An Evaluation of Graduate Students’ Efficiency Using the Data Envelopment Analysis Technique

Chutinun Sathtachotinun¹, Wichuphorn Pipitkul², Angwara Mitdee³, Sasarose Jaijit⁴*

¹,²,³,⁴Department of Industrial Engineering, Faculty of Engineering at Kamphaeng Saen, Kasetsart University, Nakhon Pathom, 73140, Thailand
sasarose.j@ku.th

Abstract: This study aims to measure the efficiency based on multi-criteria decision of 54 graduate students in 2014 of Department of Industrial Engineering at Faculty of Engineering at Kamphaeng Saen by using the data envelopment analysis (DEA) technique. The criteria include students’ sex, curriculum and teacher as inputs, and the GPA, development of learning skills, the number of withdrawal subjects, the students’ decision making to take the postgraduate program, and the working status factors as outputs. The results show that 81.5% of graduated students have the efficiency score of 0.75 to 1. The others (18.5%) have the score lower than 0.75 and only 1.8% of the graduated students with the efficiency score below 0.56 (the efficiency score of 1 is equivalent to 100%). Moreover, we can use the results to design the policy of teaching process that helps to increase the student efficiency by considering the slack in some factors.

INTRODUCTION

The evaluation of graduated students’ efficiency is an indicator to measure the performance of teaching and learning process. The previous on graduate students’ efficiency evaluation of Industrial Engineering Department, Faculty of Engineering at Kamphaeng Saen is considered by a random interview from entrepreneurs. The assessor should use other factors (e.g. GPA, development of learning skills, number of withdrawal subjects and career opportunities) to evaluate the efficiency based on the real potential of graduate students.

In 2014, the graduate students of Industrial Engineering Department, Faculty of Engineering at Kamphaeng Saen are explored the information of their learning skills and their career opportunities using the questionnaire. Data collected by questionnaires are general students’ information (e.g. sex, age, and GPA), working status (e.g. working in the field of the study or not, salary and time to get a job), decision making to take the postgraduate program, and satisfaction in the department components (e.g. curriculum, teachers, facilities and services)

The factors affecting to student performance are sex, curriculum and teacher (Harb and El-Shaarawi, 2007; Phattharayuttawat et al., 2009; Duggan et al., 2014). In addition, French et al. (2015) and King (2016) show that the students’ learning skills are effect to their career opportunities. For the decision making to take the postgraduate program, the teacher is a factor that influences students’ decision (Liu and Morgan, 2016).

The factors used to measure the graduate students’ efficiency in this study are sex, curriculum, teacher, learning skills, students’ decision making to take the postgraduate program, and career opportunities. Therefore, the graduate students’ efficiency evaluation is considered by multi-criteria decision analysis.

The efficiency evaluation on decision-making units (DMUs) based on multi-criteria decision analysis uses the data envelopment analysis (DEA) technique. For example, Sirbu et al. (2016) use the DEA to evaluate the performance of staff in the academic department of the Faculty of Economics, State Agrarian University of Moldova. Moreover, the performance score of each academic department is used to order the faculty ranking. El-Mahgary et al. (2014) measure the performance of learning unit in term of students’ GPA on Photogrammetry curriculum of Aalto University using the DEA technique. Alwadood et al. (2011) evaluate the academic department efficiency using the DEA technique for monitoring the performance and resource adequacy of teaching system. Moreover, the ranking of efficiency scores of each academic department is also used to indicate which the academic department has the best practice. Santin and Sicilia (2018) apply the DEA technique to evaluate teacher efficiency at grade 4 of
schools in Spain and found that the factors of teachers’ experience and teachers’ training do not affect to the efficiency score. However, the factors of female teachers and small teaching groups have higher efficiency scores than teachers who are determined by other factors.

This study applies the DEA technique for assessing the efficiency scores of the graduate students of Industrial Engineering Department, Faculty of Engineering at Kamphaeng Saen. The efficient graduate students will be used as a reference, in an effort to improve the efficiency of the less efficient ones. Finally, some policy will be recommended to improve the less efficient students to a satisfactory level and used as a guideline for developing further learning and teaching process.

DEA MODEL

Indicators in the Model

The factors used to evaluate the graduate students’ efficiency have ten factors, dividing into three inputs and seven outputs. The input factors are students’ sex, curriculum and teacher. The output factors are GPA, development of learning skills calculated by the difference between the first semester’ GPA and the last semester’ GPA, the number of withdrawal subjects, the students’ decision making to take the postgraduate program, and the working status factors including working in the field of the study or not, salary and time to get a job.

The factors of GPA, development of learning skills, the number of withdrawal subjects, and the students’ decision making to take the postgraduate program are used to represent the students’ learning skill factor.

Graduate Students’ Efficiency Evaluation

The fifty four students of Industrial Engineering Department are used to measure the efficiency in the form of output-oriented measure under the assumption of constant returns to scale (CRS). The efficiency score of each graduate student is calculated as:

\[
\min q = \sum_{i=1}^{I} u_i x_{ji}
\]

subject to

\[
\sum_{k=1}^{K} v_k y_{jk} = 1
\]

\[
\sum_{k=1}^{K} v_k y_{jk} - \sum_{i=1}^{I} u_i x_{ji} \leq 0, \ \forall j
\]

\[u_i > 0, v_k > 0, \ \forall i, k\]

where \(x_{ji}\) is the amount of input \(i (i = 1, 2, ..., I)\) used by the decision making unit (DMU) \(j (j = 1, 2, ..., N)\) and \(p_0\) is the DMU which is considering an efficiency, \(y_{jk}\) is the amount of output \(k\) produces by DMU \(j\), \(u_i\) is a weighted score of input factor \(i\), \(v_k\) is a weighted score of output factor \(k\) and \(q\) is the objective function.

RESULT AND DISCUSSION

The results as shown in Fig. 1 show that 81.5% of graduated students have the efficiency score of 0.75 to 1. The others (18.5%) have the score lower than 0.75 and only 1.8% of the graduated students with the efficiency score below 0.56 (the efficiency score of 1 is equivalent to 100%).

From 54 graduate students, there are 34 students divided into 15 males and 19 females whose efficiency is not equal to 1, and they are identified as inefficient.

* Corresponding author: Sasarose Jaijit
Email: sasarose.j@ku.th
FIGURE 1
The proportion of graduate students according to the ranges of efficiency score

<table>
<thead>
<tr>
<th>Efficiency score</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.48 - 0.56</td>
<td>13%</td>
</tr>
<tr>
<td>0.57 - 0.65</td>
<td>4%</td>
</tr>
<tr>
<td>0.66 - 0.74</td>
<td>2%</td>
</tr>
<tr>
<td>0.75 - 0.83</td>
<td>15%</td>
</tr>
<tr>
<td>0.84 - 0.92</td>
<td>50%</td>
</tr>
<tr>
<td>0.93 - 1.00</td>
<td>16%</td>
</tr>
</tbody>
</table>

Slacks are showed only these graduate students can improve their efficiency by increasing their outputs (since we run an output-oriented model). Fig. 2 shows the proportion of inefficient graduate students who can increase efficiency according to increase the output slacks. It is interesting to note that most of the inefficient graduate students (both males and females) are required to increase their efficiency via increasing their salary. However, the output factor that has the least inefficient graduate student proportion required for increasing their efficiency is the development of learning skill factor.

FIGURE 2
The proportion of inefficient graduate students required to improve their efficiency according to increase each output’s slacks

* Corresponding author: Sasarose Jaijit
  Email: sasarose.j@ku.th
CONCLUSION

This study applies the DEA technique to measure the efficiency of 54 graduate students of the Department of Industrial Engineering, Faculty of Engineering at Kamphaeng Saen. The graduate students’ efficiency is considered by their learning skill and their career opportunities which are affected by the curriculum and teacher factors.

There are 20 graduate students whose efficiency is equal to 1 and they are identified as efficient. Most of the efficient graduated students are female (75%). For inefficient graduate students, the increasing on salary factor can improve their efficiency. The increase in the salary factor for improving the students’ efficiency is more required in females than males. However, the efficiency enhancement via the increase GPA and the development of learning skills factors is found in males more than females.

The requirement to improve in some outputs (e.g., GPA, the development of learning skill, salary, and the number of graduate students who get the job in their field) can use to determine the strategies on teaching process for increasing the potential of student learning skills and their career opportunities.

This study provides an approach to further improve the explanation of the causal relationship between factors. A causal analysis model can also be further investigated. For example, Zeegers (2007) applies path analysis model to evaluate the learning outcomes of 194 first-year students and 118 third-year students affected by the learning process. Erdag (2017) uses path analysis to determine the effects of external academic performance pressure on school accountability policies and school accountability responses based on quantitative data obtained from teachers and school administrators. The results are used to explain the causal relationship between factors.

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REFERENCES


* Corresponding author: Sasarose Jaijit
Email: sasarose.j@ku.th


* Corresponding author: Sasarose Jaijit  
Email: sasarose.j@ku.th