Universiti Utara Malaysia

EFFICIENCY OF MALAYSIAN PUBLIC UNIVERSITIES:

A DATA ENVELOPMENT ANALYSIS (DEA)

By

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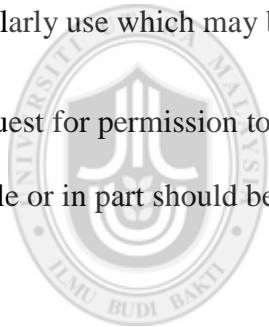
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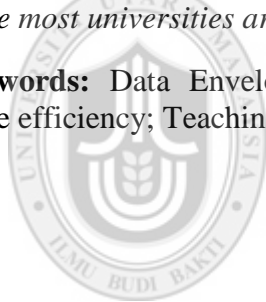
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ABSTRACT

The importance of higher education as an engine of growth is highly recognised by the Malaysian government and thus huge amounts of money are allocated to this sector. Due to large amount of money invested, it is imperative that certain analyses are to be carried out to ascertain the impact of this investment. Efficiency analysis is vital for higher education institutions as it measures how efficiently educational resources are being allocated and utilized. Against this backdrop, this study aims to evaluate the relative efficiency of 12 selected Malaysian public universities for the period of 2008-2012. A non-parametric method, known as the Data Envelopment Analysis (DEA) is applied in this study. By using different combination of input and output variables, this study applies the output oriented DEA model to assess the teaching and research performances for each university. The result shows that, on average, the pure technical efficiency for teaching and research activities appear to be high. Three universities are found to be technically efficient in teaching while three other universities are technically efficient in research. The result reveals that the average pure technical efficiency score is higher for teaching as compared to research. For the scale efficiency, there are two universities that consistently operated on the optimal scale size for the whole examined period. In addition, majority of universities are operating under decreasing returns to scale in teaching while most universities are operating under increasing returns to scale in research.

Keywords: Data Envelopment Analysis; Universities; Pure technical efficiency; Scale efficiency; Teaching efficiency; Research efficiency.
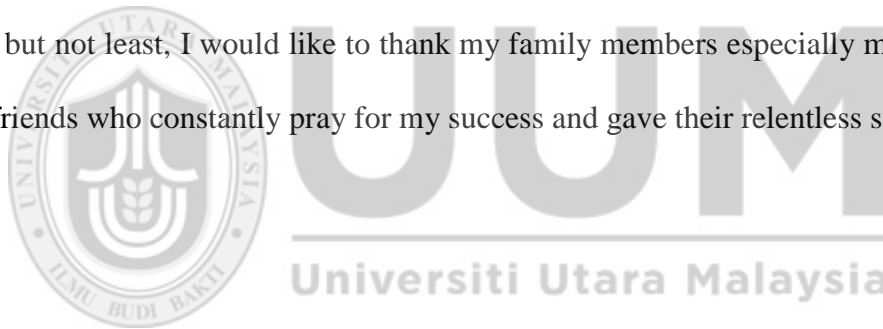
ABSTRAK

Kepentingan pendidikan tinggi sebagai penjana pertumbuhan diiktiraf oleh kerajaan Malaysia di mana peruntukan yang besar telah disalurkan untuk membangunkan sektor pendidikan tinggi Malaysia. Dengan penyaluran peruntukan yang banyak dalam sektor ini, maka kajian perlu dijalankan untuk menilai impak pelaburan yang dibuat. Analisis kecekapan ke atas institusi pendidikan tinggi adalah penting kerana ianya dapat menilai sejauhmana kecekapan sumber-sumber untuk pendidikan tinggi dialokasi dan digunakan. Berdasarkan kepada kenyataan tersebut, kajian ini dilaksanakan bertujuan untuk menilai kecekapn relatif bagi 12 buah universiti awam di Malaysia bagi tempoh antara tahun 2008 hingga 2012. Metod 'non-parametric' yang dikenali sebagai 'Data Envelopment Analysis' digunakan dalam kajian ini. Kajian ini telah menilai prestasi setiap universiti dari segi pengajaran dan penyelidikan dengan menggunakan kombinasi input dan output yang berbeza. Keputusan kajian mendapati bahawa skor purata kecekapan teknikal tulen bagi aktiviti pangajaran dan penyelidikan adalah tinggi. Selain itu, terdapat tiga universiti yang menunjukkan prestasi yang cekap dari segi pengajaran manakala tiga universiti yang berlainan didapati berprestasi cekap dalam penyelidikan. Skor purata kecekapan teknikal tulen bagi pengajaran adalah lebih tinggi daripada penyelidikan. Dari segi kecekapan skala, terdapat dua universiti yang beroperasi dalam saiz skala yang optimum sepanjang tempoh kajian. Di samping itu, keputusan kajian ini mendapati kebanyakan universiti beroperasi dalam pulangan ikut skala yang menyusut bagi pengajaran. Sebaliknya, banyak universiti yang beroperasi dalam pulangan ikut skala yang meningkat bagi penyelidikan.

Kata kunci: Data Envelopment Analysis; Universiti; Kecekapan teknikal tulen; Kecekapan skala; Kecekapan dalam pengajaran; Kecekapan dalam penyelidikan.

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LIST OF ABBREVIATION

MOE	Ministry of Education Malaysia
MOHE	Ministry of Higher Education Malaysia
UNESCO	United Nations Educational, Scientific and Cultural Organization
OECD	Organization for Economic Co-operation and Development
GDP	Gross domestic product
DEA	Data envelopment analysis
SFA	Stochastic frontier analysis
DMU	Decision making unit
MPSS	Most productive scale size
IRS	Increasing returns to scale
DRS	Decreasing returns to scale
CRS	Constant returns to scale
VRS	Variable returns to scale
PTE	Pure technical efficiency
DEAP	Distributed Evolutionary Algorithms in Python
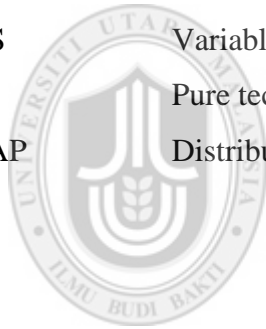
CHAPTER 1

INTRODUCTION

1.1 Introduction

Human capital is recognized as an important component in accelerating the speed of economic growth of a country. Education plays a significant role as it provides people with the appropriate knowledge and skills needed in performing their work (Katharaki & Katharakis, 2010). If the citizens of a country are all acquiring higher level of education, the labour productivity will also increase. Besides, education is one of the effective ways to reduce the level of poverty of a country. It can restore the existing inequality between different social classes and genders by creating opportunities for the poor and women to have a better job and stable life. In addition to that, education also benefits a country in various aspects such as improve the healthiness of people and create a harmony and peaceful society.

In many parts of the world, education is being subsidized by the government due to the positive externalities that it contributes to people and country. However, the global economic crisis and limited government revenues had forced the government to reduce the budget for universities in most of the countries. The problem is further deteriorated as enrolment and the cost of higher education continues to increase over time. Consequently, higher education institutions are forced to search for other funding sources to cover the excessive spending. Most of the countries around the world have shifted their higher education financing practices from a free system to a cost-sharing system. Sanyal and Johnstone (2011) defined cost-sharing as a system where the costs of higher education are being shared by the government and students. The loss of funding from one source is being covered by the other sources.

Higher education sector nowadays is more competitive compared to the past. In addition to teaching and research, universities have to compete for limited governmental funds, talented students and international students etc. Efficiency analysis became an essential tool for universities to improve and stay competitive on the world stage (Ng & Ahmad, 2012). According to Avkiran (2001), those universities who fail to utilize efficiency analysis will face the problem of inefficiency when they allocate their educational resources.

1.2 Background of the Study

Ministry of Education Malaysia (MOE) is the government ministry who overseeing all educational matters in Malaysia including policy framework, regulations, finance and expenditure, physical development, school curriculum and the rest. Historically, in year 2004, the Malaysian government decided to separate the departments of higher education from MOE and established a new ministry named Ministry of Higher Education Malaysia (MOHE). It holds the responsibilities for determining the policies and managing matters in higher education sector. However, in 2013, once again the higher education is being merged into MOE.

Public institutions
- 20 public universities
- 33 polytechnics
- 91 community colleges

Private institutions
- 70 private universities
- 34 private university colleges
- about 414 private colleges
- 6 foreign university branch campuses
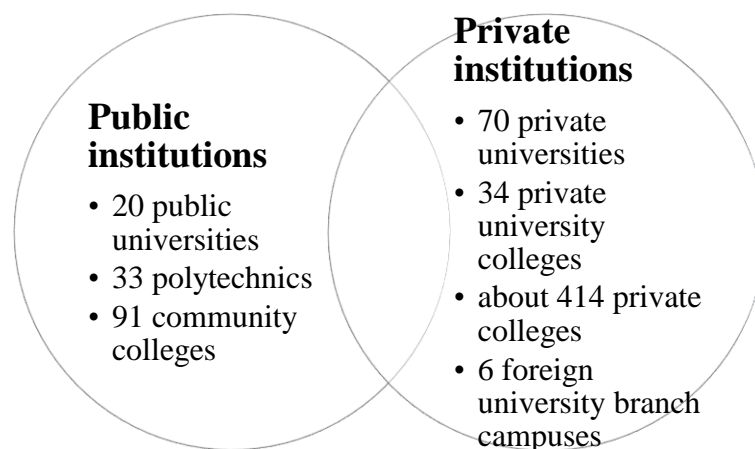
Figure 1.1
Malaysian higher education institutions
Source: Ministry of Education Malaysia (2014)

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Table 1.1
Classification of public universities in Malaysia

Research universities	Year of Officially Established
Universiti Malaya	1962
Universiti Kebangsaan Malaysia	1970
Universiti Putra Malaysia	1971
Universiti Sains Malaysia	1969
Universiti Teknologi Malaysia	1975
Comprehensive universities	
Universiti Teknologi MARA	1999
Universiti Islam Antarabangsa Malaysia	1983
Universiti Malaysia Sarawak	1992
Universiti Malaysia Sabah	1994
Focussed universities	
Universiti Malaysia Perlis	2001
Universiti Utara Malaysia	1984
Universiti Perguruan Sultan Idris	1997
Universiti Teknikal Melaka Malaysia	2007
Universiti Malaysia Pahang	2002
Universiti Malaysia Kelantan	2007
Universiti Terengganu Malaysia	2007
Universiti Tun Hussien Onn	2007
Univeristi Sains Islam Malaysia	2007
Universiti Pertahanan Nasional Malaysia	2006
Universiti Sultan Zainal Abidin	2005

Source: Ministry of Education Malaysia (MOE)

Powell, Gilleland and Pearson (2012) mentioned that higher education institutions have their own unique characteristics depending on what their visions are and who their students are. Figure 1.1 shows the total number of higher education institutions in Malaysia by year 2014 and they can be categorized into public institutions (government funded) and private institutions (not funded by government). In Table 1.1, public universities in Malaysia can be further divided into three groups which are research universities, comprehensive universities and focussed universities.

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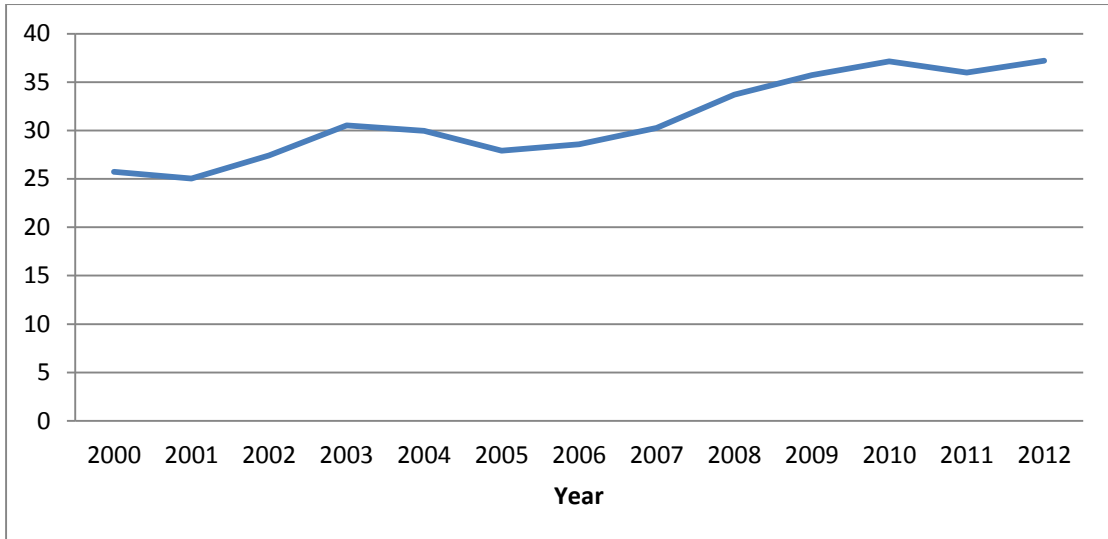
Figure 1.2
Tertiary education enrolment rates in Malaysia (%)
Source: UNESCO Institute for Statistics

In order to transform Malaysian current economy toward knowledge-based economy, Malaysian government needs a lot of skilled and educated workforces. Hence, lots of efforts have been put to increase the higher education enrolment in Malaysia. Figure 1.2 clearly shows the increasing trend in Malaysian tertiary education enrolment rates from year 2000 to 2012. The enrolment rates reached the highest rate, 37.2% in the year 2012. Malaysian government aims to increase the tertiary education enrolment rates to 53% by the year 2025 (Malaysia Education Blueprint 2015-2025).

Education at primary and secondary levels have always been fully subsidizing by the Malaysian government since the past. It is the responsibility of government to provide the basic level of education to its citizens. Nonetheless, Malaysian government never neglects its responsibility toward higher education sector. Table 1.2 shows the amount of expenditures that the government spent on whole education and higher education sector each year.

Table 1.2
Expenditure on education from 2000 - 2011

Year	Expenditure on education as % of total government expenditure (%)	Expenditure on higher education as % of government expenditure on education (%)
2000	21.39	32.06
2001	24.35	34.25
2002	25.90	33.30
2003	24.54	34.99
2004	21.01	33.45
2006	16.75	36.13
2007	16.12	33.03
2009	18.46	35.94
2010	18.41	34.45
2011	20.98	36.97

Source: UNESCO Institute for Statistics

Based on the table, Malaysian government had spent about 15%-25% of total government expenditure on the whole education sector annually. We can also observe that more than 30% of the government expenditure on education was spent on higher education sector throughout the year 2000 to 2011.

According to OECD (2014), government expenditure on education as a percentage of GDP reveals how a government priority the education sector in the country. With regards to the government expenditure per tertiary student as a percentage of GDP per capita, the data from the World Bank shows that high income countries such as Japan, United States of America and Singapore had spent around 20%-30% of their GDP per capita annually on each student in higher education. In Malaysia, the spending pattern tends to vary over time. For example, in year 2001, the government spent 110.1% of GDP per capita on each tertiary student and it decreased to 48.1% in the year 2007. On average, from year 2000 to year 2011, Malaysian government had spent around 72.25% of GDP per capita on each student who studied in higher education institutions. This figure is quite high compared to other upper

middle income countries. For instance, Thailand, who is also within the upper middle income group had only spent about 25% of GDP per capita on each tertiary student.

Besides, it was found that more than 90% of Malaysian public university's expenditure is funded by the government (Malaysia Education Blueprint 2015-2025). In order to reduce the dependency of public universities on government grants, Outcome-Based Budgeting (OBB) will gradually be implemented in higher education sector. Under the new funding practice, government grants will be reduced and only be provided for the purpose of university's basic operations. In contrast, performance-based funding will be emphasized. If a university has high completion rates or had published many academic articles, that particular university will receive extra funds from government. This practice may serve as a motivation for Malaysian public universities to improve their performance and outcomes. Besides, public universities are expected to have a wider range of funding sources and higher level of investment in the future as compared to the current funding practice.
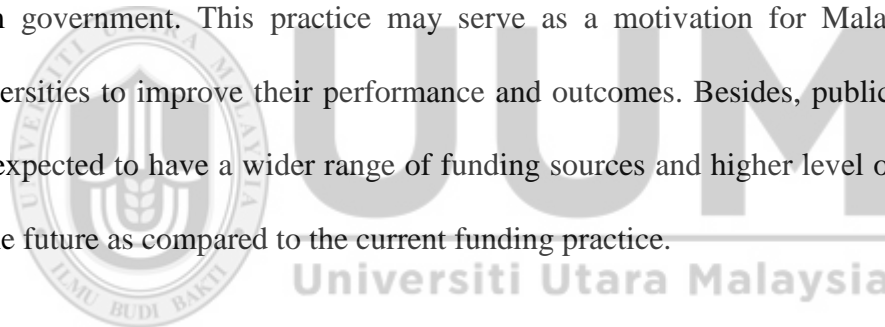
1.3 Problem Statement

In the process of transforming the economy towards the knowledge-based economy, the Malaysian government has put significant efforts to improve the higher education sector. Several programs have been launched with the aims to encourage Malaysian citizen to continue their studies in higher education. Numerous financial aids are being offered by the government and private sectors to help students from poor family to get access to higher education. As previously mentioned, huge funds have been allocated for this sector and this indicates the government's commitment in providing better quality of higher education for all citizens.

However, the government's huge amount of investment in this sector has raised concerns and questions on whether the Malaysian public universities operate in the most efficient way. To be specific, given the level of inputs (funds), are all Malaysian public universities able to generate the maximum outputs?

Based on the Malaysia Education Blueprint 2015-2025, it was mentioned that according to Universitas 21 (U21) report, Malaysia was ranked 28th out of 50 countries, while other countries such as Singapore, Thailand and South Korea were ranked 10th, 42nd and 21st respectively. The U21 report compares higher education systems in 50 selected countries through four different dimensions: resources, environment, connectivity and output. According to the report, Malaysia was ranked at 12th position in the aspect of resources investment while the production of outputs were ranked at 44th. The outputs were evaluated from research output, institutions ranking, enrolment and graduate employability of a particular country. The results of U21 report imply that the amount of funds being invested in the Malaysian higher education sector is not

matched up with the level of outputs that are being produced and therefore raised concern about the efficiency of public universities in Malaysia.

In light of increasing higher education cost, students and parents want to ensure that their investment in higher education is worth and have value for money. The interest of students and their parents regarding which university to be chosen partly rely on the performance of the universities. The efficiency of higher education institutions in the teaching context which translated into issue related to employability are being emphasis by students and their families. The increased in unemployment rates among graduates, perhaps is a major factor that contributes to their worries.

According to the World Bank, graduates unemployment as a percentage of total unemployment in Malaysia had increased continuously since the year 1995. There was 8.9% of unemployed graduates within the total unemployment in Malaysia in year 1995 and reached 29.8% in year 2011. There are many factors that lead to this problem, perhaps one of the factors is because of the programs being provided by universities are not responsive to match with the fast-changing demands of the job market. Besides, employers frequently report that fresh graduates nowadays are lacking in terms of communication skills and other soft skills needed to perform in their work.

Based on the aforementioned issues, it is thus important for a research to be undertaken to analyse and evaluate the efficiency of higher education institutions in Malaysia, especially public universities. As Malaysia effortlessly strive to be visible internationally in terms of having a good quality education and excellence in research, ensuring the optimal outcome of the higher education output based on the funds being invested is definitely crucial.

1.4 Research Objectives

The main objective of this study is to evaluate the relative efficiency of 12 Malaysian public universities for the period of 2008-2012. The analysis will focus on the ability of public universities to maximize the production of their outputs by optimally using the given level of inputs.

In particular, the specific objectives are as follows:

1. To examine the pure technical efficiency and scale efficiency in teaching of the public universities in Malaysia

2. To study the pure technical efficiency and scale efficiency in research of the public universities in Malaysia.

3. To evaluate the level of efficiency of public universities in relation to their counterparts.

1.5 Significance of the Study

There are many literatures discussing about the efficiency of firms, nonetheless few are discussing about the efficiency of higher education institutions especially in developing countries. Due to that, it is hoped that this study may add some new knowledge to higher education studies in Malaysia, especially in the aspect of efficiency. Besides, most of the previous works conducted in Malaysia measured the overall efficiency of universities with less focus being given towards teaching and research per se. By giving specific attention towards research and teaching activities, this study may provide valuable results for university administrators to further improve their performances in both activities. Moreover, by extending the examined period to five years, the findings from this study may add significant contributions in understanding the performance of universities over time.

1.6 Scope and Limitations of the Study

This study will only evaluate the efficiency of 12 Malaysian public universities (Table 3.2) with eight public universities are excluded, namely *Universiti Pertahanan Nasional Malaysia* (UPNM), *Universiti Islam Antarabangsa Malaysia* (UIAM), *Universiti Teknologi MARA* (UiTM), *Universiti Sains Malaysia* (USM), *Universiti Teknologi Malaysia* (UTM), *Universiti Malaysia Kelantan* (UMK), *Universiti Sains Islam Malaysia* (USIM) and *Universiti Sultan Zainal Abidin* (UniSZA). UPNM is excluded because it is a military university and was established with quite a distinct mission. UIAM is an international university and it operates under a different framework with different objectives and different funding practice compared to other public universities.

On the other hand, UiTM is a unique university with many branches set up throughout the whole country. Every year, the enrolment of students in UiTM exceed ten thousand people. There is a large gap between the total number of students in UiTM and other universities which makes it inappropriate to be included. Besides, USM, UTM, UMK, USIM and UniSZA are excluded from this study due to incomplete data. Recognizing that private institutions are established mostly for profit motive and considering no direct public funding from the Malaysian government, therefore these institutions are not within the scope of this study.

1.7 Organization of the Study

This study is divided into five chapters. Chapter one discusses about background of study, problem statement, research objectives, significance and scope as well as limitations of the study. In the second chapter, previous articles and journals related to this study are being reviewed. Third chapter explains about the methods and data that will be used in this study. Empirical results obtained in this study will be analysed and discussed in the fourth chapter. The last chapter provides the conclusion of the study.

CHAPTER 2

LITERATURE REVIEWS

2.1 Introduction

This chapter presents the reviews of theoretical concept and analysis regarding the education and efficiency of higher education from different studies in various countries.

2.2 Theoretical Concept

Tilak (1993) considered education as a public good and he further specified higher education as a 'quasi-public good'- a good that can be viewed as both individual and social good. Education benefits both the individuals (who received it) and society. It enhances the total productivity of labour, boosts economic growth and improves the income distribution.

Over decades, the government was the sole finance source for all levels of education. This practice has been carried out more intensively in developing countries compared to the developed countries (Rogers, 1971). However, there are severe problems regarding shortage in financial supplies from government toward higher education. The rapid growth of enrolment in higher education and constantly expanding of higher education institutions could not possibly be funded by the government alone and this problem is especially serious in developing countries. Besides, education sector needs to compete with other social and development activities in the country for the limited public funds (Kipesha & Msigwa, 2013).

Shah (2008) found that investment in all stages of education (elementary, secondary and tertiary) in India has always been neglected by the state. Therefore, it will be wiser if higher education institutions can expand their funding sources toward

any other possible ways in addition to government supplies. According to Sanyal and Johnstone (2011), the financial supplies for higher education can be acquired from (a) governments, through taxes; (b) students, through tuition and fees; and (c) society, through endowment.

Most of the government around the world are now decentralizing or have decentralized their national education system especially at higher education level. As stated by Lee (2006), this realization arises from the fact that it became tougher to oversee and conduct the activities of institutions from the centre as they continue to grow rapidly these days. People believe that decentralization would encourage greater efficiency and effectiveness in administration and finance of higher education apart from allowing institutions to become innovative and creative. Sanyal and Johnstone (2011) realized that the management of an institution can be very efficient whenever profits are involved. Other than profits, competition between universities for talented students and limited funds will also encourage universities to emphasis their efficiency (Johnes, 2006).

Efficiency of higher education institution has become an important topic for both government and the general public. According to Kantabutra and Tang (2010), efficiency in higher education can be defined as the ability of each higher education institution, compared to other higher education institutions under analysis, to produce the maximum level of educational outputs by consuming the existing level of inputs. Performance measurement in the aspect of efficiency can provide various information for universities to further improve their current performances (de Lancer Julnes, 2000) and to allocate their limited educational resources in the best way (Avkiran, 2001).

Çokgezen (2009) mentioned that the efficiency can be estimated by using parametric (econometric) or non-parametric (mathematical programming) method. There are two popular techniques that previous researchers employed in estimating the efficiency of higher education institutions: stochastic frontier analysis (SFA) and data envelopment analysis (DEA). According to Robst (2001), SFA is a parametric method and it requires assumptions to be made on distribution of the error term. Thus, it is necessary to keep in mind that any misspecification errors will lead to inaccuracy in the result of estimation. In light of this, some of the previous works adopted DEA.

2.3 Efficiency Analysis in Various Countries

Flegg, Allen, Field and Thurlow (2004) used Data Envelopment Analysis (DEA) to evaluate the relative efficiency of 45 universities in the United Kingdom (UK). They intended to examine the trend of efficiency of universities from 1980/81-1992/93. The result showed that the efficiency of 45 universities involved rose by 8.8% within the examined periods. Besides, the minimum score of efficiency also increases from 0.488 in year 1980/81 to 0.742 in year 1992/93. The gap of efficiency between the inefficient and efficient universities is clearly getting closer within those periods.

Johnes (2006) categorized higher education institutions in England into three groups: pre-1992 universities, post-1992 universities and Standing Conference of Principals Ltd (SCOP) colleges based on their historical background. He tried to discover the differences of efficiency in term of output production between those three categories. DEA was employed in his study and the efficiency of 109 higher education institutions had been computed using data from academic year 2000/01. The result showed that 61 higher education institutions in England are efficient. The average level of efficiency for all 109 institutions involved is around 95%. Institutions from different

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categories do not show any considerable gap in their efficiency even though there are obvious differences in their level of inputs and outputs.

By applying DEA, Avkiran (2001) examined the relative efficiency of 36 Australian universities for the year 1995 in two different models. The first model was about the overall performance of university while the second model focused on the performance of staffs in delivering educational services. He found out that the average efficiency score for both models are equally high, that is 95.53% for the first model and 96.67% for the second model. Similarly, Abbott and Doucouliagos (2003) measured the efficiency of 36 Australian government universities by using DEA. The result also showed that the Australian universities perform at a high level of efficiency. In their study, the average level of efficiency for all Australian universities involved is around 94%, while 64% of the Australian universities involved are considered efficient.

By adopting DEA, Katharaki and Katharakis (2010) computed the efficiency of 20 Greek public universities using data collected in year 2004. They measured the efficiency with two different output sets: the first set includes only graduates while the second set is more comprehensive in which both graduates and research income are involved. The result revealed that three universities are identified as efficient in the first set of output while the number of efficient universities increased to five in the second set of output. Besides, the average level of efficiency in the second set of output (82.29%) is also higher than the first set of output (69.58%).

On the other hand, Kipesha and Msigwa (2013) measured the efficiency of seven public universities in Tanzania from three different aspects: first, regarding how human resources have been used to produce graduates; second, about the ability of university personnel to generate income (internal fund); third, about the production of

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outputs (graduates and internal funds). For the first aspect, the DEA result showed there is a high level of average efficiency in Tanzanian public universities in the production of graduates. However, a low level of average efficiency was found in second aspect. This indicates that Tanzanian public universities are weak in revenue generation. Nonetheless, when both of the outputs are combined, a high level of average efficiency was confirmed.

Ahn, Charnes and Cooper (1988) compared the efficiency between public and private doctoral-granting universities in the United States. In their study, 161 universities were divided into: 56 public universities with medical colleges, 52 public universities without medical colleges, 24 and 29 private universities with and without medical colleges respectively. By using DEA, they found that 24 public universities are considered efficient where 11 of them with medical colleges and 13 universities without medical colleges. For private universities, only five universities with medical colleges and 12 without medical colleges are efficient. They concluded that public universities are more efficient than private universities for both groups - with and without medical colleges.

Çokgezen (2009) estimated and compared the efficiency of the faculty of economics (FEs) in 70 Turkish universities for academic year 2003. The universities that have been examined consist of 47 public universities and 23 private universities. Based on the DEA result, the average level of efficiency for all universities is 51.1%. The result also showed that the average efficiency score for public universities are higher than private universities (57.7% compared to 39.8%). In the second part of the study, the efficiency scores were calculated again using data adjusted by the quality difference since a direct comparison between public and private universities may cause a biased result. The result showed a slight increase in average efficiency score for

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private universities (from 39.8% to 42.4%), on the contrary, a small decrease of average efficiency score for public universities (from 57.7% to 55.3%).

de Guzman and Cabanda (2011) evaluated the efficiency of 16 selected private higher education institutions in Metro Manila (capital of Philippine) from year 2001 to 2005. The DEA result showed that only two institutions are efficient in all five year period. However, the average level of efficiency for those 16 institutions is relatively high which is 80.7%.

Hanke and Leopoldseder (1998) examined and compared the efficiency of 11 universities in Austrian. By using DEA, they measured the efficiency of Austrian universities in two dimensions: first, efficiency of the university as a whole; second, the teaching efficiency and research efficiency separated from the overall efficiency. In the first part, they found that there are three universities are considered not efficient. In the next part, one of the inefficient universities, named University of Vienna (UNIW) showed efficient in research but not in teaching. In contrast, the other two universities, Technical University of Graz (TUG) and University of Linz (UNIL), are more efficient in teaching but less efficient in research. Obviously, the trade-off exists between the teaching and research activities.

Beasley (1990) used DEA to compute the efficiency of chemistry and physics departments in 52 universities in United Kingdom (UK). He found that three chemistry departments and a physics department are efficient. On the contrary, the average efficiency of physics departments (71%) is slightly higher than the average efficiency of chemistry departments (68.8%). By using the same data set, Beasley conducted another research again in the year 1995. Nonetheless, in the new research, he separated the efficiency into two areas which are teaching efficiency and research efficiency

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(Beasley, 1995). The result showed that three chemistry departments and a physics department are considered efficient in teaching activities. For research activities, there are nine chemistry departments and eight physics departments proved to be efficient. Unfortunately, none of 52 universities are efficient in both teaching and research activities for both departments.

According to Kantabutra and Tang (2006), autonomous public universities are the public universities in Thailand which had undergone reformation in their bureaucratic system. By employing DEA, they measured the efficiency of 267 faculties from 22 Thai public universities (18 government and 4 autonomous universities) using the averaged data from the year 2003 to 2006. Out of 267 faculties, there were 34 and 40 faculties that found to be efficient for teaching and research activities respectively. The average teaching efficiency is showed to be higher than the average research efficiency (0.7629 compared to 0.4562). Besides, they also found that there was no difference between the government and autonomous public universities in the aspect of teaching activities, but autonomous public universities were proved to be more efficient in producing research outputs compared to the government public universities.

Based on data from the year 2003 and 2004, Johnes and Li (2008) used DEA to measure the efficiency of 109 Chinese universities specifically in the production of research (research efficiency). They revealed that these 109 universities are the top universities among more than 1500 higher education institutions in China. The result showed that there is only a slight change in the efficiency of the universities involved across the two years of examining period. The mean efficiency attained in year 2003 and 2004 is 83.21% and 83.91% respectively. It can be concluded that the research activities in 109 top universities in China are being performed at a high level of efficiency.

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By applying DEA and multi-criteria decision making (MCDM), Caballero, Galache, Gómez, Molina and Torrico (2004) evaluated the teaching efficiency of 142 departments in University of Malaga (UMA), a public university in Spain. Besides, they tried to discover a new practice for allocation of human resources which may contribute a greater degree of efficiency in the future. The first DEA result revealed that 42 departments (only about ten percent of the total) are considered efficient in teaching. Next, result from MCDM suggested that an additional of 195 new hired staffs are needed for the next semester. It appeared that the teaching efficiency of UMA had increased after the new allocation of teaching staffs.

In addition to teaching and research efficiency, some researchers evaluated different types of efficiency in their study. Athanassopoulos and Shale (1997) measured the cost efficiency and outcome efficiency of 45 universities in United Kingdom (UK) by using DEA. In cost efficiency, they tried to investigate how efficient will the universities used the funds to produce the outputs. In outcome efficiency, the ability of universities to maximize the outputs by using a given level of inputs has been focused. The result concluded that 11 universities are considered efficient for cost efficiency while 27 universities are identified efficient in the context of outcome efficiency. In addition, they found that there are six universities can be set as a benchmark for other universities for having the best performance in both cost and outcome efficiency.

2.4 Efficiency Analysis in Malaysia

By applying DEA, Ng and Ahmad (2012) computed the relative efficiency of 28 selected academic departments of a Malaysian public university named Universiti Teknologi Malaysia (UTM). They found that there are 16 departments that perform

efficiently. Department of Physics, with a score of 0.3068 was the least efficient department among the departments being examined.

On the other hand, Aziz, Janor and Mahadi (2013) evaluated the relative efficiency of 22 academic departments of a public university in Malaysia by using data from the year 2011. These departments can be categorized into Science and Social Science. Based on the DEA result, seven departments (three from Science and four from Social Science) are considered efficient. The minimum efficiency score obtained by a department was only 0.064. This showed there is a large difference between the efficienct department and the inefficient department. The average efficiency score for all departments are 0.718. In specific, the average efficiency scores for departments of Science and departments of Social Science are 0.671 and 0.765 respectively.

Furthermore, the relative efficiencies of 20 Malaysian public universities are being examined by Ismail, Ramalingam, Azahan and Khezrimotlagh (2014) based on the status of students after graduated; working, continuing study or being unemployed. They intended to identify which Malaysian public universities efficiently produce students that demanded in the job market. The result concluded that 11 public universities in Malaysia are efficient in producing students that fulfilled the demand in the job market.

2.5 Conclusion

In summary, universities from advanced countries such as United Kingdom and Australia are performing at a high level of efficiency (Johnes, 2006; Avkiran, 2001). Aside from overall efficiency, some previous works evaluated and examined the efficiency of higher education institutions in more precise areas such as in teaching and research activities (Hanke & Leopoldseder, 1998) or in term of cost and outcome (Athanassopoulos & Shale, 1997). In the case of Malaysia, most of the previous studies did not evaluate the efficiency of higher education institutions in the aspect of teaching and research activities separately. This study wish to provide more details about teaching and research efficiency of 12 selected Malaysian public universities. Research methodology and data will be discussed in the next chapter.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

A research methodology is a systematic way to explain what method will be used and how will it be done to achieve research objectives. In this chapter, method used in this study will be discussed. This chapter includes sections such as research framework, input and output indicators and data collection.

3.2 Research Framework

Data Envelopment Analysis (DEA) is a non-statistical and non-parametric method developed by Charnes *et al.* (1978). It has been used to measure the relative efficiency of a set of decision making unit (DMU). It is important to notice that the concept of efficiency in the DEA is "relative" rather than "absolute", as performances of all DMUs are being compared with the most efficient DMU among that particular group (Flegg *et al.*, 2004). DMUs under consideration may include universities, departments, branches and divisions of organization, but they must be homogenous (Kantabutra & Tang, 2010). For instance, in this study, Malaysian public universities as DMUs are non-profit making organizations, sharing the similar goals and objectives, operating under same general regulations, using the similar types of inputs (government funds, university staffs) and producing the same kind of outputs (graduates, research papers, books).

As mentioned by de Lancer Julnes (2000), one of the advantages of DEA is its ability to handle multiple outputs and inputs with different units of measurement simultaneously. Besides, DEA can also be used to identify which DMU performs the

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best within the group being examined, and hence this DMU will be used by educational administrators as a benchmark for the rest of the group to improve their performance (Abbott & Doucouliagos, 2003). Beasley (1990) also stated that DEA is capable to provide extra insights on performance measurement compared to other approaches.

However, DEA also possess some disadvantages. First, it does not provide any significance test for variables like statistical approaches do (Robst, 2001). In addition, DEA may overestimate the efficiency of DMU involved (Abbott & Doucouliagos, 2003). It is possible for the other DMUs (not from the sample) to perform better than the efficient DMU within the sample (Avkiran, 2001). Despite the disadvantages, DEA is a better method to evaluate the efficiency compared to regression analysis which can only deal with one output at a time. Besides, many researchers such as Avkiran (2001), Beasley (1990) and Flegg *et al*. (2004) agree that it is the most preferable method for measuring the efficiency of higher education institutions.

According to Katharaki and Katharakis (2010), there are various forms of efficiency that can be estimated in the context of universities. Technical efficiency determines whether a particular university makes use of its resources in the most technologically efficient manner to produce the outputs (Ismail *et al*., 2014). If a university is found to be technically efficient, then it is impossible for that particular university to further increase its outputs given the existing level of inputs (Abbott & Doucouliagos, 2003). According to Ng and Ahmad (2012), technical efficiency can be decomposed into pure technical efficiency (PTE) and scale efficiency. PTE is a measurement of technical efficiency without scale efficiency. In other words, if a DMU obtains a low PTE score, its inefficiency was purely due to dislocation of input in the production process.

On the contrary, scale efficiency measures the current scale size of universities (Ng & Ahmad, 2012) and hence helps the inefficient universities to adjust to their optimal size (Abbott & Doucouliagos, 2003). There are three different types of scale operation: most productive scale size (MPSS), increasing returns to scale (IRS) and decreasing returns to scale (DRS). The main focus of this study is to analyse the pure technical efficiency (PTE) and scale efficiency of 12 Malaysian public universities. Two different dimensions, teaching efficiency and research efficiency are being separately analysed in this study. By doing this, it should reveal more details about the true capability of Malaysian public universities in performing both activities.

Charnes, Cooper and Rhodes (CCR) model is the most basic model of DEA developed in the year 1978. The CCR model assumes all institutions under consideration are operating at constant returns to scale (CRS) or all institutions are operating at their optimum scale size (Kipesha & Msigwa, 2013). However, that is not true for all institutions. In light of this, Banker, Charnes and Cooper (1984) incorporated the assumption of variable returns to scale (VRS) into the CCR model and named this new model as Banker, Charnes and Cooper (BCC) model. Caballero *et al*. (2004) stated that the BBC model computes the relative efficiency of a particular DMU by comparing it to DMUs from the same operating scale. BBC model is adopted in this study with the assumption that not all of the universities are operating at their optimal scale.

Depending on the objective of a study, a DEA model can be studied as input orientation or output orientation. The input orientation model focuses on how much the amount of inputs can be proportionally reduced while keeping the current level of outputs, whereas output orientation model tries to discover the amount of outputs that can be expanded by using the current level of inputs (Kantabutra & Tang, 2010; Abbott & Msigwa, 2003; Johnes, 2006). Since the objective of this study is to investigate the

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efficiency of Malaysian public universities in maximizing the production of teaching and research outcomes, the output-oriented model was chosen.

This study will use DEA with output orientation, allowing for variable returns to scale (VRS):

Maximize $\phi_k + \varepsilon\sum_{r=1}^{n} S_r + \varepsilon\sum_{i=1}^{m} S_i$ (1)

subject to

$\phi_k y_{rk} - \sum_{j=1}^{h} \lambda_j y_{rj} + S_r = 0, \quad r = 1, \dots, n$ (2)

$x_{ik} - \sum_{j=1}^{h} \lambda_j x_{ij} - S_i = 0, \quad i = 1, \dots, m$ (3)

$\sum_{j=1}^{h} \lambda_j = 1$ (4)

$\lambda_j, S_r, S_i \geq 0 \; \forall \; j = 1, \dots, h; \quad r = 1, \dots, n; \quad i = 1, \dots, m$

where h is the number of DMU; n and m are the number of outputs and inputs variables respectively; y_{rk} is the amount of output r produced by DMU k; x_{ik} is the amount of input i used by DMU k and S_r, S_i are the output and input slacks respectively. The constraint of equation (4) will only be included in model under the assumption of VRS. According to Avkiran (2001), VRS assumption measures the pure technical efficiency (PTE) of DMUs. PTE score of DMU k is computed by $1/\phi_k$. The results are restricted to lie between zero and one ($0 \leq e \leq 1$) with score one for the efficient DMUs. DMU with a score less than one is considered as inefficient relative to other units (Avkiran, 2001). On the other hand, scale efficiency is computed as the ratio of CRS efficiencies to VRS efficiencies (Kipesha & Msigwa, 2013).

3.3 Input and Output Indicators

In this section, inputs and outputs for the models will be selected. In DEA, there are no rules in defining which sets of input and output to be used. However, it is very important to choose the most suitable inputs and outputs according to the objectives of the study and the availability of data (Katharaki & Katharakis, 2010). This is because the efficiency score will be affected if the choice of input and output set is unsuitable (Abbott & Doucouliagos, 2003). Besides, it is crucial to select an appropriate sample size in adopting DEA. The number of DMUs being evaluated should not be too small compared to the number of inputs and outputs. Golany and Roll (1989) mentioned that the number of DMUs should be twice larger than total number of inputs and outputs included.

According to Ahn *et al*. (1988), the inputs are the one who supports activities in universities and they can be categorized into labour and physical capital. Beasley (1990) added that financial is considered as an important input measure since the universities need money to buy equipments and hired staff. On the other hand, outputs of a university can be selected from the result of its daily activities such as teaching, research and consultancy (Flegg *et al*., 2004).

Table 3.1
Selection of inputs and outputs

DEA model	Inputs	Outputs
Model 1: (Teaching efficiency)	1. Annual aggregate expenditures 2. Number of academic staff 3. Number of non-academic staff	1. Number of undergraduates (bachelor degree) 2. Number of postgraduates (master degree) 3. Graduates employment rate
Model 2: (Research efficiency)	1. Number of academic staff 2. Research grants	1. Number of publications

Table 3.1 shows the inputs and outputs used in this study. Unlike some previous studies (Ahn *et al*., 1988; Beasley, 1990; Athanassopoulos & Shale, 1997; Flegg *et al.* 2004) where inputs and outputs for both teaching and research activities are combined, we separated them into two models. The chosen inputs reflected how much the individual university invested (in term of financial and human resources) in supporting its teaching and research activities respectively.

In model 1, the inputs selected are annual aggregate expenditures, number of academic staff and number of non-academic staff. The annual aggregate expenditures combined all expenses of a university which include emolument, maintenance and renovation, supplies and materials and other expenses in a particular year. Previous works such as Beasley (1990), Athanassopoulos and Shale (1997) and Flegg *et al.* (2004) also used annual aggregate expenditures as their input. Academic and non-academic staff represent human resources that have been invested by universities to carry out their teaching activities every year. Academic staff teach and deliver knowledge to students, whereas non-academic staff are supporting staff that facilitate the teaching process. Abbott and Msigwa (2003), Katharaki and Katharakis (2010), and Kipesha and Msigwa (2013) also selected these two inputs in their works.

According to Ismail *et al.* (2014), outputs of teaching activities should be focused on graduates. Hence, the number of undergraduates (at bachelor degree) and postgraduates (at master degree) were chosen as outputs of teaching activities. Similar to Kantabutra and Tang (2010) and Avkiran (2001), this study also selects graduates' employment rate as one of the outputs to evaluate the teaching efficiency. The graduates' employment rate is used to represent the market demand for the university graduates in a particular year (Kantabutra and Tang, 2010).

Academic staff and research grants were served as inputs for model 2. Universities have employed academic staff to conduct research activities aside from teaching (Kuah & Wong, 2011). On the other hand, it has become a controversial topic among researchers whether to include research grants as input or output while measuring the research efficiency of higher education institutions. This study followed Beasley (1990) to view research grants as a financial resource spent to produce research outputs. Avkiran (2001) also agreed that research grant should be considered as an input. The research grants used in this study are the combination of annual attracted research incomes from government, private sector and also from some international sectors.

The selected output for model 2 is the total number of publications of the university for a particular year. In this study, the number of publications is not only involving journals, but also includes books, magazines, working papers and all other academic reports. Beasley (1990) mentioned that the number of publications can be used to represent the research outputs of a university. Hanke and Leopoldseder (1998) and Johnes and Li (2008) also used publications as research output in their works.

3.4 Data Collection

Table 3.2 illustrates 12 public universities in Malaysia that will be examined in this study. Generally, public universities in Malaysia can be grouped into research, focussed and comprehensive universities. For the purpose of this study, the focussed and comprehensive universities are grouped together, and labelled as non-research universities. Data were collected from secondary sources such as Ministry of Education Malaysia, Ministry of Higher Education Graduate Tracer Study, annual reports and official website from universities involved. In this study, the efficiency scores of universities from year 2008 to 2012 will be computed by using software DEAP version 2.1.

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Table 3.2
Public universities in Malaysia

Universities	Code
Research Universities	
Universiti Malaya	UM
Universiti Kebangsaan Malaysia	UKM
Universiti Putra Malaysia	UPM
Non Research Universities	
Universiti Malaysia Sabah	UMS
Universiti Malaysia Sarawak	UNIMAS
Universiti Terengganu Malaysia	UMT
Universiti Perguruan Sultan Idris	UPSI
Universiti Teknikal Melaka Malaysia	UTEM
Universiti Tun Hussien Onn Malaysia	UTHM
Universiti Malaysia Perlis	UNIMAP
Universiti Utara Malaysia	UUM
Universiti Malaysia Pahang	UMP

3.5 Conclusion

This chapter explained about the details of research framework and model that used in this study. It is essential to learn more about the adopted method to ensure that the research can be carried out smoothly. The results of the study will be discussed in the next chapter.

CHAPTER 4

ANALYSIS AND DISCUSSION OF RESULT

4.1 Introduction

This chapter presents the data and the findings of the analysis. The first section provides the descriptive analysis as to allow for better understanding of the data. This involves the discussion on the input and output variables used in this study, particularly with respect to expenditures, academic and non-academic staff, undergraduates and postgraduates, the graduates' employment rates, research grants and publications. Subsequently, the results of the analysis of teaching and research efficiency that focus on pure technical efficiency and scale efficiency are elaborated in the next section.

4.2 Descriptive Analysis

As mentioned in the previous chapter, there are 12 public universities involved in this study for the five years examined period (2008-2012). All of the data were collected from secondary sources such as the Ministry of Higher Education Malaysia, the Graduate Tracer Study and the annual reports from selected universities.

4.2.1 Annual Aggregate Expenditures

Figure 4.1 illustrates the aggregate operating expenditures for all universities under consideration. The operating expenditures of universities included expenses for emolument, maintenance of buildings and supplies of teaching activity in a particular year. From the figure, we can clearly observe that all universities show an increasing trend in their operating expenditures from year 2008 to year 2012.
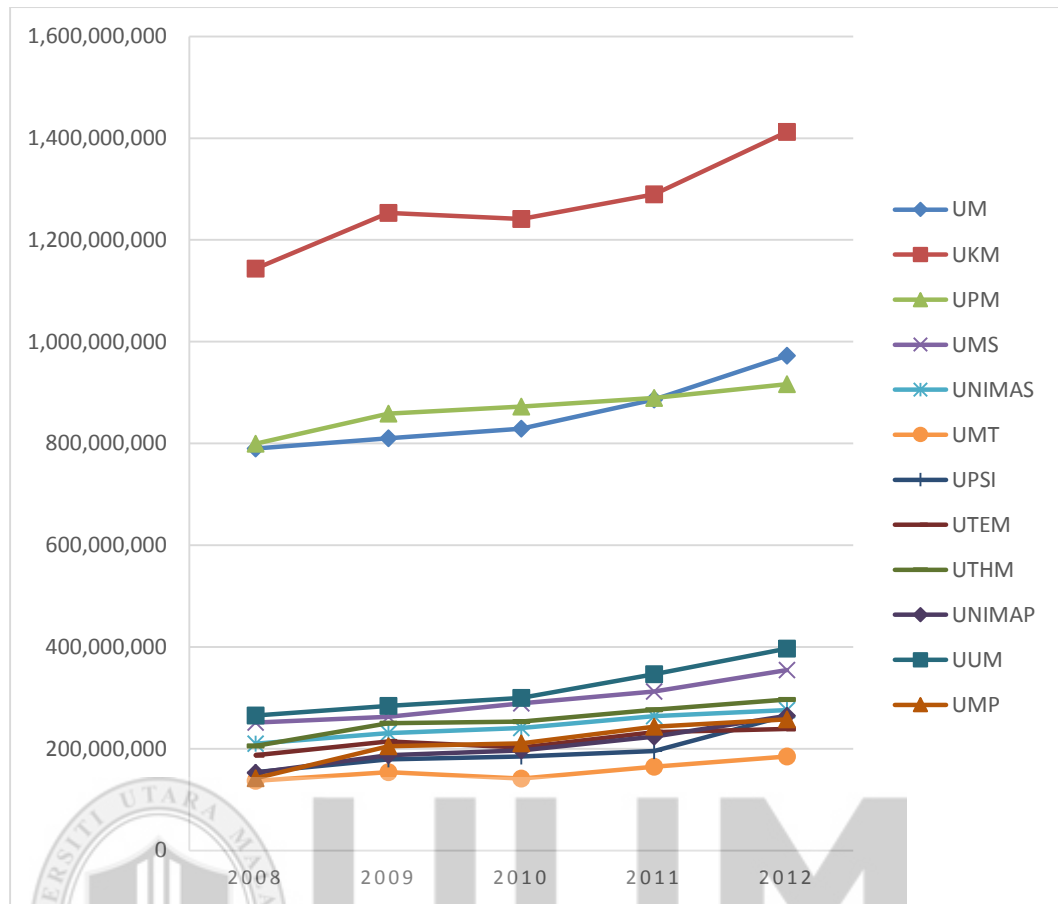
Figure 4.1
Total expenditures by universities (2008-2012)

In addition, figure 4.2 shows the average operating expenditures for each university within the examined period. It shows that *Universiti Kebangsaan Malaysia* (UKM) has spent the biggest amount of money while the smallest amount of expenditures was recorded by *Universiti Terengganu Malaysia* (UMT). The mean amount of expenditures for all 12 selected universities, RM 424 million is represented by a horizontal line in the figure. It is notable that all of the three research universities (UM, UKM and UPM) spent above RM 424 million while none of a non-research university spent more than that amount on average.

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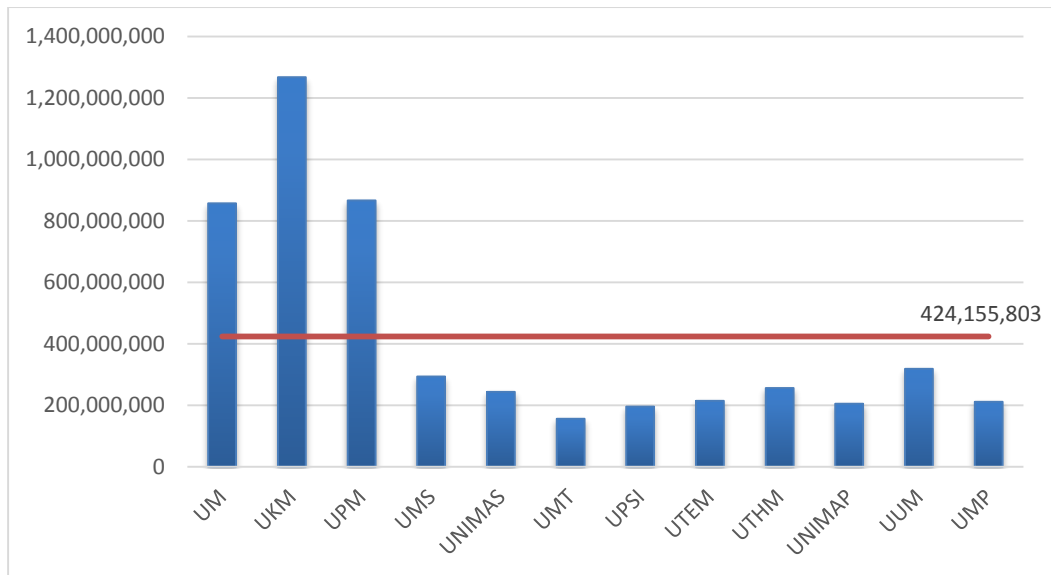
Figure 4.2
Average expenditures by universities (2008-2012)

4.2.2 Academic and Non-Academic Staff

Figures 4.3 and 4.4 show the average number of academic staff and non-academic staff at each university within the studied period. Based on both figures, it is clear that the three research universities (UM, UKM, UPM) employed more academic and non-academic staff compared to non-research universities. This can be one of the reasons to explain why research universities spent a larger amount of expenses compared to non-research universities as shown in Figure 4.2. As the number of staff increases, the emoluments also increase and the same goes to the aggregate expenditures of universities.

For the period from 2008-2012, on average, *Universiti Putra Malaysia* (UPM) recorded the largest number of academic staff (2,692) while UMT hired the lowest number of academic staff (445). For the non-academic staff, the largest numbers of staff (7,411) were recorded for UKM and the smallest, 565 were for *Universiti Malaysia Perlis* (UNIMAP).

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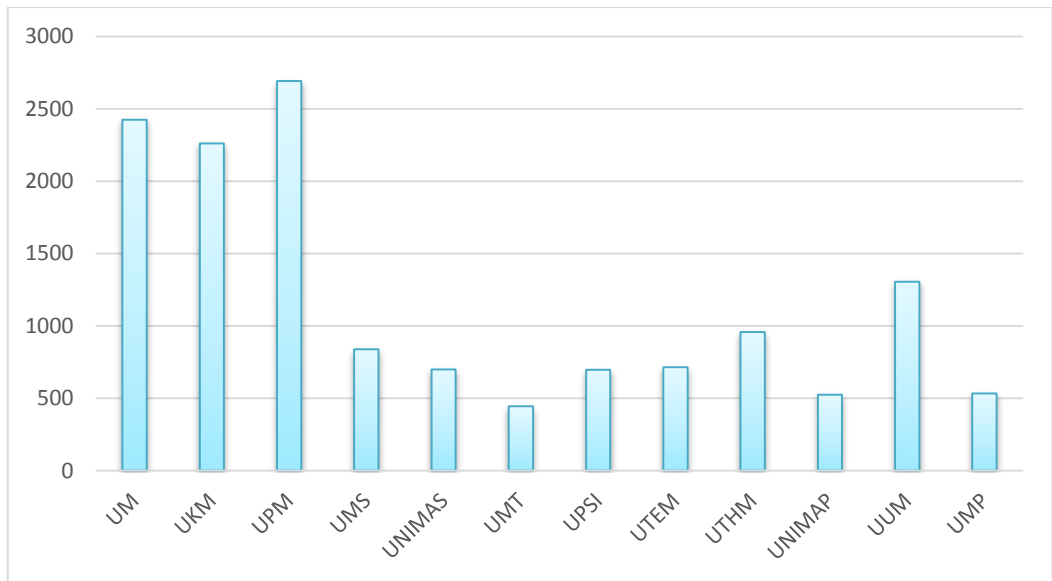
Figure 4.3
Average number of academic staff by university (2008-2012)
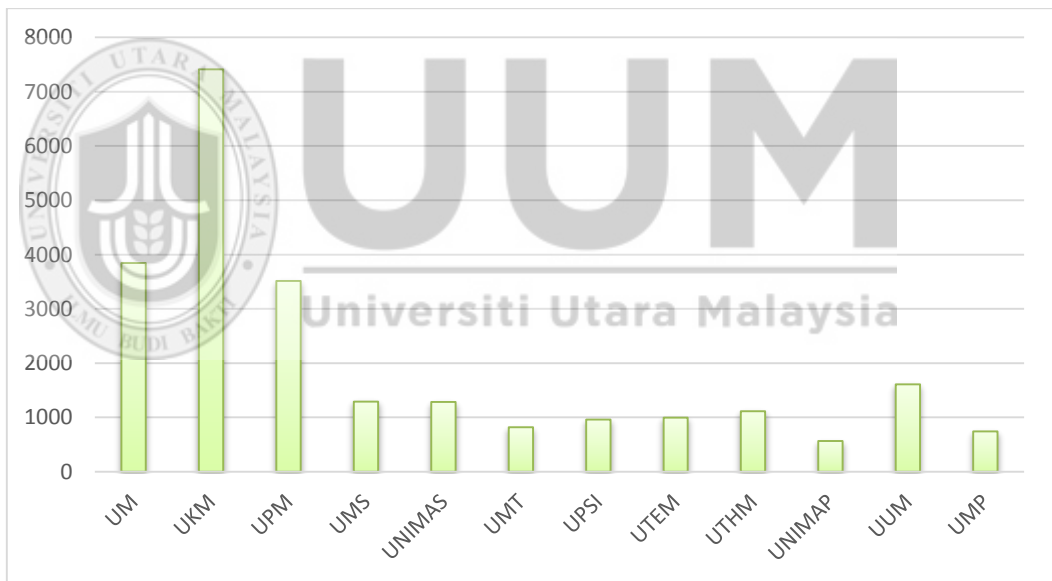
Figure 4.4
Average number of non-academic staff by university (2008-2012)

4.2.3 Undergraduates and Postgraduates

Figure 4.5 shows the total number of undergraduates and postgraduates from year 2008 to year 2012. The number of undergraduates decreased from 36,898 students in year 2009 to 34,537 students in year 2012 while the number of postgraduates increased from 5,304 students in year 2008 to 8,798 students in year 2012.

On the other hand, figure 4.6 presents the average number of undergraduates and postgraduates produced by each university within the studied period. On average, *Universiti Utara Malaysia* (UUM) produced the largest number of undergraduates while the highest number of postgraduates are graduated from UKM. It is worth noting that all the three research universities (UM, UKM and UPM) and UUM (one of the non-research universities) produced a larger number of graduated students (undergraduates and postgraduates) compared to other universities on average. This can be one of the reasons why they hired more academic and non-academic staff annually (refer figure 4.3 and 4.4) since the need for staff increases as the number of students increases. As a result, their average operating expenditures are larger than others (refer figure 4.2) because they need to spend more in terms of emoluments for staff and expenses on materials for teaching activity.
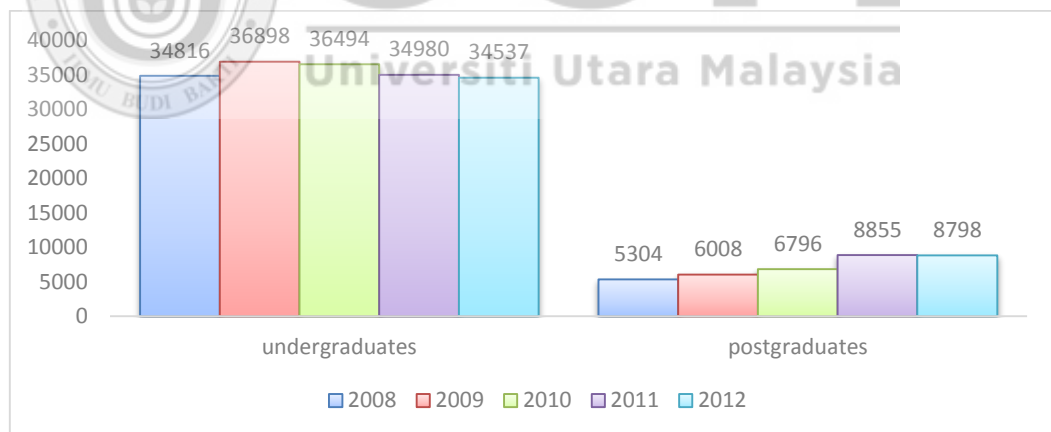
Figure 4.5
Total undergraduates and postgraduates by year
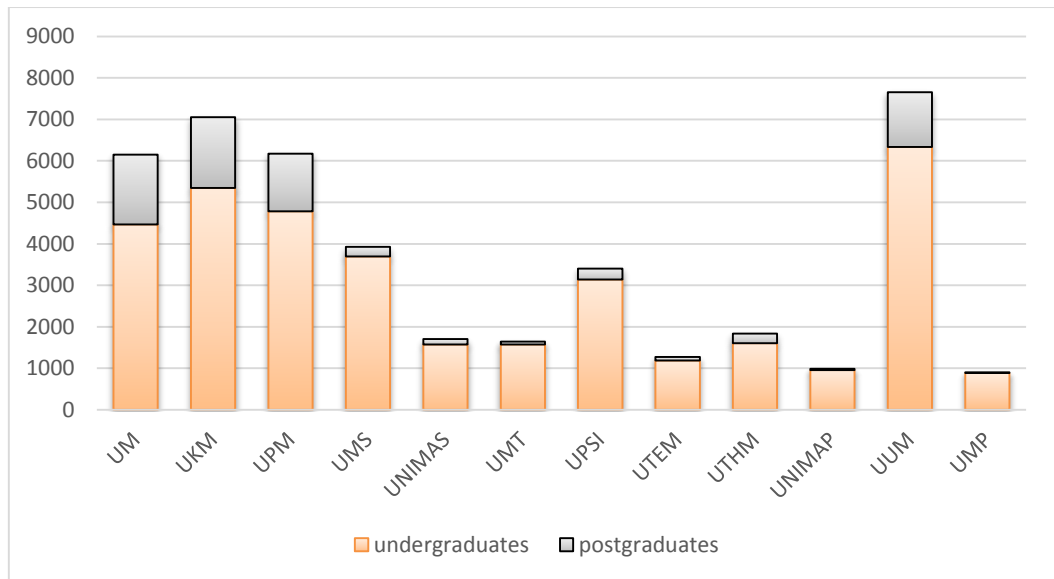
Figure 4.6
Average number of undergraduates and postgraduates by university

Table 4.1 shows the academic staff-to-student ratio and total staff-to-student ratio for each university involved in this study. The academic staff-to-student ratio refers to how many academic staff are hired compared to the graduated students each year, whereas the total staff-to-student ratio expresses the relationship between the number of total staff (academic and non-academic) employed by a university and its annually graduated students. Here, the graduated students are the combination of undergraduates and postgraduates produced by each university.

Based on the table, the largest ratio for both aspect are obtained by UUM. For academic staff-to-student ratio, 10:59 implies that every 10 lecturers teach/produce 59 graduated students while 10:26 ratio of total staff-to-student indicates every 10 staff in UUM produce 26 graduated students every year. According to Astin (1984), people believe that the lower the ratio, the smaller the class size and hence a lecturer can put more concentration on each student. As a result, students have greater improvement in the learning process.

Table 4.1
Staff-to-student ratio for each university

Universities	Academic staff : student ratio	Total staff : student ratio
UUM	10:59	10:26
UPSI	10:49	10:21
UMS	10:47	10:18
UMT	10:37	10:13
UKM	10:31	10:7
UM	10:25	10:10
UNIMAS	10:24	10:9
UPM	10:23	10:10
UTHM	10:19	10:9
UNIMAP	10:19	10:9
UTEM	10:18	10:7
UMP	10:17	10:7

4.2.4 Graduates Employment Rates

Figure 4.7 presents the average rates of graduates' employment for 12 universities. The graduates' employment rates represent the demand of university graduates from job market. If a university obtains a high rate, it indicates that a large number of students graduated from that particular university have been accepted to work in the labour market. The highest rate, 64.48% was achieved by UUM while the minimum rate, 30.35% was obtained by UNIMAP.
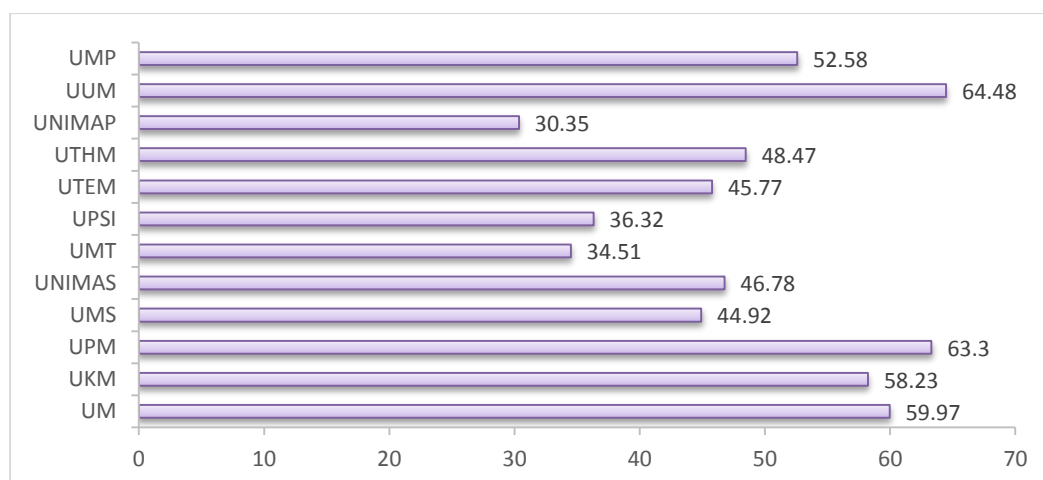
Figure 4.7
Average graduates employment rates (%)

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4.2.5 Publications

As mentioned in chapter 3, the number of publications in this study included journals, books, and all other academic papers that have been published by a university in a particular year. There are a total of 109,982 publications produced by 12 selected Malaysian public universities within the analysed period. It was stated in Malaysia Education Blueprint 2015-2025 that about 70% of total publications produced within 2003-2012 were contributed by five research Malaysian public universities. Apparently, figure 4.8 also shows that the numbers of publications produced by the three research universities (UM, UKM and UPM) are more than the number of publications produced by non-research universities involved in this study on average.
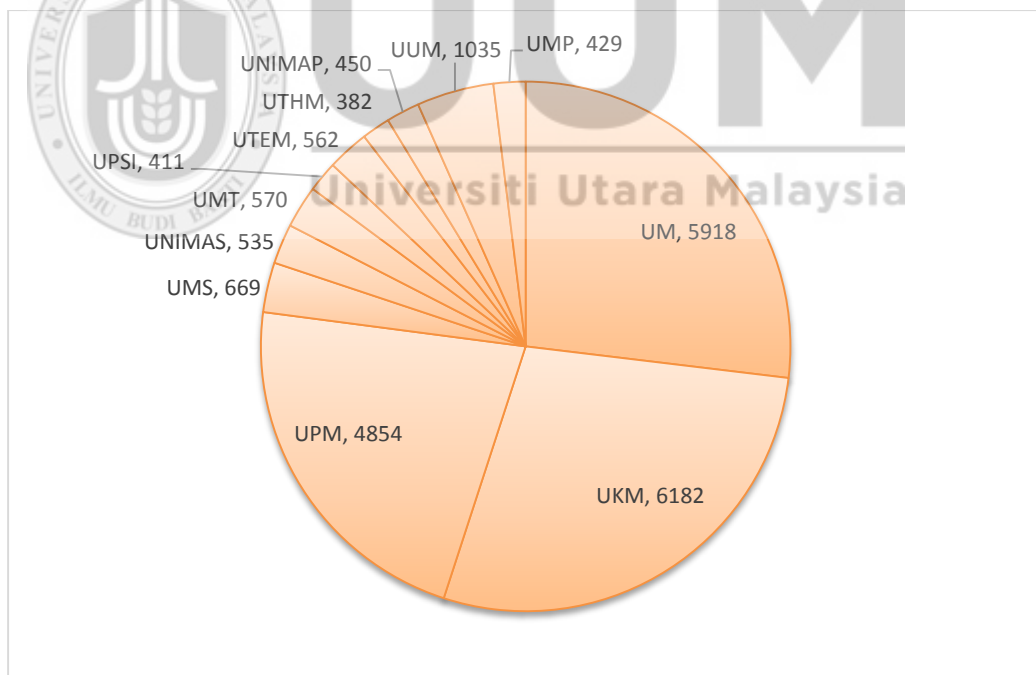
Figure 4.8
Average number of publications produced by each university (2008-2012)

4.2.6 Research Grants

Figure 4.9 shows the average amount of research grants received by each university within five years (2008-2012). Among the 12 universities under consideration, UKM secured the largest amount of research grants on average, which was around RM 155.31 million. Besides, figure 4.9 also shows that all of the non-research universities only attained a small amount of research grants compared to research universities. Research grant is an income receives by a university from government and private sectors for the purpose of research activities. Research grant is served as one of the inputs for the production of publications in this study. Research grants and publications are closely related to each other. Based on figure 4.8 and figure 4.9, both of them show that non-research universities who received a smaller amount of research grants produced less publications compared to research universities.
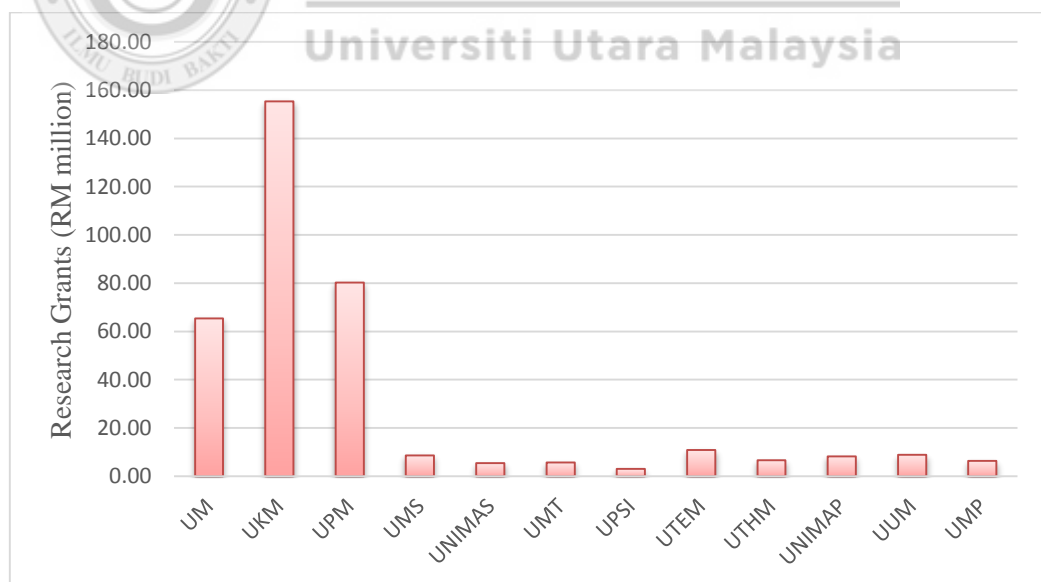
Figure 4.9
Average research grants received by each university (2008-2012)

4.3 Teaching Efficiency Analysis

The first part of this section will present the result of pure technical efficiency (PTE) of model 1 (teaching efficiency) while the result of scale efficiency of the same model will be discussed in the second part. Both of the results were computed using output oriented DEA with the assumption of variable returns to scale (VRS).

4.3.1 Pure Technical Efficiency

Pure technical efficiency (PTE) is a measurement of technical efficiency without scale efficiency (Ng and Ahmad, 2012). It reflects how efficient a particular university organizes the inputs in the production process. Table 4.2 below shows the summary of the results obtained.

Table 4.2
DEA results of model 1 (teaching efficiency)

Universities	2008	2009	2010	2011	2012	Average
UKM	1.000	1.000	1.000	1.000	1.000	**1.000**
UPM	1.000	1.000	1.000	1.000	1.000	**1.000**
UUM	1.000	1.000	1.000	1.000	1.000	**1.000**
UM	1.000	1.000	1.000	1.000	0.969	**0.994**
UNIMAS	0.831	0.846	1.000	0.969	1.000	**0.930**
UMP	0.856	1.000	0.813	0.870	0.880	**0.884**
UTHM	0.897	0.805	0.808	0.788	0.762	**0.812**
UTEM	0.725	1.000	0.684	0.736	0.803	**0.790**
UMS	0.783	0.661	0.732	1.000	0.698	**0.775**
UPSI	1.000	1.000	0.658	0.564	0.632	**0.771**
UMT	1.000	0.403	0.563	0.675	0.708	**0.670**
UNIMAP	0.408	0.515	0.442	1.000	0.580	**0.589**
Average	**0.875**	**0.852**	**0.808**	**0.884**	**0.836**	**0.851**

The last row of Table 4.2 shows the average PTE scores obtained from year 2008 to year 2012 and we can observe that all of the scores are above 0.8. This indicates that the 12 selected Malaysian public universities are good at utilizing and

managing their financial and human resources (inputs) to produce the undergraduates and postgraduates (outputs).

Based on the result, *Universiti Kebangsaan Malaysia* (UKM), *Universiti Putra Malaysia* (UPM) and *Universiti Utara Malaysia* (UUM) are the three universities which performed efficiently (PTE scores equal to one) in their teaching activities for all five years period. Both UKM and UPM are research public university, whereas UUM is a focussed public university in Malaysia. There is one similarity among three of them – old university established in early of 1970 and 1980. The data show that they have a larger number of students graduated every year compared to other universities (refer figure 4.6). They are able to perfectly allocate the given level of resources to produce the maximum number of undergraduates and postgraduates.

From the table 4.2, it is noticeable that the PTE scores of UM equal to one from year 2008 to 2011, but it dropped slightly below the efficient level in year 2012. In order to become one of the top research universities in the world, UM decided to reduce the intake of undergraduates and increase the intake of postgraduates to enhance its research quality ("UM to reduce intakes of undergraduates", 2009). The collected data show that the number of graduated students from UM decreased in year 2012, but the aggregate expenditures of UM increase continuously since year 2008 (refer back to figure 4.1). This situation indicates that there is an inefficiency in production process because the addition of input (aggregate expenditures) did not produce the desired level of output (number of graduated students). Hence, the level of PTE at UM declined in year 2012.

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Among the twelve universities involved, six of them obtained the average PTE score lower than the mean of PTE score for all universities (0.851). The lowest average PTE score, 0.589 was obtained by *Universiti Malaysia Perlis* (UNIMAP). It is one of the new universities established in recent year. By referring back to figure 4.6, UNIMAP produced the smallest number of undergraduates on average compared to other universities. Besides, the graduates' employment rate obtained by UNIMAP was also the lowest among the universities under consideration (refer figure 4.7). Nonetheless, the results in table 4.2 show that its PTE scores increase from 0.408 in year 2008 to 0.580 in year 2012. In other words, the teaching efficiency of UNIMAP rose over time. One of the explanations for this is because the number of undergraduates and postgraduates keep increasing since year 2008 and it implies that UNIMAP is gradually improving its performance in organising its inputs in the production process.

On the contrary, the PTE scores of *Universiti Perguruan Sultan Idris* (UPSI) drop from one to 0.632 (based on table 4.2). The data show that the number of undergraduates at UPSI declined over time despite its annual aggregate expenditures keep increasing within the studied period. This reveals that UPSI failed to efficiently assign its inputs to produce the maximum level of outputs after year 2009.

4.3.2 Scale Efficiency

The scale efficiency measures the current scale operation of DMUs whether they are operating under most productive scale size (MPSS), increasing returns to scale (IRS) or decreasing returns to scale (DRS). For a university to score one in scale efficiency (operates under MPSS), it is necessary for that university to score one in

technical efficiency too (Flegg *et al*., 2004). On the other hand, a technically efficient university may not operate in the most appropriate scale. The universities are deem to be operated under an unideal scale size if their scores are less than unity (< 1). According to Ahn *et al*. (1988), the MPSS or optimal scale size has been achieved if a further increase in any input will lead to a decline in at least one of the outputs.

As present in Table 4.3, *Universiti Kebangsaan Malaysia* (UKM) is the only university who is technically efficient and at the same time operated under optimal scale size or most productive scale size (MPSS) throughout the five years period of study. On the other hand, for both *Universiti Putra Malaysia* (UPM) and *Universiti Utara Malaysia* (UUM) who are also considered technically efficient in teaching activities, achieved an average scale efficiency score of 0.882 and 0.927 respectively. This indicates that both of them are efficient in allocating the current level of inputs to maximize the teaching outputs, but they failed to operate under the optimal scale size. In other words, if they increase one of the inputs, they can further increase the outputs of their teaching activities.

Based on the table 4.3, *Universiti Malaysia Perlis* (UNIMAP) scored 0.848 in scale efficiency on average. By referring back to table 4.2, UNIMAP is the university who obtained the lowest score of PTE. Both of these scores imply that UNIMAP is inefficient in allocating the inputs in the production process and at the same time operated under inappropriate scale size. According to Avkiran (2001), if a university is technically inefficient and not operating under the optimal scale size at the same time, it should focus on the methods to improve its managerial decision regarding the allocation of resources before adjusting its scale size.

Table 4.3

Result of Scale Efficiency and Returns to Scale for Model 1 (Teaching Efficiency)

Universities	2008		2009		2010		2011		2012		Average
UKM	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	**1.000**
UUM	1.000	-	1.000	-	1.000	-	1.000	-	0.637	drs	**0.927**
UPM	0.932	drs	1.000	-	0.478	drs	1.000	-	1.000	-	**0.882**
UNIMAS	0.742	drs	0.961	drs	0.876	irs	0.783	drs	1.000	-	**0.872**
UTHM	0.990	irs	0.984	irs	0.961	irs	0.718	drs	0.680	drs	**0.867**
UNIMAP	0.647	drs	0.937	drs	0.869	drs	1.000	-	0.786	drs	**0.849**
UM	1.000	-	1.000	-	0.606	drs	1.000	-	0.622	drs	**0.846**
UPSI	0.819	irs	1.000	-	0.873	drs	0.821	drs	0.712	drs	**0.845**
UMT	1.000	-	0.921	drs	0.724	drs	0.719	drs	0.717	drs	**0.816**
UTEM	0.842	drs	1.000	-	0.974	drs	0.738	drs	0.499	drs	**0.811**
UMS	0.683	drs	0.791	drs	0.681	drs	1.000	-	0.621	drs	**0.755**
UMP	0.712	drs	1.000	-	0.673	drs	0.776	drs	0.593	drs	**0.751**
Average	**0.864**		**0.966**		**0.810**		**0.884**		**0.739**		0.852
Percentage of MPSS	33.33%		58.33%		16.67%		50%		25%		
Percentage of IRS	16.67%		8.33%		16.67%		-		-		
Percentage of DRS	50%		33.33%		66.67%		50%		75%		

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In general, the average scale efficiency score of 12 universities is 0.852. Most of the universities were operating under the DRS. The percentage of universities that operating under DRS increased from 50% in year 2008 to 75% in year 2012. According to Avkiran (2001), DRS indicates that an increase in inputs will lead to a less than proportionate increase in outputs. For instance, if a university raises an input by 100%, the increase in outputs will be less than 100%. In other words, the additional of an input in the production process is not being fully utilized.

4.4 Research Efficiency Analysis

Discussion and interpretation of the results of pure technical efficiency (PTE) and scale efficiency for model 2 (research efficiency) will be discussed in the first part and second part of this section respectively.

4.4.1 Pure Technical Efficiency

Table 4.4 shows the summary of the PTE scores obtained by using an output oriented DEA with the assumption of variable returns to scale (VRS). A score of one implies that the university is efficient, while the university with scores less than one is considered to be inefficient.

Table 4.4
DEA results of model 2 (research efficiency)

Universities	2008	2009	2010	2011	2012	Average
UM	1.000	1.000	1.000	1.000	1.000	**1.000**
UMT	1.000	1.000	1.000	1.000	1.000	**1.000**
UPSI	1.000	1.000	1.000	1.000	1.000	**1.000**
UKM	1.000	0.877	1.000	1.000	1.000	**0.975**
UPM	1.000	0.970	0.979	0.808	0.727	**0.897**
UUM	1.000	1.000	1.000	0.594	0.574	**0.834**
UNIMAP	0.899	1.000	0.672	0.583	0.589	**0.749**
UNIMAS	0.865	0.790	0.880	0.630	0.547	**0.742**
UMP	1.000	0.710	0.480	0.551	0.542	**0.657**
UMS	0.839	0.618	0.589	0.590	0.513	**0.632**
UTEM	0.415	0.436	0.817	0.448	0.493	**0.522**
UTHM	0.419	0.355	0.422	0.424	0.407	**0.405**
Average	**0.870**	**0.813**	**0.821**	**0.719**	**0.699**	**0.784**

The results show that the average PTE score of research activities for 12 selected Malaysian public universities within a five years period is 0.784. The range of scores obtained are between 0.699 and 0.870. It is also worth noting that the average PTE scores in this model show a clear declining trend for the whole period of study. This indicates that the universities involved are having a weak managerial performance in allocating the inputs for production of research outputs on average.

Based on the result, three universities – *Universiti Malaya* (UM), *Universiti Terengganu Malaysia* (UMT) and *Universiti Perguruan Sultan Idris* (UPSI) are considered technically efficient in research activities. Their PTE scores for the whole examined period are equal to one. This implies that they had efficiently organise and utilize the given level of resources to produce the maximum level of research outputs, and no other universities within the group can generate larger level of outputs with the same level of inputs. Both UMT and UPSI are non-research universities while UM is one of the five research public university in Malaysia.

Other than UM, there are two research universities, *Universiti Kebangsaan Malaysia* (UKM) and *Universiti Putra Malaysia* (UPM) have also been included in this model. According to the result, their average PTE scores are 0.975 and 0.897 respectively. In addition, it is observable that the PTE scores of UPM drop from one in year 2008 to 0.727 in year 2012. As a research university, UPM hired a large number of staff and attained huge amount of research grants each year to conduct the research activities. According to the collected data, the research grants received by UPM keep rising within the studied period. Even though the number of publications produced by UPM increased over time, it seems that UPM can further increase its number of publications by using the received grants.

Based on table 4.4, it should be noted that almost all of the universities involved displayed a declining trend in their PTE scores. The most obvious case was recorded by *Universiti Utara Malaysia* (UUM) whose PTE scores equal to one in the first three years and suddenly dropped around 50% in the last two years. Similar to UPM, UUM received a large amount of research grant and increased the production of research outputs since year 2008. However, the result reveals that UUM is capable to raise its number of publications by improving the managerial decision to allocate the received grants in research activities. It is important to ensure that all the inputs (staff and research grants) are being fully utilize to produce outputs such as journals, articles, papers and so on.

Based on the result, there are half of the total selected universities obtained the average PTE score lower than 0.784 (an average PTE score for all 12 universities). *Universiti Tun Hussien Onn* (UTHM) scored the lowest among the universities under consideration. The range of its efficiency scores is between 0.35 and 0.40. UTHM produced the smallest number of publications compared to other

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universities (refer figure 4.8), but it received a larger amount of research grants compared to UPSI, UMT and UNIMAS (refer figure 4.9). By obtaining a bigger amount of grants, UTHM should be able to produce extra research outputs. Despite that, it only managed to increase a small level of the number of publication. The inadequate allocation of inputs caused UTHM to remain inefficient.

4.4.2 Scale Efficiency

Table 4.5 concluded the results of scale efficiency for model 2 computed via DEA for 12 selected Malaysian public universities. The results show that the average scale efficiency score obtained for research activities is 0.818. There is an increasing trend shown in the average score of scale efficiency from year 2008 to year 2012. This implies that the research activities conducted by these 12 universities were gradually operating in an appropriate scale size on average.

Based on table 4.5, it shows that there is only one university, *Universiti Malaya* (UM) who constantly operated under optimal scale size (scale efficiency scores equal to one) for all five years of examined period. The other two universities who are also regarded as technically efficient in research activities - *Universiti Terengganu Malaysia* (UMT) and *Universiti Perguruan Sultan Idris* (UPSI) obtain an average scale efficiency score of 0.742 and 0.606 respectively. Besides, the result shows that both of them are operating under increasing returns to scale (IRS). In year 2011 and 2012, UMT and UPSI successfully achieved the most productive scale size (MPSS) respectively.

In general, the percentage of the universities that operated under increasing returns to scale (IRS) in this model is higher than model 1. Besides, there are more universities operated under most productive scale size (MPSS) in this model. The

universities who operate under MPSS indicate that their production of outputs are maximised per unit of inputs (Avkiran, 2001). In other words, their productivity is maximised. On the other hand, the expansion of research activities is needed for universities who operating under IRS in order to ensure that they will achieve the optimal scale size in the future. Nonetheless, according to Flegg *et al*. (2004), it takes a long period for a university to adjust its scale size to an optimal scale size.

4.5 Conclusion

The main objective of this study is to examine the relative efficiency of Malaysian public universities. By using DEA, the results show that the 12 selected Malaysian public universities have quite a high level of efficiency in both teaching and research activities within the examined period. Besides, the results also reveal that the universities under consideration performed better in teaching sector compared to research sector.
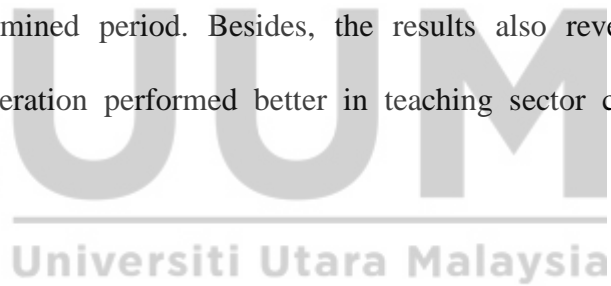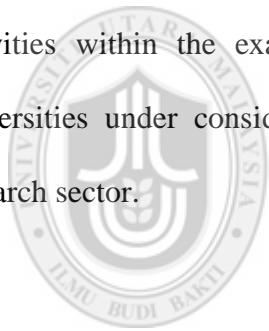
Table 4.5

Result of Scale Efficiency and Returns to Scale for Model 2 (Research Efficiency)

Universities	2008		2009		2010		2011		2012		Average
UM	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-	**1.000**
UKM	1.000	-	0.987	irs	1.000	-	1.000	-	1.000	-	**0.997**
UUM	1.000	-	1.000	-	1.000	-	0.727	drs	1.000	-	**0.945**
UTHM	0.874	irs	0.903	irs	0.888	irs	0.876	drs	0.980	irs	**0.904**
UPM	1.000	-	0.922	drs	0.906	drs	0.879	drs	0.722	drs	**0.886**
UMS	0.815	irs	0.871	irs	0.845	irs	0.841	drs	0.983	irs	**0.871**
UTEM	0.760	irs	0.848	irs	0.738	irs	0.887	drs	0.945	irs	**0.836**
UNIMAS	0.728	irs	0.759	irs	0.745	irs	0.879	drs	0.972	irs	**0.817**
UMT	0.552	irs	0.662	irs	0.495	irs	1.000	-	1.000	-	**0.742**
UMP	0.226	irs	0.674	irs	0.610	irs	0.936	drs	0.919	irs	**0.673**
UNIMAP	0.491	irs	0.386	irs	0.581	irs	0.714	irs	1.000	-	**0.634**
UPSI	0.398	irs	0.464	irs	0.748	irs	0.422	irs	1.000	-	**0.606**
Average	**0.737**		**0.789**		**0.796**		**0.847**		**0.960**		**0.818**
Percentage of MPSS	33.33%		16.67%		25%		25%		50%		
Percentage of IRS	66.67%		75%		66.67%		16.67%		41.67%		
Percentage of DRS	-		8.33%		8.33%		58.33%		8.33%		

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CHAPTER 5

SUMMARY AND CONCLUSION

5.1 Summary

Education plays an important role in a country. Every year, the Malaysian government spends a huge amount of funds on higher education sector. Hence, it is crucial to examine and evaluate the efficiency of higher education institutions in Malaysia, especially Malaysian public universities since a lot of effort and fund have been invested into them. Besides, efficiency analysis has become an essential tool for universities to improve and stay competitive in the world these days.

In this study, data envelopment analysis (DEA) was employed to evaluate the relative efficiency of 12 selected Malaysian public universities for the period of 2008-2012. The analysis focuses on the pure technical efficiency and scale efficiency of the selected universities in the production of academic outputs in two dimensions: teaching and research. The teaching efficiency (model 1) and research efficiency (model 2) were analysed separately to reveal the true capability of the universities in performing both activities.

The findings show that the selected Malaysian universities were operating at a fairly high level of efficiency. The results clearly show that the average pure technical efficiency (PTE) score for model 1 is higher than model 2. This indicates that the selected universities are more efficient in allocating and utilizing the inputs for the production of teaching outputs rather than research outputs. Nonetheless, the results reveal that average PTE scores for model 2 increased from year 2008 to year 2012.

In specific, there are three universities (UKM, UPM and UUM) who are considered as technically efficient in teaching and another three universities (UM, UMT and UPSI) in research. It is also worth noting that none of the universities involved are deemed as technically efficient in both activities within the studied period.

For the case of scale efficiency, the findings indicate that 12 Malaysian public universities were operating at satisfactory level of scale size with the average scale efficiency score obtained in model 1 slightly higher than model 2. Again, the results prove that the selected universities performed better in teaching compared to research on average.

However, unlike model 1, the average scale efficiency scores in model 2 show an upward trend over time. Besides, the number of universities who operated under the optimal scale size or most productive scale size (MPSS) are also higher in model 2. In general, the majority of universities in model 1 were operating under decreasing returns to scale (DRS) while only a small number of universities were operating under increasing returns to scale (IRS). On the contrary, in model 2, the number of universities operated under IRS are higher than those who operated under DRS.

5.2 Suggestions and Recommendations

Based on the findings, here are some suggestions for few universities in order to improve their efficiency. As mentioned in previous chapter, *Universiti Malaya* (UM) implemented a new strategy in which it reduced the intake of undergraduates and increase the intake of postgraduates. However, based on the collected data, both of the number of undergraduates and postgraduates dropped in year 2012. Hence, UM should focus on methods to attract a large number of postgraduates so that its level of efficiency can be improved.

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Universiti Malaysia Perlis (UNIMAP) was considered to be the least efficient universities in teaching. It obtained the smallest average pure technical efficiency (PTE) score mainly due to the fact that it produced a small number of undergraduates and postgraduates. Even though the data show that the number of undergraduates and postgraduates increased over time, the PTE scores obtained indicate that both of them can be further increased with the given level of inputs. Thus, UNIMAP should improve its decision in allocating the inputs to maximise the total outputs.

For the case of *Universiti Utara Malaysia* (UUM), who is regarded as technically efficient in teaching activities, but its scale efficiency scores reveal that it is not operating under the optimal scale size. Thus, it need to focus more in adjusting its scale size. Besides, the result of model 2 also showed that the research efficiency of UUM dropped in the last two years. The data show that the research grants obtained by UUM keep increasing from year 2008 to year 2012. Despite that, the number of publications (output of research activities) fail to rise to the maximum level. Hence, UUM should concentrate to increase the production of research outputs with the given level of inputs.

Based on figure 4.9, it shows that *Universitis Kebangsaan Malaysia* (UKM) is the university who obtained the largest amount of research grants among 12 universities involved. Furthermore, UKM is also the university who produced the highest number of publications within the examined period (refer figure 4.8). However, the results deemed UKM to be technically inefficient in managing and allocating the inputs in production of research. The efficiency level of UKM can be improved by increasing the current number of publications.

In conclusion, the 12 selected Malaysian public universities were performing in a high level of efficiency in both teaching and research sector. More focus should be put into research activities since the level of efficiency in research sector is lower than the teaching sector. In addition, the universities considered as technically efficient within this study should not neglect their responsibilities in teaching nor research. This is because there is always a space to improve the efficiency level. Flegg *et al*. (2004) mentioned that the efficiency scores can be influenced by the change in input or output variables as well as the change of DMU in the study. Besides, it cannot be concluded that the Malaysian university system is efficient when the comparison with universities from other countries are not included. Therefore, it is important for a university to keep improving the level of efficiency so that they can stay competitive on the world stage.

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