Chapter 4

4.0. EVALUATING THE EFFICIENCY OF MALAYSIAN PUBLIC UNIVERSITIES

4.1. Introduction

In this chapter, four DEA models specified in the previous chapter are employed to evaluate the efficiency of 15 Malaysian public universities in 2001. We begin this chapter with a descriptive statistics of the input and output data followed with a brief discussion on the correlation of all possible pairs of the variables employed. The introduction to the DEA results generated by a DEA software programme follows next together with discussions on the empirical results of generated by specific DEA model outlined in Chapter 3. We will also attempt to identify the best practice university within this group by examining the efficiency of all universities that appear to be fully efficient in the models developed. In general, there are five universities which are deemed to be efficient. Out of these five, the "genuinely efficient" university is to be identified.

4.2. Data

A descriptive statistics for the input and output employed for the DEA models specified in Table 3.1 of the previous chapter is presented in Table 4.1. This table reflects data for the assessment year of 2001/2002. The average operating expenditure incurred by the universities under study is about RM158,177,600. While the mean research income received amounts to RM34,563,387. The number of students enrolled for undergraduates and graduates programs in each university averages to 16,561 and 1,919, respectively.

The table also depicts the number of publications produced with a mean value of 123. In general, there is a large variation in the data distribution for almost all data set. The highest value for operating expenditure, for example, amounts to RM500,729,600 while its lowest value is RM10,195,000 which is actually KUSTEM's operating expenditure. The distribution of research income is also widely dispersed as depicted by a standard deviation of RM62,105,287. The wide dispersion in the data distribution could possibly be due to the wide age gap between two types of public institutions, the universities and the newly established college universities. However, DEA-based framework for efficiency evaluation measure the output/input ratios of each unit with respect to outputs, hence, wide data dispersion would not pose any problem to measuring efficiency of these universities (Tomkins & Greens, 1988).

To validate the input and outputs variables, the Pearson's coefficient of correlation is constructed and the correlation coefficient matrix is tabulated in Table 4.2. This matrix shows the simple correlation between all possible pairs of variables included in this analysis. The correlation coefficients reveal that the single input variable i.e. the operating expenditure is significantly correlated to the teaching and research output variables. (Graduate student = 0.580, undergraduate student = 0.850, and publication counts = 0.548). A correlation coefficient of 0.354 between operating expenditure and research income still indicates that there is a meaningful correlation between these two variables. The significant correlation between operating expenditure and the output variables shows that the DEA models to be developed do capture the important factors that influence operating expenditure, hence, producing reliable results.

Table 4.1

Descriptive Statistics of Inputs and Outputs for the universities (2001/20012)

	INPUTS		OUTPUTS		
	Operating Expenditure (RM)	Number of Graduate Student Enrolments	Number of Undergraduate Student Enrolments	Publication Counts	Research Income
Mean	158,177,607	1,919	16,561	123	34,563, 387
Standard Deviation	142,390,667	2,416	20,848	191	62,105,287
Maximum	500,729,600	7,702	84,453	530	226, 689, 223
Minimum	10,195,000	0	348	0	0

Table 4.2

Pearson Correlations Matrix of the input and output data

	Operating Expenditure	Graduate Student Enrolments	Undergraduate Student Enrolments	Publication Counts	Research Income
Operating Expenditure	1.00	0.580*	0.850**	0.548*	0.354
Graduate Student Enrolments	0.580*	1.00	0.265	0.902**	0.383
Undergraduate Student Enrolments	0.850**	0.265	1.00	0.137	0.214
Publication Counts	0.548*	0.902**	0.137	1.00	0.448
Research Income	0.354	0.383	0.214	0.448	1.00

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

4.3. DEA Empirical Results

The specifications and definitions of the four DEA models used to evaluate the efficiency of the Malaysian public universities have been discussed in detail in Chapter 3. These models utilize the input and output data comprised of variables illustrated in Table 4.1. We implement these models using the software programme Efficiency Measurement System (EMS) version 1.3 by Holger Scheel (2000). We use the CRS assumption in evaluating the universities because quite a number of studies assume a condition of CRS in their studies as mentioned in section 3.3.4 of Chapter 3 (page 48).

The EMS results generated contain three sets of figures i.e. the efficiency scores of each university, the weights (virtual) of inputs and outputs, and the benchmarks or peer referents. These results are tabulated in Table 4.3 to Table 4.6. The results produced by the DEA models actually measure the relative efficiency of each target university. It is a relative efficiency measurement as the measurement is made with reference to the considered set of universities in comparison with the rest of the universities. Each university is considered in turn to select its most favorable weights. The efficiencies of all other universities are computed by using these sets of weights.

4.3.1. Understanding the DEA results

Before examining the empirical results in section 4.3.2, we need to understand the DEA results, in general. This section gives a brief explanation on the DEA results generated by the EMS DEA software programme. The results obtained from the DEA assessment will provide an insight into the efficiency/inefficiency level of each university discussed below.

Efficiency Scores

In an input orientation measure of efficiency, a university is considered to be efficient if it is possible for it to lower its input levels without increasing at least another one of its input levels and/or without lowering at least one of its output levels. The concept of efficiency rating has been explained in detailed under the CCR Input Orientation model in section 2.4.1 of Chapter 2. A score of 100% or 1.00 is considered as fully efficient (Thannasoulis, 2001). An efficient university will provide the view on the scope for this university to be a role model for other inefficient universities. The universities scoring less than 100% or 1.00 are designated as the inefficient universities. The inefficient universities must first identify the efficient universities before attempting to emulate the efficient ones in order to improve their performance. In the input oriented model, efficiency score rated as less than 100% or 1.00 clearly indicates that the cost at which the university delivers its outputs is in excess of the minimum required. For example, a university scoring an efficiency level of 85% indicates that this university could have produced the same level of output by actually using only 85% of its operating expenditure. In other words, this university is said to be 15% cost inefficient assuming it operates at CRS.

Weights

The weights or virtual inputs and outputs of a university shed light on the extent to which the efficiency rating of efficient universities is underscored by each one of its input and output levels. The basic DEA model CCR version in Chapter 2 page 27 clearly illustrates that the aggregate the virtual inputs or outputs equals to 1 (or 100%) for each unit. These virtual inputs and outputs of each DMU reveal the relative contribution of each input and output to its efficiency rating (Sarrico & Dyson, 2000) because each university selects inputs and outputs weights that maximize its efficiency score. This characterization enables us to identify which input or output essentially contributes to the efficiency rating obtained by a university. This factor will be further expanded in the coming section featuring DEA empirical results.

Benchmarks

The set of corresponding efficient universities are utilized as benchmarks (Lewis,2000) by the inefficient universities. Benchmarks or peer referents (Thanassoulis,2001) offer two different interpretations depending upon whether the unit is efficient or inefficient. For the inefficient units, benchmarks provide information on which unit(s) they should emulate in order to be efficient. Conversely, benchmarks for the efficient units illustrate how many inefficient units are using that particular efficiency unit as their benchmark. The concept of benchmark has been illustrated by Figure 2.1 of Chapter 2, page 18.

4.3.2. Results by Model Specification

The following section discusses the efficiency of 15 public universities of this study based on the four model specifications. In particular, we will examine the efficiency scores obtained, weights allocated for the variables and the benchmarks or referent peers of each university.

4.3.2.1. DEA1

This basic model has a single cost-based input variable, which is the amount of operating expenditure and a single unit each of teaching and research output variables i.e. the aggregate number of student enrolments and publication counts, respectively. The EMS results produced by model DEA1 are presented in Table 4.3. From these results, two out of fifteen universities under study are rated as fully efficient (100%). They are UM and KUSTEM. UUM is close to full efficiency with a score of 91.8%. These three universities can be regarded as the top ranking universities. In an input oriented model, efficiency score rated as less than 100% or 1.00 clearly indicates that the cost at which the university delivers its outputs is in excess of the minimum required. UUM could have produced the same level of output by actually using only 91.8% of its operating expenditure. Put it in another words, UUM is 8.2% cost inefficient assuming it operates at CRS. The interpretations of the efficiency/inefficiency scores for other universities can be derived similarly. KUSTEM is the only college university that achieved full rating. After further analysis, we come to a conclusion that its outstanding performance could be due to the fact that it has the lowest operating expenditure in the set of universities under evaluation and therefore, may not be truly efficient.

Table 4.3

EMS results of efficiency, weights and benchmarks of DEA1

		INPUT	OUTPUTS		BENCHMARKS	
DMU	Efficiency	OPExp	TotStE	ICPUB	(referent peers)	(no. of emulating universities)
1. UM	100.00%	1	0.22	0.78	-	7
2. USM	69.26%	1	0	1	UM	-
3. UKM	61.38%	1	0.46	0.54	UM, KUSTEM	-
4. UPM	66.76%	1	0.52	0.48	UM, KUSTEM	-
5. UTM	66.80%	1	0.73	0.27	UM, KUSTEM	-
6. UUM	91.80%	1	1	0	KUSTEM	-
7. UiAM	23.08%	1	0.9	0.1	UM, KUSTEM	-
8. UNIMAS	30.34%	1	0.59	0.41	UM, KUSTEM	-
9. UMS	47.73%	1	0.78	0.22	UM, KUSTEM	-
10. UPSI	52.29%	1	1	0	KUSTEM	-
11. UiTM	58.64%	1	1	0	KUSTEM	-
12. KUSTEM	100.00%	1	0.93	0.07	-	12
13. KUIM	19.02%	1	1	0	KUSTEM	-
14. KUiTTHO	33.71%	1	1	0	KUSTEM	-
15. KUTKM	1.96%	1	1	0	KUSTEM	-
Average Efficiency Score	54.85%					

Definitions:

OPExp = Operating expenditure TotStE = Total Student Enrolments

ICPUB = Publication Counts

The middle ranking universities are USM, UPM, UKM and UTM with scores ranging from 61% to 69%. The other five universities and three college universities, UiAM, UNIMAS, UMS, UPSI, KUIM, KUiTTHO and KUTKM are designated as poor performing universities with scores below the mean level of 54.85% while UiTM is the only inefficient university scores above the mean level.

KUTKM scores the lowest efficiency level of 1.96%. This indicates that this institution is performing way below the other universities within this group. This particular college university KUTKM, nonetheless, was only effectively established on December 2000 (Education Guide MALAYSIA, 2004). Hence, it may not yet be able to "produce" any significant efficiency indicators for the assessment year of 2001.

The results of DEA1 also reveal that UM is highly rated for its publication counts. UM has assigned a weight of 0.78 to publication counts. The attributing factor could be because UM has made voluminous contributions to publication in comparison to the other universities. As a matter of fact, UM is the only university on which its efficiency rating is essentially contributed by publication counts. Distinctively KUSTEM has placed a high weight of 0.97 to its total number of student enrolment. Evidently, UiAM, UTM and UMS have also put much emphasis on teaching output while UUM, UPSI, UiTM, KUIM, KUiTTHO and KUTKUM set a full weight of 1.00 to their teaching output. UKM, UPM and UNIMAS, nonetheless, have more balanced weights allocation between teaching and research output.

Results on benchmarks reflect seven inefficient universities have chosen UM as their benchmark. The seven universities are USM, UKM, UPM, UTM, UIAM, UNIMAS, and UMS. This implies, for example, that UM can provide useful information for USM to emulate in order for USM to be efficient. This is true given the fact that they have similar mix of input-output levels and similar environment to recommend the adoption of similar operating practices to UKM.

4.3.2.2. DEA2

Similar to DEA1, DEA2 applies the same input and output variables. Research income is added as an additional research output. The inclusion of research income as another research output attempts to assess research funding as a good proxy to research output (McMillan & Datta, 1998). Some researches argue that employing both research output in a model invites the danger of double counting, hence reducing the discriminating power of DEA model. This is mainly because it is believed that publications would not have been possible without favorable research environment created by the research income (Johnes & Johnes, 1995). To verify whether there is ground for these claims in our study, the Pearson Correlation coefficient tabulated in Table 4.2 is referred. It is found that the correlation coefficient for publication counts and research income is 0.45. This indicates that these two variables are not highly correlated. This may be because research does not necessarily produce publications. Therefore, both of these variables will be employed for model DEA2. The result of DEA2 is presented in Table 4.4.

The results show that the number of efficient universities rose to five (UM, USM, UTM, UiTM and KUSTEM) from the earlier two (UM and KUSTEM) in model DEA1. The table shows that USM, UTM and UiTM attained full efficiency due to high weight allocated to research income (0.95, 1.00 and 0.93, respectively).

Table 4.4

EMS results of efficiency, weights and benchmarks of DEA2

		INPUT	OUTPUTS			BENCHMARKS	
DMU	Efficiency	OPExp	TotStE	ICPUB	RI	(referent peers)	(no. of emulating universities)
1. UM	100.00%	1	0.09	0.86	0.05	-	4
2. USM	100.00%	1	0	0.05	0.95	-	(none)
3. UKM	63.97%	1	0.27	0.58	0.15	UM, UTM	-
4. UPM	69.55%	1	0.3	0.52	0.18	UM, UTM	-
5. UTM	100.00%	1	0	0	1	-	3
6. UUM	91.80%	1	1	0	0	KUSTEM	-
7. UiAM	21.50%	1	0.96	0.01	0.03	UM, UTM, KUSTEM	-
8. UNIMAS	30.34%	1	0.59	0.41	0	UM, KUSTEM	-
9. UMS	47.73%	1	0.78	0.22	0	UM, KUSTEM	-
10. UPSI	52.29%	1	1	0	0	KUSTEM	-
11. UiTM	100.00%	1	0.07	0	0.93	-	(none)
12. KUSTEM	100.00%	1	0.9	0.06	0.04	-	8
13. KUIM	19.02%	1	1	0	0	KUSTEM	-
14. KUiTTHO	33.71%	1	1	0	0	KUSTEM	-
15. KUTKM	1.96%	1	1	0	0	KUSTEM	-
Average Efficiency Score	62.12%						

Definitions:

OPExp = Operating expenditure TotStE = Total Student Enrolments

ICPUB = Publication Counts RI = Research Income

The efficiency scores produced in each DEA model will determine the rank order of the universities. Universities with higher scores will command better ranking. This means that those universities with scores of 1.00 will be ranked at the top. The results of DEA2 demonstrate that some universities like USM, UTM, and UiTM, are very responsive to research income as the inclusion of research income to the model enabled them to gain maximum efficiency.

The inclusion of research income into the model, however, does not have significant effect to the group of inefficient universities. This is because the efficiency scores of UUM and the two middle ranking universities, UKM and UPM, remains the same when compared to scores of DEA1. Similarly, there are also no changes evident in the efficiency scores and weights allocation of seven inefficient universities (UNIMAS, UMS, UPSI, KUIM, KUiTTHO and KUTKUM) depicted by the results of DEA2. (UIAM only experienced a very minimal reduction of 1.42% in its efficiency score).

Whether or not the approved research income has an associated significance in improving efficiency of these universities (McMillan & Datta, 1998) should be dealt with considerable caution. This can possibly be revealed by the findings of DEA4 which is discussed in section 4.2.2.4. A change in rank order and rating produced by the two different models DEA1 and DEA2 has enlightened us to the fact that DEA allows a university to show itself in its 'best light'. This is because the inherent flexibility of weights enables a university to attach a high weight on a dimension it excels in, while at the same time attach a zero weight in weak areas (Tomkins & Greens, 1998). The case in point is UTM where it is 100% efficient by specializing in one area at the expense of the other output variables. This is regarded as one of DEA strengths because a DMU can still be seen as a hundred per cent efficient by doing well in at least one dimension as long as it does it more efficiently than any other university.

4.3.2.3. DEA3

DEA3 is aimed at examining the significance of dividing student enrolment numbers into two different mixes of graduates and undergraduates. The research outputs still remain as publication counts as well as research income. Table 4.5 presents the EMS results of model DEA3. When the results of DEA2 (Table 4.4) and DEA3 (Table 4.5) are compared, there is not much difference in the ranking and rating produced by both models.

Table 4.5

EMS results of efficiency, weights and benchmarks of DEA3

		INPUT	OUTPUTS				BENCHMARKS	
DMU	Efficiency	OPExp	StEPG	StUG	ICPUB	RI	(referent peers)	(no. of emulating universities)
1. UM	100.00%	1	0.32	0	0.63	0.04	-	6
2. USM	100.00%	1	0	0	0.06	0.94	-	(none)
3. UKM	64.54%	1	0.41	0.22	0.22	0.15	UM, UTM, KUSTEM	-
4. UPM	79.06%	1	0.71	0.14	0	0.16	UM, KUSTEM	-
5. UTM	100.00%	1	0	0	0	1	UKM	1
6. UUM	92.95%	1	0	1	0	0	KUSTEM	-
7. UiAM	29.74%	1	0.74	0.24	0	0.02	UM, KUSTEM	-
8. UNIMAS	31.63%	1	0	0.55	0.45	0	UM, KUSTEM	-
9. UMS	50.24%	1	0	0.77	0.23	0	UM, KUSTEM	-
10. UPSI	56.00%	1	0	1	0	0	KUSTEM	-
11. UiTM	100.00%	1	0	0.03	0	0.97	-	(none)
12. KUSTEM	100.00%	1	0.43	0.51	0	0.06	-	10
13. KUIM	20.60%	1	0	1	0	0	KUSTEM	-
14. KUiTTHO	35.67%	1	0.65	0.35	0	0	UM, KUSTEM	-
15. KUTKM	2.12%	1	0	1	0	0	KUSTEM	-
Average Efficiency Score	64.17%							

Definitions:

OPExp = Operating expenditure

StEPG = Graduate Student Enrolment StEUG = Undergraduate Student Enrolments

ICPUB = Publication Counts RI = Research Income

From Table 4.5, all the previous universities, UM, USM, UTM, UiTM, KUSTEM are consistently scored as efficient as in DEA2. Disaggregating the total number of student enrolments does not appear to have much impact on the efficiency scores. UTM and UiTM also maintain their highest rating contribution particularly from research funding as revealed in DEA2.

Although none of the high achievers has done significantly well in producing the total student numbers, notably, UUM which is rated 92.95% has assigned a weight of 1.00 to its number of undergraduate student enrolments showing its good performance in churning undergraduate enrolments even it is clearly indicates that UUM only specialize in only one area. As shown in Table 4.5, there are three inefficient universities, namely, UPSI, KUIM and KUTKM, who all specialize in producing undergraduate students just like UUM, by assigning a full weight of 1.00 to their number of undergraduate student enrolments.

In the case of UM, there are also some indicators that the number of graduate enrolments has some contributions towards UM's maximum efficiency rating, apart from publication counts. UM allocates a weight of 0.32 and 0.63 for its graduate enrolments and publication counts, respectively. Another interesting finding is that, both variables are found to be strongly correlated with a correlation of 0.902. These findings can be related to the study by Anthanassapoulos & Shale (1997) which states that the efficient universities produce far more successful postgraduates. This may suggest that both variables, graduate numbers and publication counts are the important contributing factors towards increasing universities' efficiency level.

4.3.2.4. DEA4

The final model specification attempts to examine the efficiency of universities research activities. DEA4 specifically assesses how efficient these universities are in producing research publications and obtaining fund. Table 4.6 presents the results of the efficiency evaluations using model DEA4.

Table 4.6

EMS results of efficiency, weights and benchmarks of DEA4

		INPUT	OUTPUTS		BENCHMARKS	
DMU	Efficiency	OPExp	ICPUB	RI	(referent peers)	(no. of emulating universities)
1. UM	100.00%	1	1	0	-	6
2. USM	100.00%	1	0.31	0.69	-	6
3. UKM	66.84%	1	0.54	0.46	UM, USM	-
4. UPM	72.10%	1	0.5	0.5	UM, UPSI	-
5. UTM	59.37%	1	0.12	0.88	USM, KUSTEM	-
6. UUM	7.22%	1	0.04	0.96	USM, KUSTEM	-
7. UiAM	5.58%	1	0.16	0.84	USM, KUSTEM	-
8. UNIMAS	19.86%	1	1	0	UM	-
9. UMS	18.94%	1	0.59	0.41	UM, USM	-
10. UPSI	7.25%	1	0	1	USM	-
11. UiTM	3.18%	1	0.32	0.68	UM, UPSI	-
12. KUSTEM	100.00%	1	0	1	-	6
13. KUIM	1.06%	1	1	0	UM	-
14. KUiTTHO	5.56%	1	0	1	KUSTEM	-
15. KUTKM	1.01%	1	0.06	0.94	USM, KUSTEM	-
Average Efficiency Score	37.80%					

Definitions:

OPExp = Operating expenditure

ICPUB = Publication Counts   RI = Research Income

From the results, it appears that UM, USM and KUSTEM remain at the top of the list for being highly efficient in producing research. Referring to these scores, a few findings can be deduced. First, UM and KUSTEM have consistently allocated high weights on publication counts and still achieves a full rating 100%, with or without the inclusion of research income (see DEA1). In the case of UM, one could actually relate this to UM's excellent performance in academic research activities over the past seven years (www.ippp.um.edu.my.)

The efficiency scores of all DEA models are summarized in Table 4.7. This table shows the efficiency scores of all 15 universities produced by the four DEA models employed in this study.

Table 4.7

DEA Efficiency Scores of 15 Malaysian Public Universities

University	DEA1 %	DEA2 %	DEA3 %	DEA4 %
UM	100.00	100.00	100.00	100.00
USM	69.26	100.00	100.00	100.00
UKM	61.38	63.97	64.54	66.84
UPM	66.76	69.55	79.06	72.10
UTM	66.80	100.00	100.00	59.37
UUM	91.80	91.80	92.95	7.22
UIAM	23.08	21.50	29.74	5.58
UNIMAS	30.34	30.34	31.63	19.86
UMS	47.73	47.73	50.24	18.94
UPSI	52.29	52.29	56.00	7.25
UITM	58.64	100.00	100.00	3.18
KUSTEM	100.00	100.00	100.00	100.00
KUIM	19.02	19.02	20.60	1.06
KUiTTHO	33.71	33.71	35.67	5.56
KUTKM	1.96	1.96	2.12	1.01
Mean Scores	54.87	62.20	64.20	37.80
No. of Efficient Units	2	5	5	3

The second finding is USM which is regarded as inefficient without the inclusion of research income (in DEA1) has become efficient with its inclusion. UTM and UiTM, that were fully efficient in the models, DEA2 and DEA3, have failed to achieve full efficiency when the evaluation is solely made on research performance. The only "close to efficient" university in DEA3, UUM also demonstrates the same findings. UUM score fell from 92.95% in DEA3 to 7.22% in DEA4. DEA4 reveals that UUM is designated as inefficient in terms of research when compared to the others, and compared to its performance in the previous three models. Thus, research output is an important area these universities must improve on to position themselves on the efficiency frontier.

In short, the summary efficiency scores of all DEA models presented Table 4.7, reveal that there are five universities that appear to be fully efficient. They are UM, USM, UTM, UiTM and KUSTEM, which achieved the maximum score of 100%. UM and KUSTEM score full efficiency rating in all four models. USM is deemed to be efficient in models DEA2, DEA3 and DEA4. While UiTM and UTM both appear to be fully efficient in DEA2 and DEA3.

For a university which is deemed to be fully-efficient in one model, it is crucial for it to be actually fully-efficient in all other models under study. This is to ensure that the university is an 'all-rounder'. Only then, will it be genuinely efficient and actually suitable to be used as a role model to be emulated by other universities.

An approach to look into the aspects of 'genuinely efficient' units can be attained by investigating three different aspects of efficiency. These three aspects are, the consistency of these universities in scoring full efficiency in all four models, the frequency of the fully-efficient universities used as benchmarks by the inefficient universities and finally, the robustness of the efficiency measurement of the fully efficient universities(Thanassoulis, 2001). These areas are discussed next.

Consistency in performance

To check on the efficiency scores of all 15 universities produced by the four DEA models employed in this study, Table 4.7 is referred. From this table it is obvious that UM and KUSTEM have consistently scored as the fully-efficient universities throughout all four DEA models. USM scored 100% in three models i.e. DEA2, DEA3 and DEA4. Results of models DEA2, DEA3 and DEA4 have clearly indicated that USM is heavily rated for its research income. However, USM only scores 69.26% in the basic model DEA1 when research income is not included as an output. UTM and UiTM achieve 100% in two models i.e. DEA2 and DEA3 that is only when these two universities have assigned high weights on research income.

Based on these findings, it can be concluded that UM and KUSTEM are consistent in their performance as the fully efficient universities.

Frequency of use as a benchmark

The findings of this simple analysis can be extracted from the number of benchmarks for all fully-efficient universities in DEA models DEA1 to DEA4 as summarized by Table 4.8 below. The benchmarks of the efficient universities will provide information on how many inefficient universities (as well as which universities, but, is not addressed here) should emulate them in order to be efficient.

Table 4.8

Benchmarks for the fully-efficient universities (DEA1-DEA4)

Pareto-efficient university	DEA1	DEA2	DEA3	DEA4
UM	7	4	6	6
USM	0	0	0	6
UTM	0	3	1	0
UiTM	0	0	0	0
KUSTEM	12	8	10	6

Table 4.8 reflects that both KUSTEM and UM are most frequently used as the benchmarks by the other inefficient universities. UTM and UiTM are rarely used as benchmarks by the other inefficient universities. Two implications can be derived from these findings. Firstly, it can enhance our confidence about the efficiency measure of the fully-efficient universities, that UM and KUSTEM are genuinely well performing universities because they outperform many other universities in all four models of this study. Secondly, UM and KUSTEM are likely to be the better models for the less efficient universities to emulate as their operating practices and environment are more closely matched to those other inefficient universities

Robustness of the efficiency measurement

Robustness of the efficiency scores indicates the extent to which the efficiency of these universities rely on a limited number of outputs (all models in this study have single-input) so as to achieve the maximum level of 100%. Or simply, this analysis examines whether a university allocated its entire weight for one dimension of output so as to be deemed as the most efficient. The analysis will be based on model DEA3 since this is the most comprehensive model. The EMS results from Table 4.5 are utilized to shed light on this analysis and the weights allocated to outputs are summarized in Table 4.9.

Table 4.9

The allocation of weights for outputs in DEA3

	University				
	UM	USM	UTM	UiTM	KUSTEM
Teaching Outputs					
Graduate enrolments	0.32	0.00	0.00	0.00	0.43
Undergraduate enrolments	0.00	0.00	0.00	0.03	0.51
Total	0.32	0.00	0.00	0.03	0.94
Research Outputs					
Publication Counts	0.63	0.06	0.00	0.00	0.00
Research Income	0.04	0.94	1.00	0.97	0.06
Total	0.67	1.00	1.00	0.97	0.06

This table clearly reflects USM, UTM and UiTM rely heavily on research output for it to be fully efficient as they assign a high weight for research outputs (1.0, 1.0 and 0.97, respectively).

These findings may suggest that the efficiency scores of USM, UTM, UiTM and KUSTEM, do not reflect their performance on inputs and outputs taken as a whole. USM, UTM and UiTM are good in research output (specifically, research income) but not in teaching output. On the other hand, KUSTEM's efficiency is due to its high reliance on teaching output (weight allocation of 0.94). USM, UTM, UiTM and KUSTEM which rely on a single dimension of outputs to be deemed efficient, cannot be said to have a very robust efficiency score.

Only one university seemed to be balanced in producing its 100% rating i.e. UM. UM has been evaluated on both teaching and research activities and is rated as fully efficient. Hence, the efficiency measurement of UM is generally robust.

Based on the above evidence, we can therefore, conclude that UM is a genuinely efficient university, or the best practice university because it is an "all-rounder" university.

4.4. Conclusion

In this chapter, we have looked into the application of an input-oriented, constant returns-to-scale version of EMS DEA program onto four DEA models, DEA1, DEA2, DEA3 and DEA4 as specified in Chapter 3. The results of these models are reported in Table 4.3 to Table 4.6. The DEA assessments consist of efficiency scores, weights (or virtual input and outputs) and benchmarks (or peer referents) for each university under evaluation.

The efficiency scores provide some information on the relative efficiency of each university, while weights or virtual outputs enshrines each university's best "areas of performance" because a university can actually attach a high weight on a dimension that it is good in, while attaching a zero weight in areas where it is weak in.

In general, the evaluation of the universities efficiency in this study has shed light on the performance levels for the universities under consideration. Four DEA models which have been presented produced fairly consistent results. UM and KUSTEM have been rated as fully efficient throughout all models. USM, UTM and UiTM come to the picture when research income is included as one of the research output. The efficiency measurements of all these fully efficient universities, (UM, KUSTEM, USM, UTM and UiTM) were examined further. From an analysis based on consistency of performance, the frequency of these universities being used as benchmarks by the inefficient universities, and the robustness of their efficiency measurements, we conclude that UM is an 'all-rounder" and the best practice university within the group of universities under study, and therefore it is "genuinely efficient".

Notably, the finding on UM is consistent with the analysis conducted by the Times Higher on the World University Ranking which ranked UM as the 89th World Top University for the year 2004 (THES, 2004). UM is the only Malaysian university to be ranked at the top 100 in this ranking. Although this efficiency study on the Malaysian public universities is based on the 2001 data, our findings actually support the findings of the Times Higher analysis. The method of assessment used by Times Higher is based on a few dimensions or elements hence, producing different ratings.

The elements of score for institutions under the Times Higher Study include the peer review, citations, faculty-to-student ratio and university's international orientation (The Times Higher, 2004). The Times Higher method is only using ratios and could be problematic because the universities can be good in one ratio but not the other. Evaluating the efficiency of a university based only on one single dimension would not portray the actual capability of university if it were to be highly rated. On the other hand, an assessment which is based on a few dimensions producing different ratings, tend not to be integrated, hence fail to provide a well-rounded view of overall performance (The OR Society, 2001).

DEA is a sophisticated method of measuring efficiency by aggregating multiple inputs and outputs to produce one single rating. The beauty of DEA also lies on the fact that the best practice university can be utilized as a role model as it provides a basis from which the inefficient universities can manage to improve their performance (The OR Society, 2001).

The potential areas of improvement and policy implications are to be addressed in the concluding chapter together with some recommendations for future DEA study measuring the efficiency levels of higher educations