AN EVALUATION OF RESOURCES EFFICIENCY IN UNIVERSITY MALAYSIA PAHANG USING DATA ENVELOPMENT ANALYSIS (DEA) METHOD

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Industrial Management with Honors.

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STUDENT'S DECLARATION

I hereby declare that the work in my thesis entitled "An Evaluation of Efficiency in University Malaysia Pahang Using Data Envelopment Analysis (DEA) Method" in my own except for cited in references. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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DEDICATION

I dedicated this research to my parents who support me all along. I also would like to dedicated this thesis to my late supervisor (Allahyarham Professor Razman Bin. Mat Tahar) who give me a lot of advice and suggestion while doing my Final Year Project 1. Also dedicated to my supervisor Final Year Project 2 Dr Cheng Jack Kie, who are put a full commitment and advice for courage me to finish my throughout work.

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ABSTRACT

This research study involves DEA in order to determine the performance level of 9 faculties in University Malaysia Pahang (UMP). The aim of the research is to estimate and analyse the efficiency in (UMP) for the academic year 2014. Using the number of students enrolled, number of lecturer and lecture room provided as inputs, and the total number of graduate student and a number of publication as outputs. Technical efficiency was used to estimate efficiency. And by using DEA it is possible to get a general execution measure performance through the examination of a gathering of decision units. Objective of this study is to identify the efficiency variable influencing faculty's performance and to evaluate the efficiency of faculties' performance using DEA. Recently, in many studies DEA method has been use to evaluate performance of university. The result showed that UMP faculty obtained average scale efficiency 0.86 and only three UMP faculties get the optimum size.

Key Words: Data Envelopment Analysis (DEA), Decision Making Unit (DMU), Efficiency.

ABSTRAK

Kajian ini melibatkan DEA untuk menentukan tahap prestasi 9 fakulti di Universiti Malaysia Pahang (UMP). Tujuan kajian ini adalah untuk menganggarkan dan menganalisis kecekapan dalam (UMP) bagi tahun akademik 2014. Dengan menggunakan bilangan pelajar yang mendaftar, bilangan pensyarah dan bilik kuliah yang disediakan sebagai input, dan jumlah pelajar siswazah dan beberapa penerbitan sebagai output. Kecekapan teknikal telah digunakan untuk menganggarkan kecekapan. Dan dengan menggunakan DEA ia adalah mungkin untuk mendapatkan prestasi langkah pelaksanaan umum melalui pemeriksaan perhimpunan unit keputusan. Objektif kajian ini adalah untuk mengenal pasti pembolehubah mempengaruhi prestasi kecekapan fakulti dan untuk menilai kecekapan prestasi fakulti menggunakan DEA. Baru-baru ini, dalam banyak kajian kaedah DEA telah digunakan untuk menilai prestasi universiti. Hasilnya menunjukkan bahawa UMP fakulti diperolehi purata skala kecekapan 0.86 dan hanya tiga fakulti UMP mendapat saiz yang optimum.

Kata Kunci: Data Envelopment Analysis (DEA), Unit Pengambilan Keputusan (DMU), Kecekapan.

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

University Malaysia Pahang (UMP) is a technical university established in 2002. The UMP offers various academic programs in Engineering and Technology. On research, the university focuses on applied research and industrial projects with local industry to enrich the teaching and learning activities as well as promote research product commercialization activities. UMP is committed to developing the human capital and technical resources to satisfy the demands of the industry and contribute to internal growth. The university has two campuses which are located at Gambang and Pekan, Pahang. In university campus Pekan, it comprises 3 faculties which are Faculty of manufacturing engineering (FKP), Faculty of electrical and electronic (FKEE) and Faculty of mechanical (FKM). In main campus of Gambang, it contains 5 faculties which are faculty of chemical engineering and natural resources (FKKSA), Faculty of civil engineering and natural resources (FKASA), Faculty of computer system and software engineering (FSKKP), Faculty of science and technology industry (FSTI), and faculty of Technology (FTECH). As in 2015, FTECH has split to two other new Faculties which is Faculty of engineering technology (FTEK) and Faculty of industrial management (FIM) has made it as 9 total of Faculty now in UMP. FTEK has offered various Engineering Technology and Safety & Health programs. FTEK is aiming at launching more Engineering Technology programs soon in a way to become one of the best world class Engineering Technology faculties. Teaching and learning in FTEK are nurtured through creativity and innovation and facilitated by academicians of high calibre.

Moreover, the establishment of the university, it has encountered an exceptional development in enrolment and a noteworthy extension of its staff and administrative .The quantity of male and female student enrolled at college during 2014 by the last year approached 7660 including undergraduate and postgraduate and number lecturer and staff got to well over 1000. At present the university envelops 9 faculties both for male and female student. This quick development University Malaysia Pahang should to be joined by rational exploitation of these possible outcomes in order to create the execution markers and minimizing wastage of human and material assets.

The aim of study is measuring the effectiveness of university units which is 9 faculty of UMP that represent DMUs. The effectiveness of the organization is important to determine how well the organization's resources are used, how well the outputs are obtained and how well processes are managed.

1.2 BACKGROUND OF STUDY

Higher education has become a vital mainstay of human development worldwide (BANK, 2002). University, as a major source of human capital, play important roles in a nation's growth and maturation. Faculties in this subject were measured using DEA method which is the best or for benchmarking purpose for faculty. This faculty of the university offers a wide range of subject areas and are mainly expected to demonstrate high character of the teaching provision. It was anticipated to provide high quality of educational activity and also have specialist research-oriented subject areas.

Secondly, to identify variable contributing to efficiency of faculty performance, the universities can support knowledge-driven economic growth strategies by a high expertise of lecturer to generating new knowledge and produce the calibre of student. The era and utilization of knowledge are progressively critical for improvement. The development and dissemination of technological innovations for the most part emerging from essential and connected examination embraced in universities, is thought to be the foundation of more prominent productivity. Higher skill levels in lecturer, together with subjective change that empower them to utilize new innovation, likewise help productivity in efficiency.

According to Reichert, as prime producers of knowledge, universities have gotten to be enter foundations in the learning based economy. According to Azman,

Sirat and Karim (2010), as somewhere else in the universe, the universities in Malaysia are the boss drivers of the knowledge economy and the primary makers of value human capital. Over the previous decade, the Malaysian government has put more prominent accentuation on enhancing efficiency and productivity in the advanced education segment as a motor for advancing quality human capital for a knowledge-based economy. This area has experienced some major changes, which have added to its fast extension.

The detail of this research study cover background of study, research objective, problem statement, research questions, scope of study, significant of study, expected result, summary and operational definition of measuring the efficiency of faculty performance in this sector. The remainder of this work provides a brief literature review and the methodology employed.

1.3 PROBLEM STATEMENT

Although on that point are numerous surveys have calculated the efficiency of universities in different states round the world using various parametric and non-parametric methods, especially in development economics like the United States (Kokkelenberg et al. 2008), the United Kingdom (Izadi et al. 2002, Flegg et al. 2004, Glass et al. 2006), Canada (McMillan and Chan 2006) and Australia (Abbott and Doucouliagos 2003, Worthington and Lee 2008) , Another group of papers has estimated the efficiency of departments within a university (Johnes and Johnes 1993, Tauer et al. 2007, Kao and Hung 2008) and of a given academic program across universities (Colbert et al. 2000). But there are a few or rare studies in Malaysia countries especial in Pahang, so this study is fulfilling this gap.

In any organization, there is a department or faculty which advance and slow. Same as in University Malaysia Pahang different faculty have different level of efficiency. Hence in this study, analyzing the most efficient faculty is essential to be the bench mark for the others. Sufficient number of expertise like lecturers will enhance the efficiency of the student performing valuable research. The great figure of student need lecturer as their references in subject. Hence, if the faculty cannot provide enough

lecturers to monitor and guide the students, the problems like student extend their semester or percentage of students graduated will be down.

1.4 RESEARCH OBJECTIVE

The aim of the study indent to meet the objective below:

- To identify the efficiency variable influencing faculties performance
- To evaluate the efficiency of faculties performance using DEA.

1.5 RESEARCH QUESTIONS

This inquiry is further directed by the research questions with the intent to acquire fuller understanding of the research based on the identified research objectives. The research questions which have been identified are as follows:

- What is the variable contributing to efficiency of faculty performance?
- Which faculty are most efficient?

1.6 METHOD OF ANALYSIS

DEA is a linear programming methodolgy to evaluate the efficiency of decision making units (DMUs) when the creation technique shows a structure of various inputs and outputs. It likewise spotted as an important scientific examination apparatus and practical decision support tools. DEA had been credit for not taking a complete detail of the useful type of the generation frontier nor the appropriation of wasteful deviation of frontier. Maybe, DEA requires general creation and dissemination supposition only. Thus, the measurement procedure for this research is by setting the relevant input and output of data. This method can be utilized by using training version of Basic CCR Model.

The objective of DEA is to measure the efficiency of resources utilization of decision making unit (DMU) relative to other similar DMU's within an establishment that receive by input and output. Efficiency is obtained by the maximum ratio of weighted output to weight input subject to the stipulation that the similar ratio for every DMU be less than or equal to one. Once relative efficiency values are received for each

DMU an efficiency frontier is settled, which become significant when preparing recommendation for the inefficient unit to turn efficient. The effective frontier is characterised by efficient unit and will enclose the inefficient unit, thus giving DEA its name. All point beside the efficient frontier represents a 100% relative efficiency (Charnes et al, 1978). It can be formulate as:

$$\text{efficiency} = \frac{\text{output}}{\text{input}}$$

Figure 1.1: The usual measure of efficiency

1.7 SCOPE OF STUDY

The point of this work is a contributing to efficiency of faculty performance and to assess the efficiency of those faculties using DEA. This work purported to examine which input for that decision making unit (DMU) like the number of students enrolled, number of lecturer, lecture room provided and that influence the performance towards their production which is number of graduate student and number of publication. The study is be broken down into university's faculty which is 9 faculty including Faculty of chemical engineering and natural resources (FKKSA), Faculty of civil engineering and natural resources (FKASA), Faculty of computer systems and software engineering (FSKKP), Faculty of science and technology industry (FSTI), Faculty of engineering technology (FTK), Faculty of industrial management (FIM), Faculty of manufacturing engineering (FKP), Faculty of electrical and elect ronic (FKEE) and Faculty of mechanical (FKM) in UMP, and a comparison is conducted between the DEA model results and the faculties' performance ratios and benchmarks, validating the use of the proposed DEA models for efficiency analysis in the faculty. Therefore, this study will help the faculty performance improvement.

Furthermore, it can be seen as a relative efficiency to focus on improving the competitiveness between the faculties in this university. The focus on the efficiency on this title is used the DEA method by using training version 3.0 of basic CCR model to see the efficiency of resources used for that current year.

1.8 SIGNIFICANT OF STUDY

The aim of this research will help readers to better understand about the efficiency of that chosen faculty regarding the Data Envelopment Analysis (DEA) method that use to evaluate it. It also provides detail information of the output through a number of graduate student and number of publication.

This research is important to evaluate and to promote with scale efficiency ranging from 0.98 to 1.0; the study was able to reason that the faculty under study is efficiency of faculty in reaching performance. As this search use DEA, the variable of efficiency will be detect at least one.

The proposed DEA model identifies the best practices of efficient faculty, and evaluates the faculty performing at the University. Moreover, the outcomes derived from the proposed efficiency score based on a DEA analysis and the faculty's own were compared to each other for validation. This study in performance measurement focuses on evaluating the current system and proposes of methodology to effectively address efficiency improvements, then comparing them to a benchmark that is desired by the management.

From this research, students can be clearer to understand this input, which is number of students enrolled, number of lecturer and lecture room provided for their satisfaction of the quality of the each faculty. It can produce a practical instrument that delivers the ability to first identify, and thereafter, evaluate opportunities, and providing a comparison to the faculty to evaluate how well them to be benchmarked.

1.9 EXPECTED RESULT

By the end of this project, this study will assist the administration of the associations with having the efficiency in each of the university's faculty. In addition, by deciding this matter, the association may have the capacity to distinguish component variable adding to efficiency of staff execution of those DMUs. This model comprises of 3 inputs which are students enrolled, number of lecturer, and lecture room provided and 2

outputs which is the number of student graduate and number of publication. The high expertise is expected to create a valuable research or large number of students is required to hold a great number of future products depending on management's desired benchmark set for university.

This study is utilizing Data Envelopment Analysis (DEA) Solver, which is fundamental CCR model to survey the efficiency of creating in the faculty performance. In conclusion, this knowledge would further prompt the collection of knowledge and be a helpful wellspring of data, including for future exploration including this topic.

1.10 OPERATIONAL DEFINITION

i) DATA ENVELOPMENT ANALYSIS

DEA is a nonparametric method in operations research and economics matters for the estimation of generation frontire. It is utilized to experimentally measure profitable effectiveness of decision making units (or DMUs). In spite of the fact that DEA has a strong connection to creation hypothesis in financial matters, the instrument is likewise utilized for benchmarking as a part of operations administration, where an arrangement of measures is chosen to benchmark the performance of assembling and administration operations. (Cooper, Seiford & Tone, 2007; Thanassoulis, 2001

ii) DECISION MAKING UNITS (DMU)

DMU is a significant in applying the DEA methods. Its definition in the higher education sector differs depending on the nature of the study. However, there are a number of significant studies on the higher education sector that have used department, research centers and program of studies as they DMUs. The rationale for this was to compare the characteristics of DMUs (Glass, Mc Callin, McKillop, Rasaratnam and stringer, 2006).

iii) EFFICIENCY

Efficiency here is characterized as the degree to which the observed utilization of assets to create output of giving quality matches the ideal employments of assets to produce output of a given quality.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will survey the relevant literature and the article and the past literatures that related to the proposed study that has been issued by the accredited scholar and researcher was are summarized. It also connected to this study such as the definition, the measurement of productivity, efficiency, decision making unit and data envelopment analysis (DEA) method used in this field and their advantage of DEA.

There are few efficient methods that researcher used nowadays like ratio analysis, Analytical Hierarchy Process (AHP), Queuing system and Data Envelopment analysis (DEA). Ratio analysis, means method for studying so as to look at the wellbeing of an organization the connections of key money related variables. It is utilized to assess different parts of an organization's working and monetary execution. Plus, AHP is a multi-criteria decision making tool which is widely applied to incorporate human judgment in quantitative evaluations. AHP is used to specify the user defined weights. While queuing system is a scientific strategy for delays of the waiting line. The queuing system inspects each segment of waiting in line to be dished out, including the landing operation, service operation, number of hosts, number of framework spots and the amount of clients. This study used DEA method as a modern approach in evaluating the efficiency since it is a powerful method among others.

By completing this research, it is not only the education industry can get clear of DEA method that was the use of measuring this problem, but also other industry such as healthcare industry, hospitality industry, dental services, police, food industry, manufacturing industry and banking sector. It also provides a practical guide to developing and refining a DEA model ad interpreting of results.

2.2 EFFICIENCY

The efficiency and productivity of university division assume significant parts in the furtherance and maturation of a country, both as major sources of human capital and as a principle driver of the learning economy. During recent decades, the Malaysian government has a set greater emphasis on productivity change in the public higher education part as a method for advancing the improvement of value human capital. This area has experienced some key changes which have prompted its fast extension. The use of the NHESP (National Higher Education Strategic Plan) in 2007 was the most critical policy change here. This essential policy concentrates on the government's motivation to transform Malaysia into a major provincial canter for higher training. In spite of the allotment of an extensive volume of subsidizing into the part, there has been no observational study to show how public colleges have performed either before or after this policy change.

The efficiency of faculty performance are divided by three which teaching efficiency, research efficiency and management efficiency. Firstly, the argument in the showing productivity model is that colleges utilize academic staffs to teach the student enrolled to deliver graduates with a sure level of quality. In this way, showing teaching efficiency is refer to the showing execution of colleges in exhibiting learning to undergrad taught course understudies. The nature of understudies is taken as an information in view of a general presumption that better passage capabilities will create better quality items, for this situation, the graduates. The deciding results of showing exercises are focused on graduates. Graduates' outcomes and graduation rate of a college are connected with the academic caliber of graduates; while graduates' job rate is mirroring the businesses' recognition on the on the caliber of graduates from a particular university. (Chuen Tse Kuah & Kuan Yew Wong, 2011)

Moveover, according to Chuen Tse Kuah & Kuan Yew Wong, 2011, in the research efficiency model is that universities utilize research staffs and register research student to deliver research outputs, in particular productions, prizes, and reasonable properties. Normal research staffs' capability is figured in view of a proposed reviewing framework. Various research understudy graduates are likewise considered as an output

in this model. A few studies considered research awards as an output in light of the conflict that they are the results of research execution. This infers if the research performance of a college is better, more subsidizes will be drawn. Interestingly, in this subject, research grants are dealt with as an asset for research activities, thusly they are viewed as an output.

It ought to be watched that university use is a mutual asset for both showing and research exercises, and along these lines in assessing guideline and research efficiencies, the proportion of the consumptions for both capacities should be seen. Indeed, even along these lines, it is regularly hard, if not outlandish, for a university to quantify or learn the measurement of its consumptions for research and direction exercises. In this way, joint DEA amplification (J. Beasley, 1995) has been utilized to allocate the consumptions between the two capacities and deciding the general efficiency, showing efficiency, and research efficiency.

Thus, efficiency management from those faculties itself when they are easily formed. It can be said if they are afforded to give a facility to the student, the good system and very good in communication towards their staff and others. Since this university has received a large number of students registered in each faculty per year, the university needs to fulfil their purpose of management efficiency. Moreover, when the faculty management is well efficient, the problem like student needs to share same lecture and laboratory rooms even they are from different faculty can be avoided. To develop a great product, the university needs to provide good facilities for all students. With a conducive lecture room, students will be more focus on study, hence reducing the number of students extend. Number of student graduation per year is the productivity of the faculty. The accessibility of this efficiency, it shows that, these universities continuously monitor and judge their public presentation and achievement all time.

As we know, DEA is used to calculate efficiency when there are many input and output and there are no generally acceptable weights for aggregating inputs and outputs. In the case of one input and one output, the output-input ratio reveals efficiency (Mcmillan & Datta, 1998). Different theoretical expansions have been created, in light of the first CCR model: Banker et al. (1984) added to a variable return to-scale variety; the multiplicative model was created by Charnes et al. (1978) in which the information

are changed utilizing a logarithmic structure; Charnes et al. (1978) built up the added substance variety in which the target capacity contains slack variable alone.

DEA is especially fitting when the researcher is occupied with exploring the efficiency of changing over various inputs into numerous outputs. For instance, DEA can distinguish elective design of inputs that can bring about higher outputs without essentially raising the overall use of resources. DEA is a linear programming technique that empowers administration to benchmark the best practice DMU, i.e. a university. Further, DEA gives evaluations of potential change of wasteful DMUs (Avkiran, 2001).

There are a lot of types of efficiency such as economic efficiency, scale efficiency and technical efficiency. DEA used in this paper for type of efficiency is technical efficiency. As a specialized examination, DEA is relative. From the arrangement of DMUs investigate, it decides a efficient gathering. Regardless it may be conceivable, however to enhance the specialized efficiency of even those effective units were the best generation probability known. Be that as it may, the real generation capacity is not known and none is accepted. The effective units in DEA are the most efficient of those watched, not in correlation to some perfect. In this way, the DEA efficient gathering is that subset showing the "best practice" among a gathering of working units. Insufficient DMUs are contrasted with those units exhibiting high-ranking performance (Mcmillan, & Datta, 1998).

As an efficient frontier technique, DEA identifies the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient, rather than trying to associate a DMU’s performance with statistical averages that may not applicable to that DMU(Avkiran, 2001).

Moreover, technical efficiency is an organization that can't deliver more output from its current inputs. On account of university, this implies the in fact efficiency university is not ready to convey all the more educating in addition to research output without decreasing quality given its current work, capital and other inputs. Technical efficiency is a rational performance measure, as the procurement of training and research by university at a given level of value, inside of asset requirements is a prime target of university. A few researcher contend that, alongside the conveyance of education training, technical efficiency is presumably the main legitimate measure of

performance of tertiary establishments (Pestieau and Tulkens, 1993). A university may be actually effective yet it may in any case be creating too little or a lot of output.

DEA is set of non-parametric programming technique that help with recognizing which set of decision making units may be considered as best practice. Best practice units are given a rating of one and efficiency scores are allocate to different units by contrasting them with best practice units for a full talk on DEA as indicated by Coelli, Prasad Rao, and Battese, 1998; Fare, Grosskopf, and Knox Lovell, 1985; Knox Lovell and Schmidt, 1988. The arrangement of units to be broke down should to be picked with some alert so that rational comparison can be made. DEA is a standout amongst the most widely recognized techniques utilized as a part of the investigation of efficiency of government associations. The fundamental different option for DEA is the utilization of stochastic creation or stochastic expense frontiers taking into account Coelli et al., 1998. Since it is a non-parametric technique, DEA has the point of preference, over the stochastic frontier methodology, of keeping away from the need to make suppositions with respect to the utilitarian type of the best practice frontier (e.g. Cobb-Douglas or translog), and maintaining a strategic distance from the need to make distributional suppositions with respect to the residuals in the regration analysis. DEA can likewise readily fuse various outputs and be utilized to ascertain technical utilizing just data on output and input amounts.

2.3 DECISION MAKING UNIT (DMU)

Cooper, Seiford & Tone, 2007; Thanassoulis, 2001, Data Envelopment Analysis (DEA) is linear programming system that is especially valuable for evaluating similar execution between a few homogeneous substances, termed as Decision Making Units, DMUs. Each DMU, in the current setting is university being assessed, expends the same arrangement of assets to deliver a similar arrangement of yields. This highlight empowers distinguishing proof of practical change focuses for failing to meet University Expectations essentially taking into account the particular performance of faculty distinguished as good.

According to Thanassoulis, 2001, to evaluate execution level, DEA produces non-parametric outskirts as a kind of perspective for best practice and a faculty's effectiveness score is judged as far as its separation from that Effective frontier (EF). EF

contributes all watched input-output blend portrays the best practice since it is comprised of effective colleges that exhibit most astounding achievable output levels for mix of assets at present accessible. Here, the fascinating part of the performance concerns the faculty's capacity to efficiently change over inputs into instructing also, research related outputs.

For case, the clinics, gathering practices, and different offices that are assessed for execution utilizing DEA are considered as DMUs by numerous famous DEA software. In this study, the DMU that are used is 8 faculty in University Malaysia Pahang which is Fcaulty of chemical engineering and natural resources (FKKSA), Faculty of civil engineering and natural resources (FKASA), Faculty of computer system and software engineering (FSKKP), Faculty of science and technology industry (FSTI), Faculty of technology (FTECH), Faculty of Industrial management (FIM), Faculty of manufacturing engineering (FKP), Faculty of electrical and electronic (FKEE), and Faculty of mechanical (FKM).
Expect there are n DMUs: DMUi, DMU2,..., and DMU,,. Some common input and output items for each of these j = l,..., n DMUs are selected as follows:

1. Numerical data are usable for each input and output, with the data supposed to be positive for all DMUs.
2. The focuses (inputs, outputs and choice of DMUs) should reflect an analyst's or a researcher's interest in the components that will insert into the relative efficiency judgement of the DMUs.
3. In guideline, little input amounts are ideal, and bigger output amounts are preferable so the efficiency scores should reflect these standard.
4. The estimation units of the diverse inputs and end products need not be congruent. Some may require a number of souls, or fields of floor space, money spent, etc.

The input data matrix X and the output data matrix Y can be set out as follows where X is an (m x n) matrix and F an (s x n) matrix.

$$X = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{pmatrix}$$

$$Y = \begin{pmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ y_{s1} & y_{s2} & \cdots & y_{sn} \end{pmatrix}$$

Figure 2.1 Sources: Charnes, Cooper and Rhodes, 1978

Hence, in linear program used will have the weights as the decision variables and they are determined in a way such that it gives each DMU the highest efficiency score. The variable which is an input, output oriented, in this study shows when it's run in software, it will depend on the number of DMUs because each DMU is compared to the rest of the DMU in one formulation to see how efficient it is compared to the others. An input oriented model will receive an objective function which will get a value of 1.0 if a DMU is efficient. The nearer the value is to 1.0 the more efficient the DMU. An output oriented linear program will experience its opposite logic and hence the more depressed the value of the objective functions, the more efficient the DMU will be.

This is related to input reduction and output augmentation. The desired result for a DMU will be a means to reduce its inputs to produce more production. This is the methodology used by the DEA. Hence an advantage comes out of this method. The most efficient DMU can serve every bit a "benchmark" for improvements. Regression analysis does not exclude the efficient from the inefficient when providing suggestions for betterment. DEA measures performances relative to all the other DMUs.

2.4 DATA ENVELOPMENT ANALYSIS (DEA)

Data Envelopment Analysis (DEA) is a powerful method and benchmarking technique initially created by Chames, Cooper and Rhodes (1978) to assess non-benefit and public sector associations. DEA has subsequent to been experimented with to find

approaches to enhance administration not noticeable with different proficiencies. Yet there is an oddity encompassing this advancement system. Each administration association can profit by DEA in distinctive ways and DEA can be obliged to enhance administration profitability. Expanded use by administration chiefs will recognize new qualities and advantages that can be gotten from DEA alongside crevices and failings. The last can go down the plan for future examination on adjusting DEA and will recognize areas where this procedure is improper and ineffectual, leaving executives to recognize these sorts of utilizations of DEA.

Linear programming is the fundamental method that makes the DEA especially powerful contrasted and option profitability administration instruments. DEA has been broadly read, rehearsed and analyse by employees that comprehend linear programming. Supervisors have not broadly embraced DEA to improve organizational performance, in part, because most DEA publications are in academic journals or books requiring the ability to understand linear programming and supporting numerical documentation. Actually, a few chiefs attempting to utilize DEA taking into account their comprehension of scholarly distributions have misconstrued the heading to apply DEA. They credit to week results to the technique when the inconvenience is every now and again because of the misapplication of DEA. This part clarifies what the DEA does, how DEA assesses efficiency, how DEA recognizes ways to better efficiency, limitation of DEA, and how to utilize DEA. This will empower administrators to examine and assess the benefit of utilizing DEA as a part of their administration operations.

According to Springer, 2006. What does DEA do?

- DEA contrast about service units considering all resources utilize and services provided, and pick out the most efficient units or best practice units (branches, departments, individuals) and the inefficient units in which real efficiency enhancement are possible. To put it plainly, DEA is a very powerful benchmarking technique.
- DEA compute the sum and type of expense and resource savings that can be accomplished by making each inefficient unit as the most efficient.
- DEA compute the measure of extra service an inefficient unit can provide without the need to utilized extra resources.

- Management get data about performance of service units that can be utilized to exchange framework and managerial expertise from better-managed, relatively efficient units to the inefficient ones. This has brought about enhancing the efficiency of the wasteful units, diminishing working expenses and expanding benefit.

The above four sorts of DEA data demonstrate to a great degree important on the grounds that they recognize connections, not identifiable with option techniques that are normally connected in administration frameworks. Thus, upgrades to operations broaden past any performance enhancements administration may have achieved utilizing different technique.

The analysis compares the relative efficiency of organizational units of the faculty in University Malaysia Pahang in Malaysia where units perform same tasks. These units utilize similar resources, referred to as inputs, to generate same outputs in which this work points to find out which faculty is the most efficient among others. For instance, each faculty has inputs of number of student, number of staff and lecture room provided that has the outputs of a number of student graduations per year and number of research. But, there can be considerable differences in the way in which each faculty combines inputs to produce outputs.

2.5 ADVANTAGE OF DEA

DEA can deal with numerous data and different output models. In this manner, DEA is utilized to figure the relative efficiencies of various choice making units (DMUs), in these study case faculty, in view of different inputs and outputs. DEA distinguishes conceivable companions as good examples who have an efficiency of 1 and sets change focuses for them. By giving change targets, DEA goes about as vital device for benchmarking. Possible sources of inefficiency can be determined using DEA.

According to Savitri Narayanan 2009, DEA has numerous focal points why it has been a well-known strategy for assessing efficiencies, they have been separated under:

- The most powerful method
- Easy to use and more understand
- Allow multiple input and multiple output
- Inputs and outputs can take in different units of measure.
- It can calculate the sources and the extent of inefficiency in inputs and outputs
- It can use benchmarking techniques to use the efficient units as a benchmark to evaluate inefficient units

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

The proposed method is explained with its methodology in this chapter. Assumption will be started clearly then followed by the DEA analytical framework that is formed. The DEA software will be clarified by this method of DMUs of input and output. Faculty organization was presented by means of an input-output model whereby each faculty uses quantities of inputs to generate outputs in the form of quality. Despite the challenges in conceptualizing faculty regarding an input-output display, the strategy suggested here can be utilized to benchmark which faculty best practices by studying at the input-output amounts and the creation size of the productivity of faculty as distinguished by the beneficial efficiency scores, the data inferred can be applied to enhance the performance of faculty efficiency.

Likewise, it is an apparatus for university choices in regards to its role of DEA and accordingly, it is a pace towards the benchmarking of faculty relative performance and it is efficiency. The answers can be known clearly on their factor contributing to efficiency of faculty and this method that affect their functioning. Research design, data collection method and basic CCR model are included in this chapter.

3.2 RESEARCH DESIGN

All organization needs to start the research with a background on their sector. From this research, the educational sector is chosen. Research design is a process to establish a framework and planning to conduct the research from the beginning steps of the research until the final stage of this field. Moreover, it will elaborate more on DEA design, how to gather data and then analyse the outcome. Research designs are made more us more understanding because it figures out over all of research so that it will do smoothly. Hence, through this research design this study will able to understand if the faculty hold the slack that are occurring when the research are done.

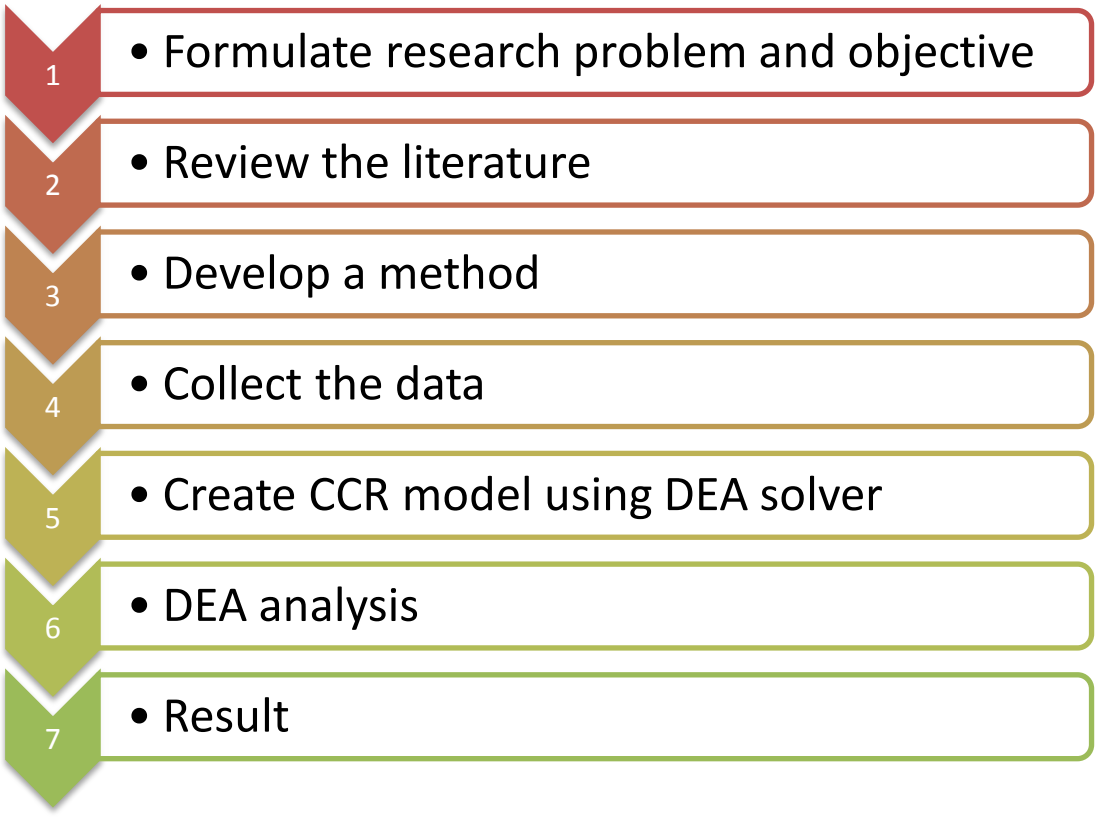

Figure 3.1: The flow of the research design

Step 1: Formulate the research problem and research objective

For the beginning footstep of the research on faculty efficiency is defined on what is the problem that the organization was faced which affects the efficiency of management of

the system. From that problem, research objective can be developed in the research design.

Step 2: Review the literature

Then, the researches continue with the review of literature. It is a process of study the previous research which is related to the research objective. The literature material can be journal, newspaper, articles, book and any other stuff that will present information.

Step 3: Develop a method

Afterwards that, this research needs to infer the entire problem and the objective of the research. When understand, the designers are making and the suitable method is developed. Important to select the suitable method in the research subject because the correct method can pass the most accuracy answer to the research objective. The subject may become a good research and will not give benefit to be studied by others. Hence, CCR method is the most desirable and suitable method.

Step 4: Collect the data

In the following step, data collection is needed to continue with the research. This is because the data give accurate and valid information that can be used to evaluate and analyse the efficiency of faculty. Data collection is the most important because it is the key for every research. The type of data is referring method and how to run the method. For DEA method, the decision making units (DMUs) are really important to get the right inputs and outputs. The inputs consist of a number of staff, number of student and lecture room provided while the output is the number of bachelor's degree and number of research. The inputs and outputs must be logic because it affects the efficiency rate.

Step 5: Create CCR model using DEA solver

After we get the data from the organization, the date of the inputs and outputs can be put into the DEA solver which is training version of CCR model to create faculty model. Choosing the correct method in the DEA software is important which can compute the efficiency in a particular year. So, we can produce the correct outcome for the efficiency of faculty.

Step 6: DEA analysis

DEA analysis is an analysis to evaluate and analyse the model to be more efficient and identify variable contributing to of faculty performance. After using the DEA efficiency model and get the result analysis, we were able to address some of the characteristics around specific faculty issues.

Step 7: Result of the study

After that, the outcome of all models that produced using the CCR model need to quantify its performance. From the outcome, we will get efficiency of the faculty that gives higher efficiency.

3.3 METHOD OF DATA COLLECTION

Data collection is the cognitive operation of gathering and evaluating data on constituent of interest like faculty to answer stated research questions, test theories, and measure results. Data collection method is an important aspect during doing a research. The data collection component of research is common for all fields of study especially input and output of an organization. The precision of the data choice is critical to catch the nature of proof that can be changed into rich data investigation which can be utilized to answer the exploration questions. It is significant to maintain data integrity and accuracy which can support the detection of errors in the data collection process. The data must be evaluated before implementing it. Data can be split up into two categories which are qualitative and quantitative. But in this study, we use quantitative data. This study will undergo visited at (BPA) and faculty to collect of inputs and outputs by recorded data. These collections of data will be collected using the secondary data.

3.4 SELECTION INPUT AND OUTPUT

In education, it is hard to utilize market instrument, for example, benefits to decide the performance of DMU. A key point of preference of DEA is that instructive directors or their selected scientists can pick inputs and outputs to speak to a specific viewpoint or methodology. For instance the key business drivers basic to achievement of the hierarchical can be the outputs. At that point those variables that can be argue to show themselves as outputs turn into the inputs (Avkiran, 2001).

In the DEA approach, the number of input and output is always tightened up by the number of DMUs in the sample. The capability of DEA in differentiating between efficient and inefficient universities depends on the number of input and output included in the DEA model. For this reason, there is a need for the number of input and output to be smaller than the number of DMUs in the sample (Avkiran, 2011).

As a guideline, Sinuany-Stern, Mehrez and Barboy (1990) suggested that the total of the number of input and output must be no more than one-third of the sample. In addition, McMillan and Datta (1998) advise that it is enlightened to keep the quantity of variables less than one-third of the number of observations. Even so, the limitation on the variables included may also produce understated relative efficiency assessment.
Hence, for this subject, three inputs and two outputs of DMUs are used consisting of:

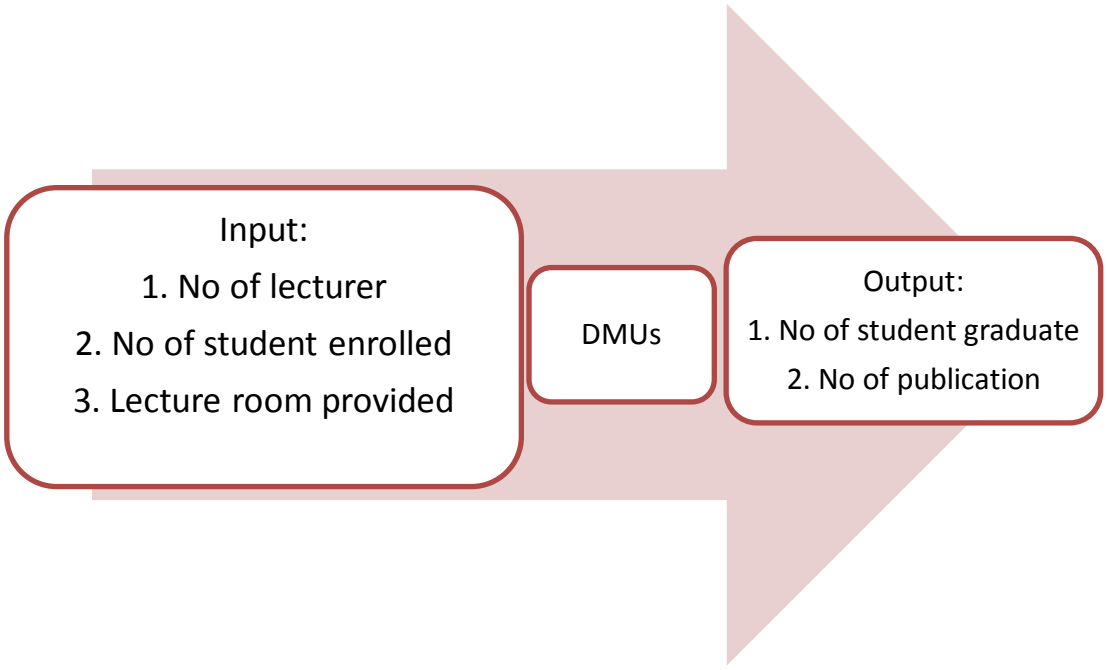

Figure 3.2: PROCESS FLOW

This analysis is the situation analysis for 2014/2015, because data refer to that current year. Moreover, data in the study obtained from the Academic and International Affair (BPA) and certain form faculty of this university. At the point when all outputs and inputs are incorporated into the efficiency measure it is called absolute productivity. Outputs and inputs are characterized in the aggregate productivity measure as their qualities. It is a measure of aggregate efficiency of a creation process and accordingly

the goal to be expanded in the production process. In this study, the inputs and outputs were chosen based on the previous chapter.

3.5 MANUAL CALCULATION OF DEA

Calculation of efficiency is done for the weighted cost approach of faculty performance. This involves calculating the weighted sum of input and dividing the weighted sum of output and input. The input and output data is being normalized with respect to the maximum value of the factors entered by the user.

DEA is a linear programming based technique for measuring the relative performance of DMUs where the present of various inputs and outputs makes comparison difficult. DEA gives a method for apparent efficiency levels inside of a gathering of DMUs. The efficiency of a DMU is figured with calculated relative to the group's observed best practice.

Efficiency = input/ output

When there are multiple inputs and multiple outputs, a common measure for relative efficiency is,

Efficiency = Weighted Sum of Outputs / Weighted Sum of inputs

Each DMU picks weights such that it amplifies its own particular efficiency, subject to limitations that ensure:

- No unit cannot have efficiency score greater than 1
- Weight must be strictly >0.

Let us assume there are *n* DMUs, each DMU has *t* outputs and *m* inputs. Let us take DMU_1 as the example, the output orientated DEA model is:

[Output Orientated DEA model]:

Output to input ratio (1):

$$\max h_0(u, v) = \frac{\sum_k u_k y_{ko}}{\sum_i v_i x_{io}}$$

$$subject\ to\ \frac{\sum_k u_k y_{kj}}{\sum_i v_i x_{ij}} \leq 1\ for\ j = 1, \dots, n,$$

$$u_k, v_i \geq 0 \text{ for all } i \text{ and } k.$$

Where:

μ_k, v_i - *weights given to output k and input i respectively;*

x_{io} – *amount of input i consumed by DMU o ;*

y_{ko} – *amount of output k produced by DMU o ;*

o – marks DMU being evaluated.

Cooper et al (2011) explains that this ratio form generalizes engineering science definition of efficiency from a single output to single input and does so without the use of preset weights. Ratio of weighted output to weighted input prompts that the model is input oriented. At the same time the efficiencies of all the units in the set when evaluated with these weights are prevented from exceeding a value of 1. It is also needed to be notified that model (1) has an infinite number of solutions; if (u*, v*) is optimal, then (αu*, αv*) is also optimal for all α > 0. To obtain a model that would select a single solution a transformation had to be made. The transformation that was developed by Charnes and Cooper (1962) for linear fractional programming selects a solution (i.e., solution (u, v) for which $\sum_{i=1}^{m} v_i x_{io}$) and yields the equivalent linear programming in which the shift from variables (u, v) to (μ, v) is a result of the "Charnes – Cooper" transformation (Cooper et al, 2011).

3.6 BASIC CCR MODEL

Basic CCR model is the training version in DEA solver. DEA measured the near efficiency of DMUs. It wraps the perception data to name the best-practice DMU's area, and after that uses the frontier to calculate productivity record measures for each DMU. The DEA model was originally developed by Charnes, Cooper and Rhondes (1978),

and is recognized as the CCR model. It identifies the efficiency for any DMU by maximizing the ratio of weighted outputs to weighted input, subject to the stipulation that the corresponding ratios for every DMU be less than or equal to one. As a resolution, efficient DMUs are identified by having a ratio equal to one and inefficient DMU are identified by having a ratio less than one or less.

The most commonly applied DEA models in empirical studies are the CCR model and the Banker, Charnes and Cooper (BCC) model developed in 1984. BCC model was subsequently carried into the CCR model by including an additional convexity constraint. During the process of enveloping the observation data in the CCR model, the shaped of the piecewise surface is limited. Standing out from the CCR model, BCC models applies variable of the Return to Scale condition (augmentation, decrement, or sconstant to scale) in distinguishing the figure of a piecewise-surface. Furthermore, this present BCC's model (Banker et al (1984)) accepted variable output concerning the scale. In the model, the technical efficiency is decayed to immaculate technical efficiency and scaled efficiency keeping in mind the end goal to gauge the output to scale and also efficiency itself.

As indicated by Boussofiane et al (1991) stipulate that to get good discriminatory power out of the CCR and BCC models the lower bound on the quantity of DMUs ought to be the different of the quantity of the inputs and the figure of the end product. This thinking is gotten from the issues that there is adaptability in the determination of weights to allocate to data and output values in deciding the efficiency of each DMU. That is, in attempting to be proficient at DMU can dole out the greater part of its weight to a solitary data or output. The DMU that has a particular proportion of an output to an input as highest will assign all its weight to those specific inputs and end products to appear effective. The quantity of such possible inputs is the result of the quantity of inputs and the quantity of outputs. Case in point, if there are three inputs and 4 outputs the base aggregate number of DMUs should to be 12 for some discriminatory power to subsist in the mannequin. Hence, since this study comprise of five inputs and two outputs, the base aggregate number of DMUs should to be ten for some discriminatory power to exist in this model.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter will provide and organize data analysis and result summary of the data collection from all faculties in UMP. DEA is helpful in distinguishing the best performing units to be benchmarked and in addition in giving noteworthy measure to change of faculty performance. Through data analysis, the most efficient faculty in UMP can be determined and hence can be benchmark for others faculties in UMP. Software named DEA solver with training version 3.0 of CCR is used to help in analyse the data. So, this chapter the method from input to output produces from DEA solver will be shown. Then, the findings will be presented in the form of graph, table and explanation.

A process model is constructed according to recent year which is 2014/2015 using DEA solver. In this chapter, it will show how the model is being used. Next, the inefficient DMU will be appearing. The result of each DMU will be analysed and compared between them in order to know the best efficient of DMU.

4.2 DATA FINDINGS (INPUT/OUTPUT)

Based on this study, DEA method had the data collection of inputs and outputs that was taken from all faculties in UMP including IPS for total number of publication. In this study, secondary data is the technique used to get the data from the faculties by

recorded data. The data and information was obtained will be analyse by using the Input of CCR-I in the DEA Software. The function of the CCR model is to estimate the efficiency of the DMUs recent year.

The efficiency of the faculty's performance can be seen based on their academic performance. If the academic is good, indirectly the faculty achievement is high because all selection uses same of variable input and output. The sample variable had selected based on the previous research which the input are number of lecturer, number of student enrolled specific for fourth year, number of lecture room while output are number of graduate student and number of publication . The data was collected using the secondary data on the session 2014/2015. Table 4.1 shows the faculty's data finding of input and output in the efficiency analysis. The number of input and output must be matched in order to achieve the efficiency.

Table 4.1: The data of each faculty

Faculty	No of Lecturer	No of student enrolled	No of lecture room	No of student graduate	No of publication
FK4ASA	58	380	17	369	7
FKKSA	106	411	30	392	65
FSKKP	71	320	30	316	43
FTEK	54	75	30	200	8
FIM	39	215	8	207	41
FSTI	40	163	25	152	30
FKP	46	122	49	115	10
FKM	91	314	45	300	28
FKEE	79	295	48	284	11

The selection of Decision Making Unit (DMU) is based on rules of thumb. According to Boussofiane et al (1991) stipulate that to have good discriminatory power of the CCR and BCC models the lower bound on the quantity of DMUs needs to be many of the quantity of the inputs and number of output. Hence, this research should have minimum of 3 DMU in order to achieve rule of thumbs of DEA.

4.3 MODEL DEVELOPMENT

CCR model will be used in creating model development using DEA solver in step number five in previous study chapter 3. After get the data from all the faculties, the date of the inputs and outputs can be put into the DEA solver which is training version of CCR model to create faculty model. The choosing of the suitable inputs of data is very important because it affect the outputs. Choosing the correct method in the DEA software is important which can compute the efficiency in a particular year. So, we can produce the correct outcome for the efficiency of faculty. The data must be accuracy to capture the quality of the evidence which can be used to answer the research question and significant for the result.

Firstmake an Excel document containing the data sheet as showed in Table 4.2 where (I) and (O) demonstrate Input and Output, individually.

Table 4.2: Excel File "DEA data"

Faculty	(I)No. of Lecturer	(I) No. of Student enrolled	(I) Lecture room provided	(O) No. of graduate student	(O) No. of publication
FKASA	58	380	17	369	7
FKKSA	106	411	30	392	65
FSKKP	71	320	30	316	43
FTEK	54	75	30	200	8
FIM	39	215	8	207	41
FSTI	40	163	25	152	30
FKP	46	122	49	115	10
FKM	91	314	45	300	28
FKEE	79	295	48	284	11

This study was using DEA Solver Training Version software to interpret the data. Since the DEA is a powerful method which is most suitable to be used to calculate

the efficiency of the DMUs. The understanding and interpreting of this software is very important because it may cause the data result.

Figure 4.1: Learning Version for DEA Solver

Model selection is the crucial step because the selection of the correct model will affect the result. There are several options which model option to use such as CCR, BCC, RTS and window analysis. In the research, the CCR model is select to measure the efficiency of DMUs of faculties because it can estimate the efficiency over a year. Then CCR-I must be choose before proceed with the next step. Hence, we can get the right result for the efficiency of the faculties in the organization.

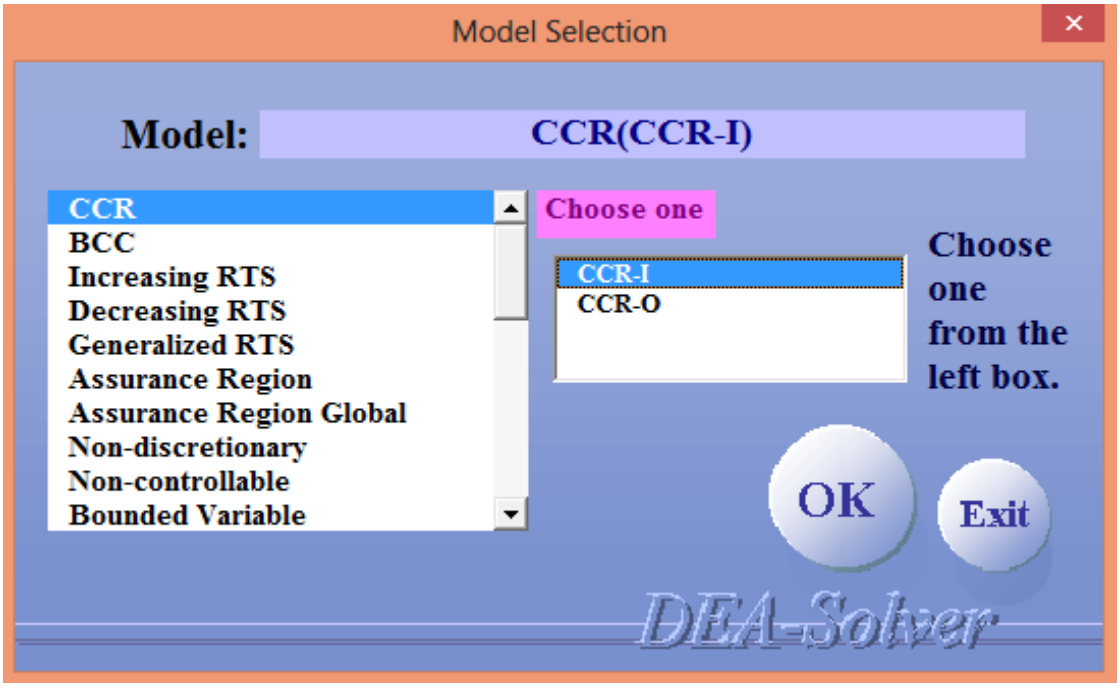

Figure 4.2: Selection of CCR Model

When all the data and the information have, the data of the inputs and outputs can be put into the DEA software to create a model. The CCR-I model will proceed with the data file selection which the data was already was saving in Excel sheet before using Excel DialogBox to open up data file in Excel sheets.

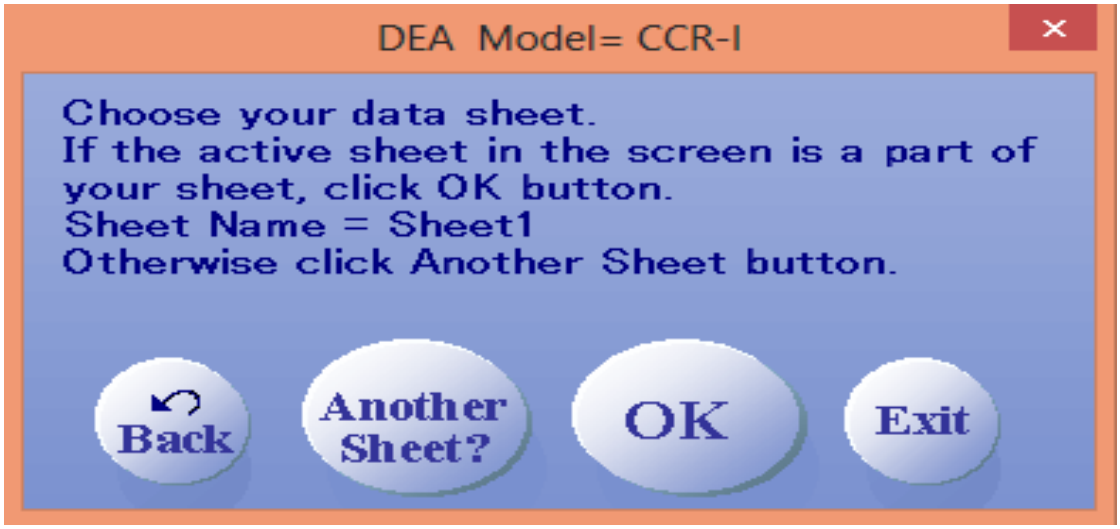

Figure 4.3: CCR-I

The Excel sheet that was choose must be save again for results of DEA computation with different name excel sheet.

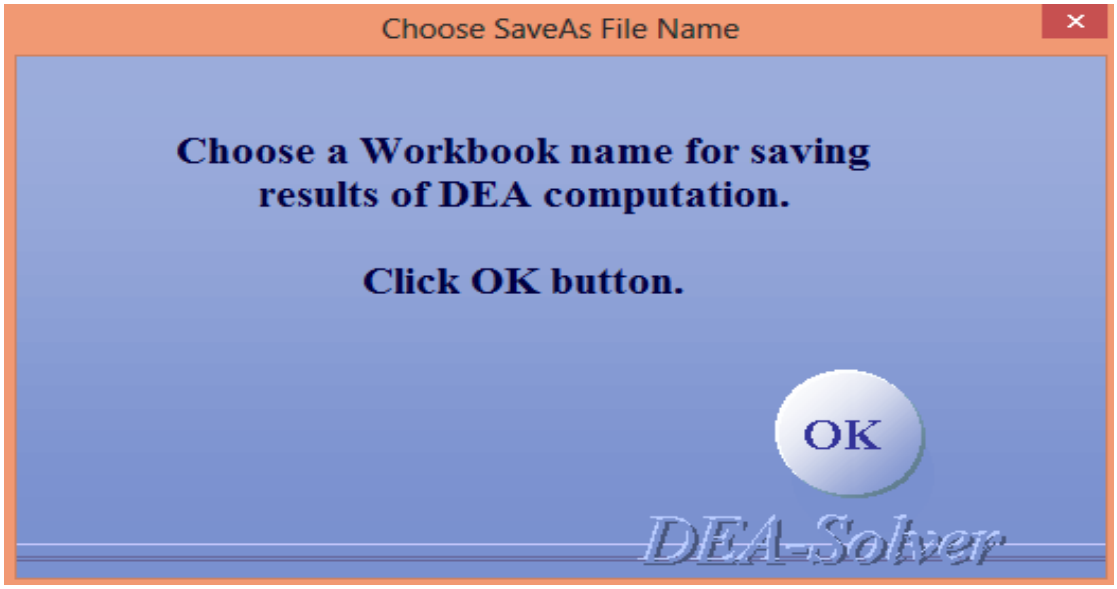

Figure 4.4: Choose a Workbook name

The DEA Model which is CCR-I was run to get the result for all faculties and which faculty is most efficient and suitable to be the benchmark to other warehouse.

Figure 4.5: Run the DEA

4.4 ANALYSIS OF DEA METHOD

After run the DEA solver, the result appears for the slack, weighted data, weight, projection, graph, rank, score and summary. In this result, FKASA, FTEK and FIM is most efficient than other where the achievement of efficiency = 1. The rest of faculty had received inefficiency result due to several factors of lack or excess in variables.

4.4.1 SLACK

Table 4.3: Slack of DEA result

No.	DMU	Score	Excess No. of Lecturer	Excess No. of Student enrolled	Excess Lecture room provided	Shortage No. of graduate student	Shortage No.of publication
			S-(1)	S-(2)	S-(3)	S+(1)	S+(2)
1	FKASA	1	0	0	0	0	0
2	FKKSA	0.861485	10.93624739	0	1.788606714	0	0
3	FSKKP	0.889962	0	0	6.88973667	0	0
4	FTEK	1	0	0	0	0	0
5	FIM	1	0	0	0	0	0
6	FSTI	0.965817	9.94013904	0	18.1961596	0	0
7	FKP	0.59141	0	0	16.5486962	0	0
8	FKM	0.716495	0	0	5.75291576	0	0
9	FKEE	0.736468	0	0	10.4369323	0	0

For the explanation of slack, all faculties that are most efficient had achieve 1 score with very strong positive relationship. Faculty of FKASA, FTEK and FIM are efficient because in the result above they showed that they do not have excess lecturer,

student enrolled and lecture room. For the output, they also do not have shortage of student graduate and number of publication.

Furthermore, FKKSA had score of 0.8614 < 1 which is very strong positive relationship. This faculty had excess in number of lecturer = 10. For FSKKP, they had score of 0.8885 < 1 that is very strong positive relationship and it has an excess of 6 unit of lecture room. Then, for FSTI, the score get from this solver is 0.9658 < 1 which is very strong positive relationship also. This faculty had excess in excess of lecturer = 9, no excess of student enrolled, excess in lecture room = 18.

In addition, FKP had the score of 0.5914 < 1 which is strong positive relationship. This faculty only had excess on lecture room = 16. For FKM and FKEE, both had less than 1 for the score. FKM 0.7165 while FKEE 0.7365 which is very strong positive relationship. FKM had excess in lecturer room provided = 5 while, FKEE had excess of lecture room provided = 10. Both do not have shortage as well.

Table 4.4: Scale of efficiency

0.70 – 1	Very strong positive relationship
0.40 – 0.69	Strong positive relationship
0.30 – 0.39	Moderate positive relationship
0.20 – 0.29	Weak positive relationship
0.01 – 0.19	No or negligible relationship

4.4.2 PROJECTION

Table 4.5: Projection of DEA result for FKASA, FTEK and FIM

	I/O	Data	Projection	Difference	%
1	FKASA	1			
	No. of Lecturer	58	58	0	0.00%
	No. of Student enrolled	380	380	0	0.00%
	Lecture room provided	17	17	0	0.00%
	No. of graduate student	369	369	0	0.00%

	No. of publication	7	7	0	0.00%
4	FTEK	1			
	No. of Lecturer	54	54	0	0.00%
	No. of Student enrolled	75	75	0	0.00%
	Lecture room provided	30	30	0	0.00%
	No. of graduate student	200	200	0	0.00%
	No. of publication	8	8	0	0.00%
5	FIM	1			
	No. of Lecturer	39	39	0	0.00%
	No. of Student enrolled	215	215	0	0.00%
	Lecture room provided	8	8	0	0.00%
	No. of graduate student	207	207	0	0.00%
	No. of publication	41	41	0	0.00%

Based on the result, those faculty above had achieve efficiency score = 1. The number of lecturer, student enrolled, lecture room provided are sufficient to produce number of graduate student and number of publication. It shows that there is no shortage and excess of input that need to take into consideration for fixing because this will be benchmark to others DMU.

Table 4.6: Projection of DEA result for inefficient faculty

2	FKKSA	0.8615			
	No. of Lecturer	106	80.381112	-25.62	-24.17%
	No. of Student enrolled	411	354.07014	-56.93	-13.85%
	Lecture room provided	30	24.055929	-5.944	-19.81%
	No. of graduate student	392	392	0	0.00%
	No. of publication	65	65	0	0.00%
3	FSKKP	0.89			
	No. of Lecturer	71	63.187267	-7.813	-11.00%
	No. of Student enrolled	320	284.78768	-35.21	-11.00%
	Lecture room provided	30	19.809108	-10.19	-33.97%
	No. of graduate student	316	316	0	0.00%
	No. of publication	43	43	0	0.00%
6	FSTI	0.9658			
	No. of Lecturer	40	28.692543	-11.31	-28.27%
	No. of Student enrolled	163	157.42818	-5.572	-3.42%
	Lecture room provided	25	5.9492665	-19.05	-76.20%
	No. of graduate student	152	152	0	0.00%
	No. of publication	30	30	0	0.00%
7	FKP	0.5914			
	No. of Lecturer	46	27.204858	-18.8	-40.86%
	No. of Student enrolled	122	72.152015	-49.85	-40.86%
	Lecture room provided	49	12.430392	-36.57	-74.63%
	No. of graduate student	115	115	0	0.00%
	No. of publication	10	10	0	0.00%
8	FKM	0.7165			
	No. of Lecturer	91	65.201041	-25.8	-28.35%
	No. of Student enrolled	314	224.97942	-89.02	-28.35%
	Lecture room provided	45	26.489357	-18.51	-41.13%
	No. of graduate student	300	300	0	0.00%
	No. of publication	28	28	0	0.00%
9	FKEE	0.7365			

No. of Lecturer	79	58.180952	-20.82	-26.35%
No. of Student enrolled	295	217.25799	-77.74	-26.35%
Lecture room provided	48	24.913519	-23.09	-48.10%
No. of graduate student	284	284	0	0.00%
No. of publication	11	11	0	0.00%

Based on result, FKP has the lowest efficiency among others. For the number of lecturer FKP should have 27 rather than 46. FTEK has a large gap of differences between projected data and score data they should reduce until 74.63% of lecture room to achieves efficiency. This result that it is crucial to consider how much lecture need to accommodate quantity of student enrolled rather than quality of lecture need. Same also with projection for number of student enrolled that faculty need 72 rather than 122 to avoid high differences with 49 and to reduce 40.86% differences. For output number of publication and number of student graduate does not need to add or reduce the number.

From all above projection of inefficiency faculty, this study can be concluding by seeing the dispersion of the data. The higher differences that need to reduce are 89 from FKM because data need only 224 of student enrolled rather than 314 to attain efficiency. These make 28.35% of differences. Moreover, the projection need for number of lecturer is 65 rather than 91 while number of lecture room needed is 26 rather than 45. Next, the lowest percentage from this table from FSTI for the projection of number of student enrolled is 3.42% only. The projection number need for student enrolled is 157 rather than 163 based on the 5 differences only.

Moreover, for FKKSA the projection number of lecturer is 80 rather than 106 while for FKASA 63 rather than 71. There are not many differences for both of projection. The projection number for FKEE of lecture room is 24 rather than 48. The different for this number is 23 and 48.10% differences. This means FKEE are unable to handle more lecture room efficiently that would make other faculty share same lecture room can be avoided. So, strategic plan must be plan and implemented in order to make all lecture room achieve efficiency. Lastly, there is no projection number of graduated student and number of publication from all faculty produce so it did not effect and it will consider as efficient.

4.4.3 GRAPH

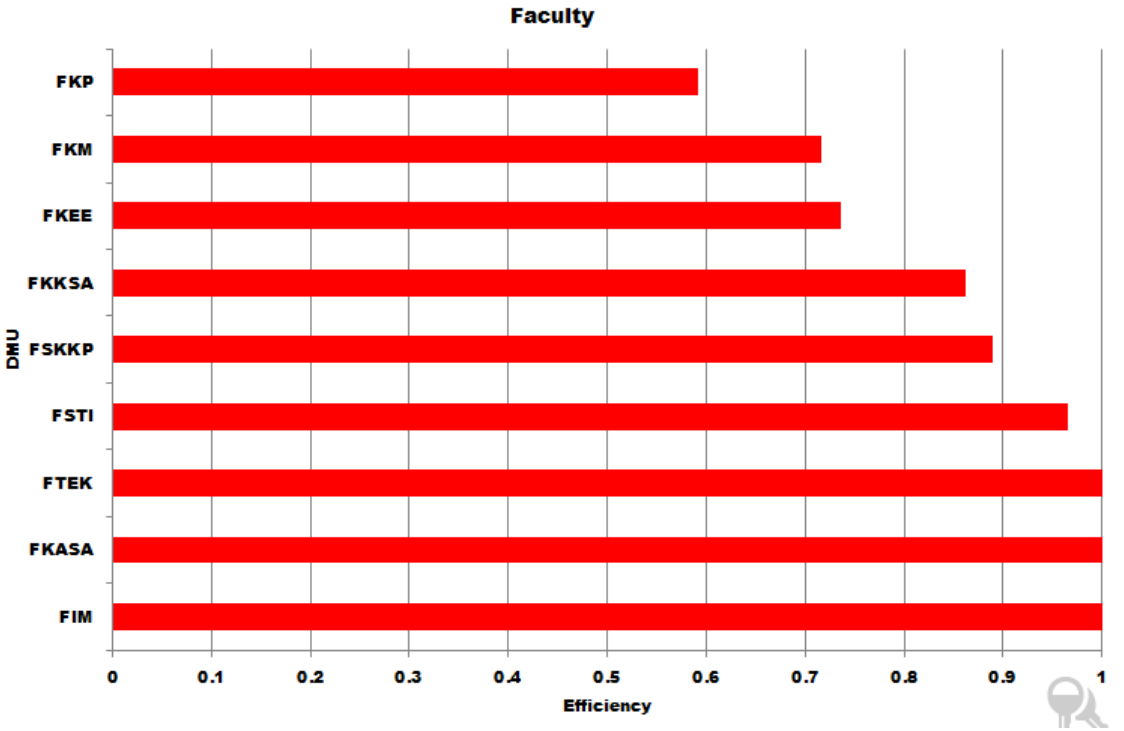

Figure 4.6: Graph of Faculty ranking following efficiency

Graph shown increasingly efficiency scale, start from FKP, FKM, FKEE, FKKSA, FSKKP, FSTI, FTEK, FKASA and FIM.

4.4.4 Rank

Table 4.7: Ranking based on efficiency

Rank	DMU	Score
1	FIM	1
1	FKASA	1
1	FTEK	1
4	FSTI	0.965817
5	FSKKP	0.889962
6	FKKSA	0.861485
7	FKEE	0.736468
8	FKM	0.716495
9	FKP	0.59141

As we can see in table above, all DMU were place in the rank from higher to lower efficiency scale, FIM > FKASA > FTEK > FSTI > FSKKP > FKKSA > FKEE > FKM > FKP. FIM, FKASA and FTEK has the score of 1 while FSTI = 0.9658, FSKKP = 0.8899, FKKSA = 0.8615, FKEE = 0.7365, FKM = 0.7165 and FKP = 0.5914.

Hence, from this study even FKKSA and FKASA is well known in this university not necessary that they are efficient. Sometimes, the new faculty is more efficient like FIM in this rank that is why this method are used to know which faculty perform well and most efficient using same variable and same business unit.

4.4.5 SCORE

Table 4.8: Ranking based on score

No.	DMU	Score	Rank	Reference set (lambda)
1	FKASA	1	1	FKASA
2	FKKSA	0.861485	6	FTEK
3	FSKKP	0.889962	5	FKASA
4	FTEK	1	1	FTEK
5	FIM	1	1	FIM
6	FSTI	0.965817	4	FTEK
7	FKP	0.59141	9	FKASA
8	FKM	0.716495	8	FKASA
9	FKEE	0.736468	7	FKASA

For the score, each DMU has its own rank, from this rank this study will know which faculty can be their references. Faculty that had achieve their efficiency =1 do not have to referred to other but they need to be as a references and would be benchmark to the others. Moreover, Data Envelopment Analysis (DEA) also wants to compare relative performance to benchmarking purposes. As the table above show, FSKKP, FKP, FKM and FKEE need to be referring to FKASA, while FKKSA and FSTI need to refer to FTEK.

4.4.6 SUMMARY

Table 4.9: Statistical Input/ Output for all DMU

	No. of Lecturer	No. of Student enrolled	Lecture room provided	No. of graduate student	No. of publication
Max	106	411	49	392	65
Min	39	75	8	115	7
Average	64.88889	255	31.33333	259.4444	27
SD	22.16326	110.2623	13.21615	90.49998	18.8915

From table above, the maximum value of number of lecturer is 106 and the minimum value is 39. The average of number of lecturer is 64.8889 and standard deviation is 22.1633. Meanwhile, the maximum number of student enrolled by that year is 411 and minimum number is 75. The average of student enrolled is 255 and standard deviation is 110.2633. Next, number of lecture room for the maximum is 49, minimum is 8, average is 31.3333 and standard deviation is 13.2162. For number of graduate student of output, the maximum number equal to 392, minimum number equal to 115, average equal to 259.4444 and standard deviation equal to 90.4999. Lastly, the value for maximum number of number of publication is 65, minimum is 7, and average is 27 and standard deviation equal to 18.8915.

Table 4.10: Correlation of variables

	No. of Lecturer	No. of Student enrolled	Lecture room provided	No. of graduate student	No. of publication
No. of Lecturer	1	0.720744	0.406011	0.76742	0.448216
No. of Student enrolled	0.720744	1	-0.09203	0.927728	0.465777
Lecture room provided	0.406011	-0.09203	1	-0.1326	-0.29327
No. of graduate student	0.76742	0.927728	-0.1326	1	0.385192

No. of publication	0.448216	0.465777	-0.29327	0.385192	1

The result show, the correlation among variables of number of lecturer, student enrolled, lecture room, number of graduate and number of publication. The number of lecturer and student enrolled indicate the strong positively correlated which is 0.7 same for correlation between students enrolled to number of graduate student with 0.7. For the correlation between students enrolled to number of student graduate with strong positively correlated with 0.9 values. Since the value is really close to 1 than others correlation, this data can make sense because number of graduate students is depends on number of students enrolled over the year.

Moreover, the correlation for lecture room to number of lecturer and number of publication to number of lecturer and students enrolled and number of publication is weak positively correlated with all 0.4. Next, the correlation between students enrolled and lecture room 0.09, lecture room and number of student graduate with 0.1 and number of publication and lecture room 0.2 gives the weak negatively correlated.

Table 4.11: Strength of correlation coefficient

Value of r	Comment
r = -1.0	Perfect negatively correlated where all the data fall on the line of negative slope
-1.0 < r < -0.7	Strong negatively correlated
-0.7 < r < -0.5	Moderate negatively correlated
-0.5 < r < 0	Weak negatively correlated
r = 0.0	No correlation between two variables
0.00 < r < 0.5	Weak positively correlated
0.5 < r < 0.7	Moderate positively correlated
0.7 < r < 1.0	Strong positively correlated
r = 1.0	Perfect positively correlated where all the data fall on the line of positive slope

4.5 DATA VERIFICATION AND VALIDATION

The verification and validation model the aim of develop a DEA model to produce an exact and reliable model. Data verification and validation process are very important process to get the CCR model running accurately. The result of the CCR models was verified. It was checked for technical accuracy and approved that is checked for their capacity to accurately reflect the performances of the valid procedure. All the DMU and variables under study were subjected to confirm. The technical rightness checked incorporated an intensive survey of the outcomes and contrasted and past study result. Since the DMUs and variables are subjected to validation, it also was valid because it was reviewed from the decision makers from high expertise who is expert in DEA method. The variables also taken from past research journal.

Other than that, it is show that CCR model by using DEA software able to run completely to get the statistic output and the best faculty is efficient. This is the evidence to prove that DEA software has no any error. So the validation of the model is strong because CCR model can run completely where it is can screening than led to selection of recommended faculty to be benchmark for other insufficient faculty. It can be conclude that CCR model is valid and significant to be used for other researcher to measure the efficiency in any kind of field.

CHAPTER FIVE

CONCLUSION AND RECOMMANDATION

5.1 INTRODUCTION

In this chapter will discuss about the conclusion of DEA method and the result shown in chapter 4 will be revised to discover the solution which could be improve the faculty efficiency. This chapter also will determine the conclusion of the findings, limitation to this study and recommendation and lastly will conclude the overall of this study.

5.2 RESEARCH SUMMARY

Data Envelopment Analysis (DEA), which has been developed to measure the effectiveness of decision-making units (DMU) that referred to as decision making units and similar in terms of their product or services, is an efficiency measure technique without parameters. This technique ensures to define how existing sources can be used effectively to create the outputs of DMU.

In this study, input oriented method has been preferred because input factors could be controlled by decision makers in university. By means of obtained results, inefficiency unit can be attained more efficient structure by way of change that decision makers will have on input. It is clear that improvements which will be made in inputs will or affect positively the value of numbers of student graduate and number of publication which are all important for all units of the university. Units can do a similar analysis with different input and output factors that are important for them. However, it

should be noted that this study is a relative efficiency analysis show that they are efficient.

In this study, we analysed the data of different unit of University Malaysia Pahang (UMP). Hence, it can be said that improvement about processes, target values and target attainment rates are determined better and optimal for each unit by using current years data that this study get on 2014/2015. So that the result of the analysis can be used not only for only one year but also longer period of time and can be more realistic result.

In conclusion, relative efficiency analysis of UMP which is non-profit organization has been done by using data envelopment analysis in this study. This offered model to get efficiency scores of university can be useful for universities. By using this model, decision makers of university could take reliable decision.

5.3 RECOMMENDATION

From this research, the efficiency of the faculty using DEA technique has been used. The efficiency of the faculty was determined by CCR model which can be benchmark for other faculty. As we know, DEA is utilized to calculate efficiency when there are various data and output and there are no for the most part adequate weights for accumulating inputs and outputs. Be that as it may, there are quality judgments in the choice variables of info and outputs. For example, the variable with zero weights are removes from evaluation. In evaluation the efficiency of a DMU, the value judgement effects the selection of optimal weights for input and output.

DEA technique is a powerful method to measure the efficiency of DMU in real situation by using DEA software. This software can be used in many different kinds of fields in industry. The consideration to include as many DMUs as possible is a bigprobability of capturing high performance that would improve discriminatory power. The focus on more type of data to be put in the software will benefit to get the better result for efficiency value. Then it cans also the solution of it.

Next, my recommendation for this faculty is to utilize all the resources they had. Then, the improvement of score is clarified through each of faculty. For faculty

FKASA, FTEK and FIM who had achieve efficiency level = 1, they do not have to add on any score for each DMU. So, for inefficient faculty, the score that they need to achieve same level for efficiency faculty is faculty FKKSA they need to have the score of lecturer 80 rather than 106 while FSKKP score for number of lecturer is 63 rather than 71, FSTI 28/ 40, FKP 27/46, FKM 65/91 and FKEE 58/79. Through this we can see the faculty need to provide a maximum number of lecturers because with high expertise it is expected to create a valuable research or large number of students is required to hold a great number of future products depending on benchmark set for university. Moreover, the other improvement for score of lecture room provided for faculty FKKSA they need to have the score 24 rather than 30 while FSKKP score 19/40, FSTI 5/25, FKP 12/49, FKM 26/45 and FKEE 24/48. Other than that, the improvement for score of number of student enrolled, they need to provided for faculty FKKSA the score of 354 rather than 411 while FSKKP score 284/320, FSTI 157/163, FKP 72/122, FKM 224/314 and FKEE 217/295. As stated, to develop a great product which is good student, the university needs to provide good facilities for all students especially lecture room. With a conducive and maximum number of lecture room, students will be more focus on study, hence reducing problem like student needs to share same lecture and laboratory rooms even they are from different faculty can be avoided.

This study also recommended to be further developed. The increasingly well known of company fields nowadays, they are trying using DEA with a powerful method. The benefit of this DEA method surely will give many benefits to all department to know how well efficient their company is. The thesis about DEA method is not much. Hence, it is an area which is still has space to be explore using other version which is suitable for Master and PHD study as well. Therefore, this research should be encouraged to further study

5.4 LIMITATION

There are a few limitation in utilizing DEA had been examined. Initially, DEA recognizes two or more decision making units (DMU) that work, best case scenario. That is, at any rate some workforce will be given a score of one, when truly even the best performing university may not be and additionally that. This may be an issue if all faculties are inefficient to some degree.

Besides, a typical practice with DEA is to infer efficiency scores utilizing just those inputs, and after that utilization data is exclude their effect of information. In any case, point by point data on all inputs may not be accessible. In a perfect world, data are required on non-physical inputs, for example, experience, data and supervision. In particular, there is the issue of the quality of the output.

In addition, the analyst ought to utilize some level of alert to translate the outcome as discovering in light of data accumulation. That is just from diary articles distributed in book. Consequently, the consequences of DEA do exclude all genuine DEA publication. Through this study just had reviewed only academic and professional journal article. Finally, the constraint is on DEA approach connected in the present study is the essential one and have two reason. Firstly, this DEA methodology is from one in the relevant literature, make the result comparable with other relevant literature. Furthermore, the first investigation of staff of efficiency of all faculty in UMP. The target in this study is to assess the performance of efficiency of faculty.

5.5 CONCLUSION

This chapter shows that the recommendation on how to improve the faculty efficiency according to the result and explanation that have been made in chapter 4. The suggestions are based on the result analysis which are limit the number of lecturer, number of student enrolled and the number of lecture room that can be used by the students. Next is the all faculty in university had to play their role to equalize the amount of student enrolled, lecturer and lecture room, so that the efficiency of faculty can be achieved.

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APPENDICES

PROGRESS/ RESEARCH ACTIVITY	WEEK													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Identify Research Issues														
Deciding The Topic and Research Objectives														
Approval of Topic and Research Objectives														
Preparation of Project Research Proposal														
CHAPTER 1 : Introduction														
Background of Study														
Problem Statement														
Research Objective														
Research Question														
Scope of Study														
Significant of Study														
Expected Result														
Operational definition														
CHAPTER 2 : Literature Review														
CHAPTER 3 : Research Methodology														
Submit Draft Proposal														
Presentation														
Submit Report FYP 1														

GANTT CHART

A WORK PROGRESS OF UNDERGRADUATED RESEARCH PROJECT 2

PROGRESS/ RESEARCH ACTIVITY	**WEEK**													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Data collection during July & August 2015														
CHAPTER 4: Finding and analysis														
Data Finding														
Model Development														
Analysis of data														
Data verification & Validation														
CHAPTER 5: Conclusion & Recommendation														
Submit Draft Thesis														
Mock presentation														
Turn it in & Submit														
Submit Poster (pdf)														
Presentation poster														
Submitted the correction report														