel trained, relative work product, and clinic visits was the selected traditional workload criteria for analysis of outputs. These output are considered traditional elements of production in health care and are relavant for inclusion along with other less traditional factors.

Grosskopf and Valdmanis (1987) examined 22 public hospital and 60 private not-for-profit hospitals in California. They found that the two classes of hospitals to be facing distinct production frontiers with public hospitals being more efficiency overall when they used DEA method.

Valdmanis (1990) applied the DEA method to a group of hospitals and found that government-owned hospitals were more efficient. This maybe due to the fact that an imperfect adjustment is made for the quality of output and patient day rather than admission are generally used to measure output. Profit hospitals tend to be disproportionately presented among highly inefficient hospitals (Ozcan, 1992) and are inefficient compared to not-for-profit hospitals when output is measure by discharging.

The DEA technique also used by Ozcan and Luke (1993) to conduct a national study of the efficiency of hospitals in urban markets. Four variables were analyzed in this study which is hospital size, membership in multihospital system, ownership and payer mix. Ownership and percent Medicare were consistently related to hospital efficiency. The Medicare percent was related negatively to technical efficiency. As a result, government hospitals were more efficient and for profit hospitals less efficient than other types of hospitals. While the other variables like hospitals size, and membership in a multihospital system were related positively to efficiency.

Another study by Puig-Junoy (1998) used a cross-sectional DEA to study technical efficiency among intensive care unit (ICUs) in Spain using two stage approach. In the first, stage enviromental factors over which the ICU has no control are ignored. While in the second stage, variation in operating efficiency was captured by a regression model. The model alleviates the problem of measuring heterogeneous outputs by focusing on the services provided by ICUs, since all ICUs treat patients that are critically ill.

DEA approach was used to treat the health production system in a certain province as a DMU. This study was identified inputs and outputs and evaluate technical efficiency in 1982, 1990 and 2000 respectively and further analyze the relationship between efficiency scores and social-enviromental variables (Ning, Angang, Jinghai, 2007).

Ozcan and Bannick (1994) used DEA to study trends in Department of Defense hospital efficiency using 124 military hospitals and data from 1998 to 1999. These authors also compared Department of Defense hospital efficiency with that of Veteran's Administration hospital efficiency (n=284) using 1989 data in 1995. These studies were conducted at the strategic level under a different operational paradigm, prior to the large-scale adoption of managed care.

The evolution of efficiency and productivity in the hospital sector of an Austrian province for the time period 1994-1996 were investigated by Maria, Iain, Monika (2002). They used panel data to design non-parametric frontier models (DEA) and compared efficiency scores and time patterns of efficiency across medical fields. They used two different approaches for output measurement because health outtcomes hardly can be measured in a direct way.

Coppola (2003) conducted a DEA study of military hospital using 1998 until 2002 data. He selected the following input variables which is costs, number of beds, and number of service offered. He also used surgical visit, ambulatory patient visit, emergency visits, and live birth as output variables. This study is focused on workload as the primary measure for efficiency, a point of view not fully congruent with the current operation of military hospitals.

Razli (2003) used DEA when measuring the productivity of public hospitals in Malaysia. This paper takes the approach of measuring productivity by incorporating both efficiency and effectiveness. Found that DEA is most useful for a composite measure of productivity. Productivity measures using both efficiency and effectiveness through the DEA is more meaningful than a measure with efficiency only.

In recent studies, DEA is used in many of the health production efficiency evaluations at the micro level, such as hospital efficiency (Chilingerian, 1995; Evans et al., 2000). The studies of health production efficiency of China have also been concentrated on the micro level, such as the hospital efficiency evaluation (Ren Ran et al., 2001) and clinics efficiency evaluation (Huan Yixiang et al., 2004)

Stanford's (2004) examination of the performance using DEA of 107 Alabama hospitals in the treatment of acute myocardial infarction patients because examined clinical efficiency and quality of care. Cross efficiencies were used to improve the efficiency discrimination between hospitals.

Non-paramertic analysis of efficiency performance for hospitals and medical centres in Vietnam was study by Nguyen and Giang (2004). The data consist of 44 observations, which include 17 hospitals and 27 medical centers in different provinces and cities from the Economic Census for Enterprises by General Statistics Office of Vietnam (GSO) in 2002. The findings indicate that the average scale efficiency of the hospitals was 77.4 percent and the medical centers was 58.7 percent.

DEA, constant return to scale, and input oriented was the study to examine technical efficiency among three teaching hospitals in Malaysia by Hossein, Syed, Rahmah, Mazna, & Wan (2011). In this study, variables categorized two output and input. Outputs of the study includes number of discharged inpatient and number of visited outpatient by each department. While bed, doctor, nurse and nonmedical staff were the inputs of the study. Result show that 87.5 percent of the selected clinical departments are operated inefficiently.

DEA also was used to measure the technical and scale efficiencies of public hospitals in Kedah (Shri Dewi, Shamzaeffa, Jamal, Abdul Razak, & Umakant, 2012). They applied pooled data which consists 27 DMUs altogether. The number of outpatients, inpatients, surgeries and deliveries represents the output, while the input comprises the number of doctors, nurses, and beds. As a result, 74 percent out of 27 DMUs are technically efficient which lie on the best-practice frontier.

A study by Ahmad Sobri, Shamzaeffa, Shri Dewi, Jamal, & Rahimah (2012) examined technical efficiency and scale efficiency of 25 hospitals in the Northern Region of Malaysia. The non-parametric DEA method was applied in this study. The findings showed the average variable return to scale (VRS) tehnical efficiency scores for inefficient hospitals were 0.880 in 2008 and 2009.

2.5 Review Of Others Study In Using Data Envelopment Analysis

Technical efficiencies of non-life insurance companies, which are active in Turkey in 2007 was evaluated by Semra, Esra, & Sureyman (2012). DEA was used to examine different input-output components. Moreover, DEA was a management evaluation tool that assist in identyfying the most efficient and inefficient decision making units in the best practice frontier. As inputs of 23 non-life insurance companies, the number of agent, the numbers of brokers, fixed assets, shareholders' equity and as outputs the investment incomes, premiums received were used in this study.

The DEA approach was used to evaluate the relative efficiency of a Malaysian hotel chain during the period of 2004 to 2008 in term of Total Factor Productivity (TFP) change by Lee, Muhammad, Mohidin, Abdul, & Yuhanis (2011). TFP change is measured using DEA- Malmquist productivity index. This paper identified the best performing hotel within the chain which can be benchmarked by others to improve performance.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter starts with Data Envelopment Analysis (DEA), followed by sub topics input- oriented measures, input- oriented model and slacks. Then data and variables, result and limitation of the study.

3.2 Data Envolopment Analysis

DEA is a very powerful service management and originally develop by Charnes Cooper and Rhodes (1978) to evaluate non profit and public sector organizational. Moreover, DEA also has been proven to locate ways to improve service not visible with other techniques. Linear programming is the underlying methodology that makes DEA particularly powerful compared with alternatif productivity management tools.

There are four steps in what does DEA do. Firstly, DEA will compares service units considering all resources used and services provided. Thus, DEA also identified the most efficient units and the inefficient units in which real efficiency improvements are possible. This result will archieved by comparing the mix and volume of services provided and the resources used by each unit compared with those all the other units.

Secondly, the amount and type of cost and resources will be calculated by DEA, saying that can be achieved by making each inefficient units as efficient as the most efficient.

Thirdly, DEA identified the specific changes in the inefficient service units which management can implement to achieve potential savings located with DEA. The effect of these change would make the efficient units performance approach the best practice unit performance.

Lastly, the information that management received about performance of service units can be used to help transfer system and managerial expertise from better-managed relatively efficient units to the inefficient ones. DEA approach has resulted in improving the productivity of the inefficient units, reducing operating costs and increasing profit ability.

Data envelopment analysis (DEA) includes the use of linear programming methods to constructs a non- parametrics piece-wise surface (or frontier) over the data. Then, efficiency measures will be calculated relative to this surface. Seiford and Thrall (1990), Lovell (1993), Ali and Seiford (1993), Lovell (1994), Charnes et al (1995) and Seiford (1996) had do the comprehensive reviews of the methodology presented.

In 1978, Charnes, Cooper and Rhodes proposed a model which had an input orientation and assumed constant returns to scale (CRS). In addition, DEA is a method for mathematically comparing different decision making units' (DMUs) efficiency based on multiple inputs and outputs.

The ratio of weighted inputs and outputs produces a single measure of productivity called relative efficiency. Thus, the measured of productivity is also referred to as relative effciency as the weights for input and output variables of a DMU are computed to maximize the ratio and then compare to similar ratios of best-peforming DMUs. DMUs units that have the ratio less than 1 are less efficienct relative to the most efficient unit. While the unit that have a ratio of 1 are referred to as efficient given the required inputs and produced outputs.

DEA has two key of advantages for efficiency analysis. Firstly, at the same time, it readily analyzes multiple inputs and outputs. Secondly, it captures more specific production characteristic of each unit (Ferrari, 2006). DEA also can avoid limitations of the paremetric method and as a result, DEA have been extensively applied in evaluating the efficiency of both public and private units (Banker et al., 1984; Charnes et al., 1985; Charnes et al., 1978).

3.2.1 Input Oriented Measures

Using a simple example involving firms which use two inputs (x_1 and $x_{2)}$, Farrell illustrated his idea to produce a single output (y), under the assumption of constant return to scale. SS' represented the knowledge of the unit isoquant of fully efficient firms, permits the measurement of technical efficiency (see Figure 3.1).

At point P, if a given firm uses quantities of inputs to produce a unit of output, the technical inefficiency of that firm could be representated by the distance QP. QP is the amount by which all inputs could be proportionally reduced without a reduction in output. The ratio of QP and 0P usually expressed in the percentage term which represents the percentage by which all inputs need to be reduced to archieve technically efficient production. The technical efficiency (TE) of a firm is most commanly measured by the ratio

$$TE_i = 0Q/OP,$$

which is equal to one minus QP/0P. This will provides an indicator of the degree of technical inefficiencyof the firm and it will take a value between zero and one. If the firm is fully technical efficient , it will indicates the value of one. For example, the point Q is technically efficient because it lies on the efficient isoquant.

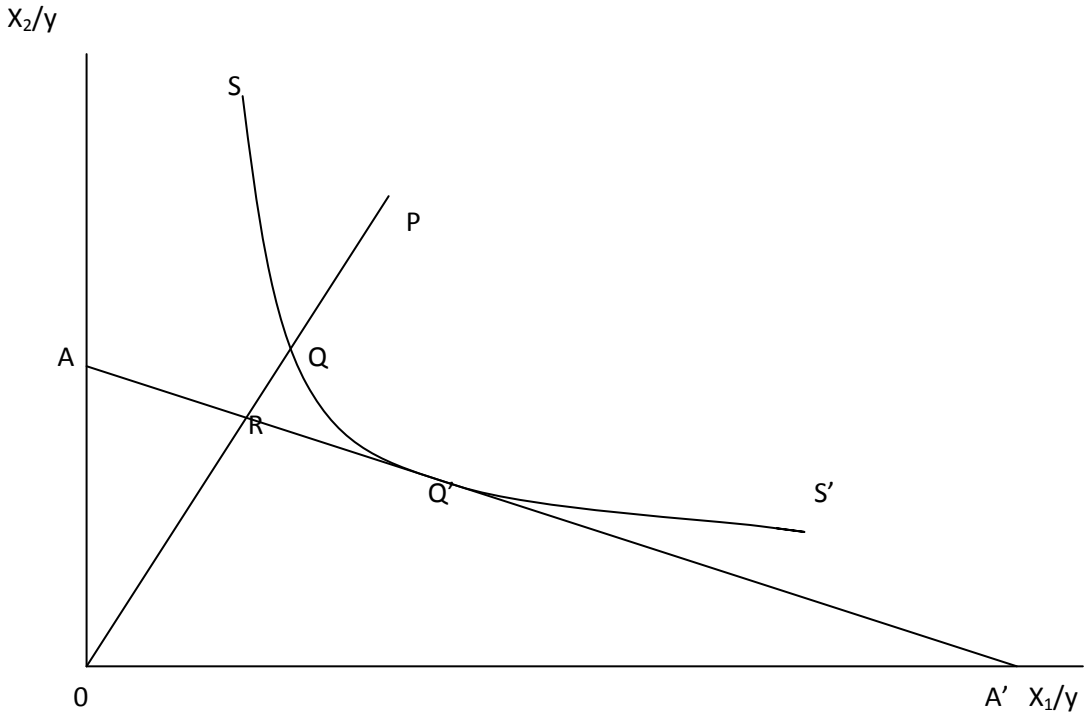


Figure 3.1: Technical and allocative efficiencies

If the input price ratio, represented by the slope of the isocost line AA', is also known allocative efficiency. The allocative efficiency (AE) of the firm operating at P is defined to be the ratio

$$AE_i = 0R/0Q,$$

Since the distance RQ represents the reduction in production costs that would occur if the production were to occur at the allocatively (and technically) efficient point Q', instead of at the technically efficient, but allocatively inefficient, point Q.

The total economic efficiency (EE) is defined to be the ratio

$$EE_i = 0R/0P.$$

The cost reduction can be interpretedwith the distance of RP. The product of the technical and allocative efficiency measures provides the measure of overall economic efficiency

$$TE_i \text{ x } AE_i = (0Q/0P)x(0R/0Q) = (0R/0P) = EE_{i.}$$

3.2.2 Input Oriented Model

The input oriented DEA model, which is solved for each district hospital individually and minimises inputs while maintaining the current levels of output. Let x_{iu} = input i for hospital u, where i = 1,...,3 and u = 1,...,10 and let y_{ru} be the level of output r for hospital u where r = 1,2,3 and u = 1,...,10.

For the particular hospital being solved, the objective of the model is to minimise the efficiency score denoted by θ where $0 < \theta < 1.0$. While holding output constant, θ is the amount by which all inputs can be contracted for each individual hospital consideration.

The decision variables λ_u (u = 1,...,10) represent the weights that will be used to form a weighted average frontier composite. The solution to the input minimization model locates the point on the frontier. Its will allows the inputs of the hospital under consideration denoted by u_0.

Minimize θ

subject to :

$$\sum_{u=1}^{10} \lambda_u x_{iu} \leq \theta x_{iu0} \; \forall i = 1,2,3$$

$$\sum_{u=1}^{10} \lambda_u y_{ru} \geq \theta y_{ru0} \; \forall r = 1,2,3$$

$$\sum \lambda_u = 1$$

$$\lambda_u \geq 0 \; u = 1... u_0..10$$

$$\text{where } \lambda_u \geq u = 1,...u_0..10$$

3.2.3 Slacks

The piece-wise linear form of the non-parametrics frontier in DEA can bring some difficulties when measuring efficiency. The section of the piece-wise linear frontier which non parallel to the axes (Figure 3.2) which do not occur in most parametric functions create a problem. Refer to the figure, A and B are inefficient while input combination C and D are the two efficient firms which define the frontier.

According to Farell (1957), the efficiency of firm A and B as 0A'/0B and 0B'/0b was the measure of technical efficiency. It is questionable as to whether the point A' is an efficienct point since one could reduce the amount of input x_2 used (by the amount CA') and still produce the same output. This in known as input slacks. The input slacks can be determined

by:

$$\mathbf{S = \theta x_{iu0} - \sum_{u-1}^{10} \lambda_u x_{ru}}$$

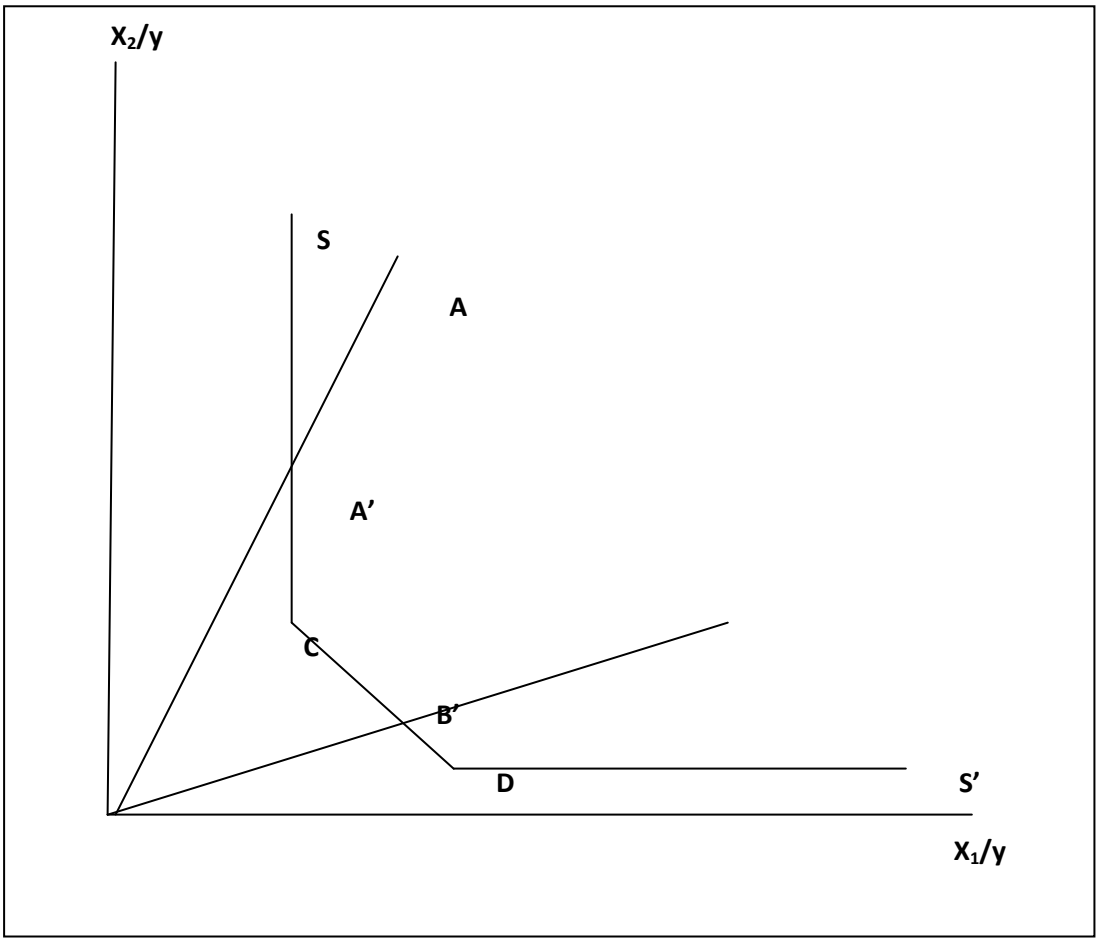


Figure 3.2 : Efficiency Measurement and Input Slacks

CHAPTER FOUR

EMPIRICAL ANALYSIS

4.1 Data and Variables

Data sources for this study were collected directly from 10 district hospitals in Perak. Data used in this study categorized into two part: input and output variables. Input variables are named as number of doctors, nurses and beds. While output variables are named as number of outpatients, inpatients, surgeries and deliveries (Table 4.1). The technical as well as scale efficiency will be identified of the best-practice units were produced by the DEA software efficiency measurement system (EMS) .

Table 4.1 : Inputs and Outputs Variable

DMUs	Doctors	Nurses	Beds	Outpatients	Inpatients	Surgeries	Delivery
H(A)08	214	585	608	202048	44731	20818	6232
H(A)09	264	632	608	213215	40893	17814	6403
H(A)10	303	640	608	221016	41138	16338	6244
H(B)08	66	379	548	286129	26250	5458	4949
H(B)09	75	410	548	317125	26409	15300	5030
H(B)10	96	409	548	299560	27254	15976	4907
H(C)08	146	325	270	193537	26139	19903	3659
H(C)09	166	339	270	215345	28487	21955	3763
H(C)10	185	350	270	219466	30234	18977	3784
H(D)08	29	176	140	44743	9713	5036	1671
H(D)09	29	182	140	46533	8392	3401	1587
H(D)10	38	214	140	51127	8289	3702	1621
H(E)08	14	55	160	117961	7964	1911	502
H(E)09	9	54	160	119582	9973	3492	645
H(E)10	13	71	160	107116	9162	3362	554
H(F)08	11	66	136	104305	7116	1542	723
H(F)09	10	60	136	133073	7780	1833	709
H(F)10	9	68	136	133064	7813	1017	643
H(G)08	12	95	120	115596	7844	6845	868
H(G)09	12	95	120	127757	9241	8035	730
H(G)10	13	95	120	126660	8142	6634	634
H(H)08	10	51	93	109157	5322	3530	508
H(H)09	10	52	93	107277	4884	3918	500
H(H)10	10	52	93	108603	5332	3890	506
H(I)08	8	55	75	59689	5270	3481	575
H(I)09	6	61	75	64301	4740	1637	642
H(I)10	6	60	75	70418	5061	1631	694
H(J)08	4	45	90	61980	3721	753	328
H(J)09	6	49	90	70546	3738	448	282
H(J)10	9	49	90	61025	3328	497	282

4.2 Descriptive Analysis

An input- oriented model was used to estimate the technical efficiency and scale efficiency of the district hospitals at Perak state. Table 4.2 provides a summary statistics of input and output variables of a district hospitals in Perak (2008 – 2010). The findings indicates substantial differences in the output and input variables among the hospitals province. In addition, the size of the hospitals in term of number of beds ranges from 75 to 608 beds. Hospitals in Perak, on average employed 59 doctors and 192 nurses and had a mean capacity of 224 beds.

Table 4.2: Summary statistic of input and output variables

	Variable	Mean	Min	Max
Input	Doctors	59.43	4	303
	Nurses	192.47	45	640
	Beds	224	75	608
Output	Outpatients	136931.8	44743	317125
	Inpatients	14478.67	3328	44731
	Surgeries	7304.47	448	21955
	Deliveries	60175	282	6403

4.3 Data Envelopment Analysis Result

The EMS software package has been used to perform the calculations. Data were collected for 10 district hospitals in Perak for an empirical analysis. Technical efficiency scores and scale efficiency scores are presented in Table 4.3. The yearly analysis has revealed that five hospitals were inefficient in 2009 compared two hospitals in 2008 and 2010. These hospitals needed to increase their inputs in order to become efficient.

The individual hospitals technical efficiency and scale efficiency scores during the three years are presented in Table 4.3. If a hospital uses all it resources optimally and there is no scope of increasing the output without altering the amount of inputs used, the hospital achieves the technical efficiency (TE).

Out of 10 hospitals, seven hospitals in year 2008 were experiencing technically constant return to scale (CRS) since the scale efficiency scores is 1. While in year 2009 and 2010 there were four and six hospitals respectively experiencing CRS. It shows these hospitals were operating at their most productive scale sizes (MPSS).

From Table 4.3, there are three hospitals in year 2009 and 2010 were increasing return to scale (IRS). While in 2008, only two hospitals were experiencing IRS. Then, for decreasing return to scale (DRS), there are three hospitals were identified as DRS in year 2009, and one hospitals in 2008 and 2010. If a hospital exhibiting IRS, they should expand its scale of operation in order to become scale efficient. But, if a hospital exhibiting DRS, they should scale down its input operation in order to operate at the MPSS.

Table 4.3: Efficiency Scores of Hospitals Perak

Efficiency 2008

Hospitals	VRS	CRS	NIRS	SCALE EFFICIENCY	RETURN TO SCALE
H(A)	100%	91.91%	100%	0.92	DRS
H(B)	100%	100%	100%	1	CRS
H(C)	100%	100%	100%	1	CRS
H(D)	100%	100%	100%	1	CRS
H(E)	97.33%	96.76%	96.76%	0.99	IRS
H(F)	92.47%	90.59%	90.59%	0.98	IRS
H(G)	100%	100%	100%	1	CRS
H(H)	100%	100%	100%	1	CRS
H(I)	100%	100%	100%	1	CRS
H(J)	100%	100%	100%	1	CRS

Efficiency 2009

Hospitals	VRS	CRS	NIRS	SCALE EFFICIENCY	RETURN TO SCALE
H(A)	100%	84.05%	100%	0.84	DRS
H(B)	99.19%	98.43%	99.19%	0.99	DRS
H(C)	100%	100%	100%	1	CRS
H(D)	96.95%	94.51%	94.51%	0.97	IRS
H(E)	67.19%	86.40%	86.40%	0.99	IRS
H(F)	100%	100%	100%	1	CRS
H(G)	98.67%	96.00%	98.67%	0.97	DRS
H(H)	100%	100%	100%	1	CRS
H(I)	100%	100%	100%	1	CRS
H(J)	96.33%	61.56%	61.56%	0.64	IRS

Efficiency 2010

Hospitals	VRS	CRS	NIRS	SCALE EFFICIENCY	RETURN TO SCALE
H(A)	100%	87.02%	100%	0.87	DRS
H(B)	100%	100%	100%	1	CRS
H(C)	100%	100%	100%	1	CRS
H(D)	95.95%	95.58%	95.58%	0.99	IRS
H(E)	100%	100%	100%	1	CRS
H(F)	100%	100%	100%	1	CRS
H(G)	100%	100%	100%	1	CRS
H(H)	100%	100%	100%	1	CRS
H(I)	100%	94.43%	94%	0.94	IRS
H(J)	97.73%	79.92%	79.92%	0.82	IRS

Further, the overall extent to which all the inputs have to be reduced in order to archieve 100 percent efficiency for the inefficient units indicate by technical efficiency scores. The amount by which an input or output must be improved in order for the unit to become efficient can calculate by DEA and called as slacks.

For example in 2008, inefficienct hospitals H(E), we could see that there are two input slacks of doctors and beds. In order for H(E)08, to become efficient, it must reduced the number of doctors by 4.68 and beds by 20.73 (Table 4.4).

In 2009, for H(A) to become efficient, a hospitals must cut the number of doctors by 14.95. While for H(D) and H(G), both hospitals must reduce the numbers of nurses by 7.98 and 3.16 respectively to become efficient. Then, in order H(I) to become efficient, the number of nurses and beds must be reduced by 0.61 and 1.45 respectively.

In 2010, we could see that three hospitals should cut the number of doctors in order to get the level of efficiency. The number of doctors should be reduced were 41.7, 13.37, and 0.03 for H(A), H(B) and H(J) respectively. Then for H(D), a hospitals should reduces the number of nurses by 35.95. While for H(G), the hospitals have two inputs should be reduce in order to become efficient. There were 0.68 the numberof doctors and 8.96 the number of nurses.

Table 4.4 : Slacks Variables for the Inefficient Hospitals in 2008-2010

DMU	SCORE	BENCHMARKS	SLACKS
2008			
H(E)08	0.967	H(E)09 (0.36), H(F)09 (0.56)	DOC(4.68) BED(20.73)
2009			
H(A) 09	0.87	H(B)08 (0.31), H(J)08(1.33)	DOC(14.95)
H(D)09	0.956	H(J)09 (0.01), H(D)08(0.91), H(I)10 (0.07)	NUR(7.98)
H(I)09	0.944	H(G)09(0.02), H(I)10(0.90)	NUR(1.45), BED(0.61)
H(J)09	0.799	H(F)10(0.52), H(H)08(0.01)	NUR(3.16)
2010			
H(A)10	0.841	H(B)08(0.28), H(J)08(1.33)	DOC(41.7)
H(B)10	0.984	H(B)09(0.89), H(J)08(0.09),H(E)09(0.18)	DOC(13.37)
H(D)10	0.945	H(J)09(0.08), H(D)08(0.80)	NUR(35.95)
H(G)10	0.96	H(G)09(0.65), H(H)08(0.40)	DOC(0.68), NUR(8.96)
H(J)10	0.616	H(E)09(0.05), H(G)09(0.05), H(H)08(0.45)	DOC(0.03)

NUR = NUMBER OF NURSES

DOC = NUMBER OF DOCTORS

4.4 Limitation of the study

Several limitations exist in this research. Technical efficiency and scale efficiency of hospitals was the main focus on this study. First, DEA may have over estimated the existing magnitudes of efficiencies. Moreover, DEA does not capture random noise such as natural disasters. Its also can inadvertently attributes any deviation from frontier to inefficiency. Second, to adjust for the quality of outputs and inputs was not possible. Lastly, to access the extent to which observed efficiency variations are explained by differences across health zones in sosioeconomic status, epidemology, geographical and financial access to hospital still was not possible.

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

This study used data envelopment analysis (DEA) approach to measure the technical efficiency and scale efficiency of the district hospitals in Perak state. This study analyses without categorizing hospitals according to the classifications which is hospitals with specialist and hospitals without specialist.

Thus, this study identyfying input reductions and the magnitudes of their return to scale that may transform ineeficient hospital to efficient hospital. Hospitals that have a relative technical efficiency (TE) score of 1 (100 percent) was said as efficienct, while hospitals that have relative technical efficiency less then 1 called as inefficient.

Overall, there are seven hospitals in year 2008, four hospitals in 2009 and six hospitals 2010 were achieve the technical efficiency since they had 1 for the scale efficiency score. Then, for the year 2009 and 2010 there are three hospitals were increasing return to scale (IRS). While in 2008, there are two hospitals were experiencing IRS. In contrast, for decreasing return to scale (DRS), there are one hospital was DRS in 2008 and 2010. While in 2009, three hospitals experiencing DRS.

DEA’s showed the result of slack as a guide to transform inefficient to efficient hospitals. For example, in 2010, three hospitals should cut the number of doctors to become efficient. For H(A), H(B), and H(J), they must cut the number of doctors by 41.7, 13.37, and 0.03 respectively.

5.2 Policy Implications

DEA slack results could guide some action. Hospital administrators or policy makers have the flexibility of achieving maximum efficiency since DEA accounts for multiple inputs and outputs. This can be either by increasing output or decreasing inputs. Then, the inefficient hospitals could operate as efficiently as their peers to become efficient.

The inefficient hospitals in Perak could operate as efficiently as their peers on the efficiency frontier. This can be either by reducing utilization of their input or by increases their outputs.

Ministry of Health (MoH) policy makers could improve their efficiency by improving access to under – utilized health promotion, preventive and outpatients services with concerning hospitals with outputs falling short of DEA targets. Through use of health promotion methods, utilization for underutilized preventive and curative services can be boosted.

Alternatively, to reduce inefficiencies by increasing utilization of currently underutilized essential health services it is not very easy. Thus, policy makers could improve efficiency through transfer of human resouces for health and beds to primary health level health facilities experiencing shortages.

REFERENCES

Ahmad Kiadaliri, A., Haghparast- Bidgoli, H., Zarei, A. (2011). Measuring Efficiency of General Hospitals in the South Iran. World Applied Sciences Journal 13 (6) 1310 1316,2011.

Applainaidu, S. D., Samsudin, S., Ali, J., Chik, A. R., Dash, U. (2012). Technical and Scale Efficiency of Public Hospitals in Kedah: A Data Envelopment Analysis. International Soft Science Conference (ISSC) 2012.

Che Razak, R. (2003). Productivity Measurement of Malaysian Government Hospitals Using Data Envelopment Analysis. Asian Academy of Management Journal, 8(12), 31-43.

Coelli, T, Roa, D. S. P., Battese, G. E. (1998). An Introduction to Efficiency and Productivity Analysis. Boston. Kluwer Academic Publishers.

Coppola, M.N. (2003). Correlates of military medical treatment facility (MTF) performance : Measuring technical efficiency with the structural adaptation to regain fit (SARFIT) model and data envelopment analysis (DEA), Unpublised doctoral dissertation, Virginia Commonwealth University. 39.

Debru, G. (1951). The coefficient of resources utilisation. Econometrica, 19, 273-292.

Farrell, M.J. (1957). The measurement of productive efficiency. Journal of the Royal Statistical Society, Series A, CCX, Part 3,253-290.

Foo, L. Y., Othman, M., Ab. Karim, M.S. & Ab. Aziz, Y. (2010). Efficiency Measurement of a Malaysian Hotel Chain Using DEA. International Journal of Revenue Management, Vol.4, No 3/4, 327-343.

Grosskopf, S., & V. Valdamis. (1987). Measuring hospital performance: A non-parametric approach. Journal of Health Economics, 6(2), 89-107.

H. David Sherman, Joe Zhu (2006), Service Productivity Management: Improving Service Performance Using Data Envelopment Analysis. Springer.

Indicators For Monitoring and Evaluation of Strategy Health For All. Retrieved August 8, 2013, from http://www.moh.gov.my/images/gallery/publications/md/hi/hi_2009.pdf

Indicators For Monitoring and Evaluation of Strategy Health For All. Retrieved August 8, 2013, from http://www.moh.gov.my/images/gallery/publications/md/hi/hi_2010.pdf

Maria M. Hofmarcher, Peterson, I., Riedel, M. (2002). Measuring Hospital Efficiency in Austria – A DEA Approach. Health Care Management Sciences 5, 7-14,2002.

Magnusson, J. (1996) Efficiency measurement and operationalization of hospital production. Health Service Research; 31(1): 21-37.

Mohshiri, H., Aljunid, S.M., & Mohd Amin, R.(2010). Hospital Efficiency : Concept, Measurement Techniques and Review of Hospital Efficiency Studies. Malaysian Journal of Public Health Care Medicine 2010, Vol.10(2): 35-43.

Mohshiri, H., Aljunid, S.M, Mohd Amin, R., Dahlui, M., & Ibrahim, W.N. (2011). Measuring Efficiency of Teaching Hospitals in Malaysia. International Journal of Business and Management Vol.6, No.4:April 2011.

Nguyen, K.M. & Giang, T.L. (2004). Efficiency Performance of Hospitals and Medical Centres in Vietnam. Munich Personal RcPEc Archieve Paper No. 1533.

Osei, D., D'Almeida, S., George , M.O., Kirgia, J.M., Mensah, A.O., & Kainyu, L.H. (2005). Technical efficiency of public district hospitals and health centres in Ghana: A pilot study. Cost Effectiveness and Resource Allocation 3(9).

Ozcan, Y.A. & Bannick R.R. Trend in Department of Defence Hospital Efficiency (1994). Journal of Medical System. 18(2), 69-83.

Puig-Jonoy, J. (1998). Measuring health production performance in the OECD. Applied economics Letters. 5: 255-25.

Turkan, S., Polat, E., & Gunay, S. (2012). Journal Zagreb International Review of Economics and Business. Vol. 15, issue 2, 1-14.

Shangula, K., Mbeeli, T. (2006). Technical Efficiency of District Hospital: Evidence from Namibia using DEA. Cost Effectiveness and Resource Allocation 2006, 4:5.

Sahin, I. & Ozcan, Y.A. (2000). Public sector hospital efficiency for provincial markets in Turkey. Journal of Medical System. 24(1), 307-320.

Sherman, H.D. (1989). Service organization productivity management – Highlight Edition, The Society of Management Accountants of Canada, Hamilton, Ontario, Canada.

Seiford, L.M and J. Zhu (1999c). Infeasibility of super efficiency data envelopment analysis models. INFOR, Information Systems & Operational Research, Vol. 37, No.2, 174-187.

Thrall, R.M. (1996). Duality, Classification and Slacks in DEA. Annals of Operation Research, Vol. 66, 109-138

Umakant Dash, S.D. Vaishnavi, V.R. Muraleedharan (2010). Technical Efficiency and Scale Efficiency of District Hospitals : A Case Study . Journal of Health Management 2010 12:231.

V. Valdamis, Sensitivity analysis for DEA models, Journal of Public Economics 47 (1992) 185-205.

Zhang, N., Hu, A., Zheng, J. (2007). Using Data Envelopment Analysis Approach to Estimate The Health Production Efficiencies in China. Front. Econ. China 2007, 2(1):1-23.