MEASURING EFFICIENCY OF PRACTICUM SUPERVISION AT SARAWAK TEACHERS’ TRAINING INSTITUTE BY USING DATA ENVELOPMENT ANALYSIS

SI TONG YONG

UNIVERSITI TEKNOLOGI MALAYSIA
MEASURING EFFICIENCY OF PRACTICUM SUPERVISION
AT SARAWAK TEACHERS’ TRAINING INSTITUTE BY USING
DATA ENVELOPMENT ANALYSIS

SI TONG YONG

A dissertation submitted in fulfillment of the requirements for the award of the degree of
Master of Science (Mathematics)

Faculty of Science
Universiti Teknologi Malaysia

DECEMBER 2012
Special dedicated to

My parents Si Thian Chin and Tan Joo Tiang. Thank you very much to my supervisor, Dr Zaitul Marlizawati Zainuddin and those people who have guided and inspired me throughout this research. I admire them all and they had given me the strength to finish my study until I get the degree of Master of Science (Mathematics). God bless.
ACKNOWLEDGEMENT

Firstly, I would like to thanks to the God for giving me a chance to complete this thesis. I would like to take this opportunity to express my gratitude to Dr. Zaitul Marlizawati Zainuddin for providing this golden chance for me. Without her continued support and interest, this thesis would not have been the same as presented here.

I also want to give my gratitude to Perpustakaan Sultanah Zanariah (PSZ) in helping me to find the references during the on-going research. My fellow postgraduate students should also be recognized for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed.

Last but not least, a million thanks to my parents, family members and friends who always support me until the end of this dissertation. It is not possible to list all of them in this limited space. Thank you.
ABSTRACT

The purpose of this study is to use Data Envelopment Analysis to measure the efficiency of practicum supervision of 20 units in Sarawak Teachers’ Training Institute. The inputs considered are the total number of lecturers Grade DG44; the total number of lecturers Grade DG48; and the total number of lecturers Grade DG52 as the supervisor for the trainees in each departments in Sarawak Teachers’ Training Institute and the outputs considered are the total number of trainees that are satisfied with the supervision of their supervisors on planning their teaching, the total number of trainees that are satisfied with the supervision of their supervisors on implementing their teaching, and the total number of trainees that are satisfied with the supervision of their supervisors on managing their classroom. Besides the overall performance model, six models are developed for the purpose of testing the sensitivity of the results, and hence identifying the strengths and weaknesses of the units. The findings show that eight units are technically-efficient. Among the efficient units, Special Education Unit, Malay Studies Unit and Moral Education Unit are the representative units. Data Envelopment Analysis helps in identifying the reference sets for the inefficient units and further determining the potential improvements. As such, it can be a valuable benchmarking tool for unit administrators.
ABSTRAK

Tujuan kajian ini adalah untuk menguji kecekapan penyeliaan praktikum bagi 20 unit di Institut Pendidikan Guru Malaysia Kampus Sarawak dengan menggunakan “Data Envelopment Analysis”. Input yang dipertimbangkan adalah jumlah pensyarah Gred DG44, jumlah pensyarah Gred DG48 dan jumlah pensyarah Gred DG52 sebagai penyelia untuk guru pelatih dalam setiap jabatan di Institut Pendidikan Guru Malaysia Kampus Sarawak dan output yang dipertimbangkan adalah jumlah bilangan guru pelatih yang berpuas hati dengan bimbingan penyelia mereka dalam merancang pengajaran mereka, jumlah guru pelatih yang berpuas hati dengan bimbingan penyelia mereka melaksanakan pengajaran mereka, dan jumlah guru pelatih yang berpuas hati dengan bimbingan penyelia mereka mengurus kelas mereka. Selain daripada model prestasi keseluruhan, enam model dibangunkan bertujuan menguji kepekaan keputusan, dan kemudian mengenal pasti kekuatan dan kelemahan unit. Dapatan kajian menunjukkan bahawa lapan unit teknikal yang cekap. Antara unit yang cekap adalah Unit Pendidikan Khas, Unit Pengajian Melayu dan Unit Pendidikan Moral merupakan unit contoh. “Data Envelopment Analysis” membantu dalam mengenali set rujukan untuk unit yang tidak cekap dan seterusnya menentukan potensi penambahbaikan. Oleh itu, ia boleh menjadi satu alat tanda aras untuk pentadbir unit.
TABLE OF CONTENTS

CHAPTER   TITLE   PAGE

DECLARATION   ii
DEDICATION   iii
ACKNOWLEDGEMENT   iv
ABSTRACT   v
ABSTRAK   vi
TABLE OF CONTENTS   vii
LIST OF TABLES   x
LIST OF FIGURES   xii
LIST OF ABBREVIATIONS   xiii
LIST OF SYMBOLS   xvi

1   INTRODUCTION   1
   1.1 Introduction   1
   1.2 Background of the Problem   2
   1.3 Statement of the Problem   3
   1.4 Objectives of the Study   3
   1.5 Scope of the Study   3
   1.6 Significance of the Study   4
   1.7 Outline of the Thesis   5
## LITERATURE REVIEW

2.1 Introduction  
2.2 Introduction to DEA  
2.3 CCR Model  
2.4 BCC Model  
2.5 Related Works on DEA  
2.6 Summary

## RESEARCH METHODOLOGY

3.1 Introduction  
3.2 Problem Identification  
3.3 Definition of the Decision Making Units  
3.4 Input and Output Items  
3.5 Collection of the Sample Data  
3.6 Construction of Performance Models  
3.7 Identification of the Orientation  
3.8 Selection of Analysis Options  
  3.8.1 Constant and Variable Returns to Scale  
  3.8.2 Input-Orientation and Output-Orientation  
  3.8.3 Optimal Weights  
  3.8.4 Slacks  
  3.8.5 CCR Projection  
3.9 Summary
4 RESULTS AND ANALYSIS

4.1 Introduction 40

4.2 Inputs and Outputs Data 40

4.3 Results 42

4.4 Results of Performance Model 1 42

4.4.1 Technical Efficiency 43

4.4.2 Pure Technical Efficiency 50

4.4.3 Scale Efficiency 54

4.5 Returns to Scale 55

4.6 Sensitivity of Results 58

4.7 Slacks 61

4.7.1 Slacks Under Input-Oriention 61

4.7.2 Slacks Under Output-Oriention 63

4.8 Potential Improvements in Efficiency 64

4.8.1 Improvements Using Input-Oriention 65

4.8.2 Improvements Using Output-Oriention 70

4.9 Summary 75

5 SUMMARY AND CONCLUSIONS 76

5.1 Introduction 76

5.2 Summary 76

5.3 Conclusions 78

5.4 Suggestions 79

REFERENCES 80
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Input and output measures for departments evaluation</td>
<td>15</td>
</tr>
<tr>
<td>3.1</td>
<td>Departments and its corresponding units</td>
<td>18</td>
</tr>
<tr>
<td>3.2</td>
<td>Definition of input and output indicators</td>
<td>20</td>
</tr>
<tr>
<td>3.3</td>
<td>Units under investigation</td>
<td>21</td>
</tr>
<tr>
<td>3.4</td>
<td>Indicators considered in performance models</td>
<td>23</td>
</tr>
<tr>
<td>4.1</td>
<td>Data for 20 units under investigation</td>
<td>35</td>
</tr>
<tr>
<td>4.2</td>
<td>Units under investigation</td>
<td>36</td>
</tr>
<tr>
<td>4.3</td>
<td>Unit’s TE score</td>
<td>37</td>
</tr>
<tr>
<td>4.4</td>
<td>Reference frequency of efficient units</td>
<td>39</td>
</tr>
<tr>
<td>4.5</td>
<td>Inefficient units and their reference set with values of $\lambda_j^*$</td>
<td>40</td>
</tr>
<tr>
<td>4.6</td>
<td>Optimal weights</td>
<td>41</td>
</tr>
<tr>
<td>4.7</td>
<td>Units’ ranks</td>
<td>42</td>
</tr>
<tr>
<td>4.8</td>
<td>Unit’s PTE score</td>
<td>44</td>
</tr>
<tr>
<td>4.9</td>
<td>TE and PTE scores</td>
<td>45</td>
</tr>
<tr>
<td>4.10</td>
<td>TE, PTE and SE scores</td>
<td>47</td>
</tr>
<tr>
<td>4.11</td>
<td>Unit’s returns to scale nature</td>
<td>48</td>
</tr>
<tr>
<td>4.12</td>
<td>TE scores for units in different models</td>
<td>50</td>
</tr>
<tr>
<td>4.13</td>
<td>Input excesses and output shortfalls of units (input-orientation)</td>
<td>53</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>4.14</td>
<td>Input excesses and output shortfalls of units (output-orientation)</td>
<td>55</td>
</tr>
<tr>
<td>4.15</td>
<td>Potential improvements for inefficient units (input-orientation)</td>
<td>56</td>
</tr>
<tr>
<td>4.16</td>
<td>Potential improvements for inefficient units (output-orientation)</td>
<td>61</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Reference frequency of efficient units</td>
<td>39</td>
</tr>
<tr>
<td>4.2</td>
<td>Units and their scores</td>
<td>43</td>
</tr>
<tr>
<td>4.3</td>
<td>TE and PTE scores of the units</td>
<td>46</td>
</tr>
<tr>
<td>4.4</td>
<td>Units and their TE, PTE and SE scores</td>
<td>48</td>
</tr>
<tr>
<td>4.5</td>
<td>The Sum of Lambda for units</td>
<td>50</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>BCC</td>
<td>Banker-Charnes-Cooper</td>
<td></td>
</tr>
<tr>
<td>CCR</td>
<td>Charnes-Cooper-Rhodes</td>
<td></td>
</tr>
<tr>
<td>CRS</td>
<td>Constant returns to scale</td>
<td></td>
</tr>
<tr>
<td>DEA</td>
<td>Data Envelopment Analysis</td>
<td></td>
</tr>
<tr>
<td>DG44</td>
<td>Total number of lecturers Grade DG44</td>
<td></td>
</tr>
<tr>
<td>DG48</td>
<td>Total number of lecturers Grade DG48</td>
<td></td>
</tr>
<tr>
<td>DG52</td>
<td>Total number of lecturers Gradd DG52</td>
<td></td>
</tr>
<tr>
<td>DMU</td>
<td>Decision Making Unit</td>
<td></td>
</tr>
<tr>
<td>DRS</td>
<td>Decreasing returns to scale</td>
<td></td>
</tr>
<tr>
<td>IIT</td>
<td>Indian Institute of Technology</td>
<td></td>
</tr>
<tr>
<td>IRS</td>
<td>Increasing returns to scale</td>
<td></td>
</tr>
<tr>
<td>ITT</td>
<td>Total number of trainees that are satisfied with the supervision of their supervisors on implementing their teaching</td>
<td></td>
</tr>
<tr>
<td>IUG</td>
<td>Islamic University in Gaza</td>
<td></td>
</tr>
<tr>
<td>JB</td>
<td>Department of Languages</td>
<td></td>
</tr>
<tr>
<td>JB1</td>
<td>English Studies Unit</td>
<td></td>
</tr>
<tr>
<td>JB2</td>
<td>Chinese Studies Unit</td>
<td></td>
</tr>
<tr>
<td>JS</td>
<td>Department of Science</td>
<td></td>
</tr>
<tr>
<td>JS1</td>
<td>Science Unit</td>
<td></td>
</tr>
<tr>
<td>JS2</td>
<td>Environment Unit</td>
<td></td>
</tr>
<tr>
<td>JM</td>
<td>Department of Mathematics</td>
<td></td>
</tr>
<tr>
<td>JM1</td>
<td>Mathematics Unit</td>
<td></td>
</tr>
</tbody>
</table>
JPPP - Professionalism Development and Research Department
JPPP1 - Professionalism Development and Research Unit
JIP - Department of Education
JIP1 - Pre-school Education Unit
JIP2 - Guidance and Counseling Unit
JIP3 - Special Education Unit
JPJK - Department of Health and Physical Education
JPJK1 - Physical Education Unit
JPJK2 - Health Education Unit
JKS - Department of Social Studies
JKS1 - Local Studies Unit
JKS2 - Unit of Art Education
JKS3 - Music Education Unit
JKS4 - Civics and Citizenship Unit
JPM - Department of Malay Studies
JPM1 - Malay Studies Unit
JTP - Department of Educational Technology
JTP1 - Library of Science Unit
JTP2 - Information and Communication Technology Unit
JPIM - Department Islamic and Moral Education
JPIM1 - Islamic Education Unit
JPIM2 - Moral Education Unit
MTC - Total number of trainees that are satisfied with the supervision of their supervisors on managing their classroom
NCKU - National Cheng Kung University
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTE</td>
<td>Pure technical efficiency</td>
</tr>
<tr>
<td>PTT</td>
<td>Total number of trainees that are satisfied with the supervision of their</td>
</tr>
<tr>
<td></td>
<td>supervisors on planning their teaching</td>
</tr>
<tr>
<td>SE</td>
<td>Scale efficiency</td>
</tr>
<tr>
<td>TE</td>
<td>Technical efficiency</td>
</tr>
<tr>
<td>VRS</td>
<td>Variable returns to scale</td>
</tr>
</tbody>
</table>
LIST OF SYMBOLS

\( u_r \) - weights of the output item \( r \) (input-oriented)

\( y_{ro} \) - amount of the \( r \)th output produced by \( o \)th Decision Making Unit

\( v_i \) - weights of the input item \( i \) (input-oriented)

\( x_{io} \) - amount of the \( i \)th input used by \( o \)th Decision Making Unit

\( \theta \) - efficiency score (input-oriented)

\( \lambda_j \) - proportion contributed by reference unit \( j \) (input- / output-oriented).

\( \eta \) - efficiency score (output-oriented)

\( \mu_j \) - proportion contributed by reference unit \( j \) (output-oriented).

\( p_i \) - weights of the input item \( i \) (output-oriented)

\( q_r \) - weights of the output item \( r \) (output-oriented)

\( \omega \) - free variable in BCC model.

\( s_i^- \) - input excesses (input-oriented)

\( s_r^+ \) - output shortfalls (input-oriented)

\( \theta^* \) - the optimal value of input-oriented DEA models.

\( t_i^- \) - input excesses (output-oriented)

\( t_r^+ \) - output shortfalls (output-oriented)

\( \eta^* \) - the optimal value of output-oriented CCR model (envelopment form).

\( \hat{x}_{io} \) - adjusted \( i \)th input for \( o \)th Decision Making Unit under CCR Projection

\( \hat{y}_{ro} \) - adjusted \( r \)th output for \( o \)th Decision Making Unit under CCR Projection
CHAPTER 1

INTRODUCTION

1.1 Introduction

All organizations have an interest in evaluating the performances of their operations. One of the performance measurement criteria is efficiency that evaluate relationship between inputs that is what is used in the production process and outputs that is production. Among the major challenge for today’s organization is incomplete knowledge on organizational productivity efficiency. Some of the reasons to count for internal performance evaluation in every organization are as follows. Using criteria that is suitable, organizations must evaluate their unit’s presentation to gain control and supervise their performance. Apart from that, the performance evaluation will result in determining appropriate criteria for budget and available resources allocation among the department (Fathi et al., 2010). Lack of information on the efficiency of organizational units will result in management inability to make decision on direction of organization and its progress path.

Higher education is the backbone of development and economic growth in any country. Therefore, it is a necessity to assess the educational institutions efficiency, to know whether the high costs spent on them are worth. To do that, a scientific method considering the inputs and outputs of the educational institutions is necessary.
1.2 Background of the Problem

Many literatures have discussed the performance evaluation using Data Envelopment Analysis (DEA) at the university and schools. Research on performance of different colleges or universities, and research comparing the performance of teaching and research in a university department has been made. But as of today, there is no research on performance appraisal using Data Envelopment Analysis at the Teachers’ Training Institute.

Teaching practice or practicum is an important component in teachers’ training courses. The main function is to provide trainees with the opportunity to develop teaching competencies in classrooms under the guidance and supervision of co-operating teachers and teachers’ training institute lecturers. During the teaching practice, trainees have the opportunities to use the knowledge, skills and theory they study and practice in schools.

Sarawak Teachers’ Training Institute have ten departments and 20 units. There are no study on the efficiency of practicum supervision in Sarawak Teachers’ Training Institute. Thus, some questions arise such as how many units in Sarawak Teachers’ Training Institute are considered efficient on practicum supervision, and which departments are inefficient. A study comparing the units in Sarawak Teachers’ Training Institute is needed, because the performance evaluation of units will provide useful managerial guidelines to all the lecturers.
1.3 Statement of the Problem

In this study, the non-parametric technique that is DEA is used to examine the efficiency of practicum supervision at each units in Sarawak Teachers’ Training Institute by evaluating the technical and scale efficiencies of units.

1.4 Objectives of the Study

The objectives of this study are:

1. To measure the efficiency of practicum supervision of units in Sarawak Teachers’ Training Institute.
2. To determine the units’ returns to scale nature.
3. To identify the areas of inefficiency for inefficient units.
4. To suggest the potential improvements for the inefficient units.

1.5 Scope of the Study

The study discusses the basic concepts of DEA, the constant and variable returns to scale assumptions, input and output oriented models and also applications of DEA to each units in Sarawak Teachers’ Training Institute. The main tools for evaluating the performance of units in Sarawak Teachers’ Training Institute are Charnes-Cooper-Rhodes (CCR) and Banker-Charnes-Cooper (BCC) models. In this study, the inputs considered are the total number of Grade DG44 lecturers; the total number of Grade
DG48 lecturers; and the total number of Grade DG52 lecturers as the supervisor for the trainees in each departments in Sarawak Teachers’ Training Institute and the outputs considered are the total number of trainees that are satisfied with the supervision of their supervisors on planning their teaching, the total number of trainees that are satisfied with the supervision of their supervisors on implementing their teaching, and the total number of trainees that are satisfied with the supervision of their supervisors on managing their classroom.

1.6 Significance of the Study

The Charnes-Cooper-Rhodes model used will demonstrate whether the technical units tested are efficient or not. If the test shows the technical unit is efficient, then the unit can be treated effectively in the process of changing inputs into outputs. If the unit does not demonstrate effectiveness when tested, the areas of inefficiency can be identified.

By using Charnes-Cooper-Rhodes (CCR) and Banker-Charnes-Cooper (BCC) models efficiency score, the scale efficiency and the returns to scale’s nature of the units can also be determined. This result is useful to the head of department because scale efficiency can determine which aspects of the unit are inefficient. By using the information of returns to scale, the unit can be more focused on aspects that are inefficient in the future.

CCR model is also used to provide some suggestion on targets of improvement to the department that is not efficient in performance. In addition to help in identifying the reference sets that is peer group for inefficient departments and determines productivity
improvements, DEA can also be a useful benchmarking tool for head of department to determine more efficient allocation of scarce resources.

1.7 Outline of the Thesis

Chapter 1 consists an introduction to background of this research study, statement of the problem, objective of the study, scope of the study and also the significance of the study.

Chapter 2 concentrates on the literature review of Data Envelopment Analysis, which includes introduction of Data Envelopment Analysis, Charnes-Cooper-Rhodes Model, Banker-Charnes-Cooper Model and related works on DEA.

Chapter 3 presents the methodology and research design for this research. The input and output measures that are used to evaluate departments, the developed performance models and analysis options chosen in this research.

Chapter 4 reported the analysis of the results. In this chapter, technical and scale efficiency measures are presented for eight units in Sarawak Teachers’ Training Institute. The results obtained by each performance model are also interpreted in this section of Chapter 4.

Chapter 5 consists of conclusions and suggestions for further research.
REFERENCES


