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Performance Efficiency of Muhammadiyah University Sumatera Area Using Data Envelopment Analysis (DEA)

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ABSTRACT

Purpose –This research aimed to measure the performance efficiency of Muhammadiyah University Sumatera Area in 2019 until 2021 by using Data Envelopment Analysis (DEA).
Methodology/approach – This research was a descriptive quantitative research with population were all Muhammadiyah Universities in Sumatera Area with purposive sampling method and obtained 12 universities as samples. This research employed secondary data and they were analyzed by utilizing DEA method using Max DEA 8 Basic program.
Findings –This research concluded that the performance which reached maximal efficiency (100%) in 2019 were 4 universities. In 2020 and 2021 increased to be 5 universities that reached efficient performance criteria. The lowest inefficient rank was Muhammadiyah University of South Tapanuli. While for Potential Improvement of Performance of Muhammadiyah University Sumatera Area in 2019, 2020, and 2021 in output side also occurred inefficiency in publication factor. The efficiency increase in publication can be achieved if the publication target is increased.

INTRODUCTION

College is considered as the main center to produce and transfer knowledge through three main activities namely education, research, and devotion (Naderi, 2019). In line with the more development of college growth in Indonesia in 2021 sourcing from Central Bureau of Statistics (BPS), February 25th, 2022 in the following diagram:

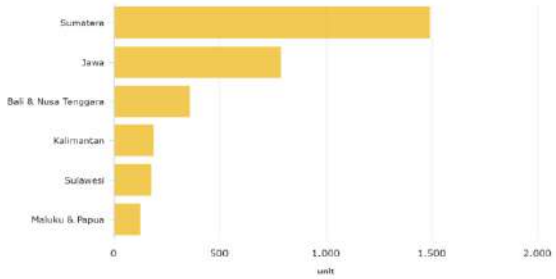

Figure 1.1: Distribution of Colleges in Indonesia
Source: Central Bureau of Statistics (BPS) Year 2022

Based on the data in Figure 1.1, there are 3.115 colleges spreaded in all over area of Indonesia in 2021. This number decreased 51 units compared to the previous year, where Indonesia had 3.166 colleges in 2020. In the amount of 2.990 units or 93.98% of registered colleges in 2021 is private colleges. While the rest, namely 125 units are state colleges. Sumatera Island is the are with the most number of colleges in national scale, with total colleges 1.489 units. The most distribution is in North Sumatera with total 221 units. Followed by Java Island in the second rank with total colleges amounted 787 colleges. Followed by Bali and Nusa Tenggara 357 units, and Kalimantan 184 units. Sulawesi Island registered to have 173 units of colleges, then Maluku Island and Papua have 125 units of colleges. Seen from the phenomenon based on the data in Figure 1.1, there is decrease in college numbers. This shows that competition among colleges occurs. Competition can cause the college survives or even closed (Heni and Dahli, 021), then also merger of colleges in order to compete nowadays and in the future.

One of factors that cause the decrease number of colleges is the college ability to gain accreditation. For few years back, accreditation system becomes prominent in higher education and making policy which in the end becomes an important tool for students and academician who want to discriminate academic institutions (González-Garay et al., 2019). The gain of expected accreditation is the college's performance itself because performance measurement is required for organzation in education sector. Just like other organizations, college performance and its effectiveness become important considering the competition that occurs among colleges (Türkan & Özel, 2017). Research concerning the comparison nowadays continuous to develop as the follow up of improvement process, quality guarantee, evaluation, and performance improvement (Lai et al., 2011). One of the ways to assure quality of college acrredication is by measuring the performance efficiency of the college itself. Abdullah et. al. (2018) contended that the measurement of college performance efficiency is very important to conduct, but it is difficult to do considering the different characteristics of colleges let alone if it is viewed as a non profit organization with multiple output produced from multiple input. Until it is necessary to do input and output limitation so that the performance efficiency comparison can be aligned. The research carried out by (Bouzouita, 2019), (Sagarra *et al*., 2017), (Aziz *et al*., 2013), (Ghimire *et al*., 2021) there are 2 (two) main outputs that can be used to measure the performance of a college namely: the number of graduates and the number of publication. Performance efficiency measurement of Muhammadiyah University in Sumatera Area is felt very important to answer various challenges based on the number of lecturers, research, efficiency of using the resources covering the number of lecturers and employees, and the students who can be accomodated based on the efficiency measurement using DEA.

LITERATURE REVIEW

Efficiency

Efficiency is the measurement of resources usage level in certain process. The more economical or the less usage of resources, then the process can be said more efficient. An efficient process is marked by the process improvement to show the ratio between output towards input of certain system. Measurement in exact science relies on certain ideal situation where output quantity resulted is exactly the same with the input quantity given or the ratio is precisely the same with 1 (one). Efficiency in this ideal situation is called as ideal efficiency (absolute) which its value is always 100%, while the efficiency of not ideal condition (normal) its ratio is smaller than 100% (Haryadi, 2011).

Performance

Performance the result or success level of someone thoroughly in certain period in carrying out the duty compared to various possibilities (Rivai, 2005). The masurement of public sector performance aims to find out the achievement level of organization purposes, providing the employee learning facility, fixing the performance of the next period, giving systemic consideration in making decision, giving reward and punishment, and to motivate the employee and create public accountability (Mahmudi, 2015).

***Data Envelopment Analysis* (DEA).**

DEA is a linear programming based technique to evaluate the relative efficiency of Decision Making Unit (DMU) by comparing between DMU one and another by using the same resources to produce the same output. The solution from this model indicates the productivity or efficiency of certain unit towards another unit (Abdullah, et. al., 2020).

The things to watch for in the usage of DEA method are as follows (Haryadi, 2011):

1. The need of input and output values for each DMU,
2. DMU has the same process which uses the same type of input and output,
3. Defining the value of relative efficiency of each DMU through the ratio between the addition of output and input weight;
4. The efficiency value ranges from 0 until 1,
5. The weight value obtained can be used to maximize the relative efficiency value.

There are 2 models of efficiency measurement using DEA, namely:

a. CCR models

This model assumes that the addition ratio between input and output is the same, called CRS (Constan Return To Scale). CRS allows the assumption that if the input increases by x times, the output will also increase by x times. This model also allows another assumption: each company operates at an optimal scale (optimum scale). The results of the CCR model measurements are reflected in the Technical Efficiency value. To get an efficiency score for the company I (θ), which has input (x) and output (y). It is obtained by solving a system of linear equations, namely the formula from CRS as follows:

$$Max = \sum_{k=1}^{p} \mu_k y_{k0}$$

$$\mu_k v_i$$

$$s.t \sum_{i=1}^{m} v_{ki} x_{10} = 1$$

$$\sum_{k=1}^{p} \mu_k y_k j - \sum_{i=1}^{m} v_{ki} x_i j \leq 0 \; j = i, \ldots, n$$

$$\mu_k \geq \varepsilon_{vi} \geq \varepsilon$$

$$k = 1, \ldots, p \quad i = l, \ldots, m$$

Where the maximization above represents technical efficiency (CCR), xij is the number of inputs of type (i) from DMU (unit to be studied) to (j), and ykj is the number of outputs of type (k) from DMU to (j). The efficiency value is always less or equal to 1 (one). A DMU whose efficiency value is less than 1 means it is inefficient or inefficient, while a DMU whose efficiency value is equal to 1 means that the DMU is efficient.

b. BCC model

This model assumes that the company does not operate at an optimal scale. This was caused partly by competition and financial constraints. This model assumes that the input and output additions ratio is not the same or is called VRS (Variable Return To Scale). If the input increases x times, the output does not increase x times. It can be bigger or smaller. The efficiency calculated by the VRS model is called pure technical efficiency. The model of this VRS with input-output can be written with the following equation:

$$Max = \sum_{k=1}^{p} \mu_k y_{k0} - \mu_0$$

$$\mu_k v_i$$

$$s.t \sum_{i=1}^{m} v_{ki} x_{10} = 1$$

$$\sum_{k=1}^{p} \mu_k y_{kj} - \sum_{i=1}^{m} v_{ki} x_{ij} \leq 0 \; j = i, \ldots, n$$

$$\mu_k \geq \varepsilon_{vi} \geq \varepsilon$$

$$k = 1, \ldots, p \quad i = l, \ldots, m$$

Where the maximization above represents technical efficiency (CCR), xij is the number of inputs of type (i) from DMU (unit to be studied) to (j), and ykj is the number of outputs of type (k) from DMU to (j). The efficiency value is always less or equal to 1 (one). A DMU whose efficiency value is less than 1 means it is inefficient or inefficient, while a DMU whose efficiency value is equal to 1 means that the DMU is efficient.The concept of efficiency measures can be seen by focusing on the input side (input-oriented) and focusing on the output side (output-oriented). This study uses the output side (output-oriented), which aims to maximize output with the assumptions of VRS (Variable Return to Scale) and CRS (Constant Return to Scale) analysis.

RESEARCH METHOD

This research employed descriptive quantitative approach. The secondary data were collected from each university which became the sample from year 2019 until 2021. The data were analyzed with DEA by using Max DEA 8 Basic Software.

The population in this research were all Muhammadiyah Universities in Sumatera Area in 2019 until 2021. The sample selections were through purposive sampling technique based on the data availability required in this research and gained 12 samples, namely:

1. Muhammadiyah University of Riau
2. Muhammadiyah University of Bengkulu
3. Muhammadiyah University of Sumatera Utara
4. Muhammadiyah University of Palembang
5. Muhammadiyah University of West Sumatera
6. Muhammadiyah University of Aceh
7. Muhammadiyah University of South Tapanuli
8. Muhammadiyah University of Lampung

9. Muhammadiyah University of Jambi
10. Muhammadiyah University of Kotabumi
11. Muhammadiyah University of Metro
12. Muhammadiyah University of Pringsewu

RESULT AND DISCUSSION

Performance Efficiency of Muhammadiyah University Sumatera Area in 2019 until 2021

The result of performance efficiency measurement of Muhammadiyah University Sumatera Area in 2019 until 2021 by using DEA method is displayed in Table 1 as follows:

Table. 1. Performance Effiiency of Muhammadiyah University Sumatera Area in 2019 – 2021

NO	DMU	Year 2021	Year 2020	Year 2019
1	Muhammadiyah University of Aceh	52%	50%	48%
2	Muhammadiyah University of Bengkulu	66%	61%	55%
3	Muhammadiyah University of Jambi	100%	100%	100%
4	Muhammadiyah University of Kotabumi	71%	100%	100%
5	Muhammadiyah University of Lampung	100%	100%	75%
6	Muhammadiyah University of Metro	100%	100%	100%
7	Muhammadiyah University of Palembang	61%	59%	55%
8	Muhammadiyah University of Pringsewu Lampung	72%	73%	74%
9	Muhammadiyah University of Riau	55%	57%	63%
10	Muhammadiyah University of Sumbar	100%	56%	48%
11	Muhammadiyah University of Sumut	100%	100%	100%
12	Muhammadiyah University of South Tapanuli	26%	26%	25%

Source: Processed data 2023

Based on Table 1, in year 2019 out of 12 samples whose efficiency reached maximal value (100%) were 4 universities namely yaitu Muhammadiyah University of Jambi, Muhammadiyah University of Kotabumi, Muhammadiyah University of Metro and Muhammadiyah University of North Sumatera. While 8 other universities were still in inefficient criteria (<100%) and the lowest (25%) is Muhammadiyah University of South Tapanuli.

Improvement occurred in 2020 where there were 5 universities in efficient criteria (100%) namely Muhammadiyah University of Jambi, Muhammadiyah University of Kotabumi, Muhammadiyah University of Metro, Muhammadiyah University of North Sumatera and Muhammadiyah University of Lampung. While 7 samples were inefficient with the lowest rank was Muhammadiyah University of South Tapanuli (26%).

There were still 5 universities reaching maximal performance (100%) in 2021, however position shift occurred where Kotabumi University went to inefficient level with score 71% and

replaced by Muhammadiyah University of West Sumatera. The lowest inefficiency was at 26% namely Muhammadiyah University of South Tapanuli.

Potential Improvement of Muhammadiyah University Performance in Sumatera Area Year 2019 – 2021.

After finding out the result of efficiency analysis of each period of Muhammadiyah University Performance in Sumatera Area, then there is what is called as Potential Improvement (PI) namely the difference percentage between the actual value and target in DMU which is inefficient or in efficiency score under 100%. This difference showed that the institution has unic potential to do improvement in input and output variable which was not optimal yet until it can achieve optimally efficient position (Rustyani and Rosyidi, 2018). PI Calculation of Muhammadiyah Performance in Sumatera Area year 2019 until 2021 is displayed in Table 2 as follows:

Table. 2. Potential Improvement of Muhammadiyah University Performance in Sumatera Area Year 2019 – 2021

Variable of *Input* and *Output*	2021			2020			2019		
	Actual	**Target**	**PI**	**Actual**	**Target**	**PI**	**Actual**	**Target**	**PI**
Number of Study Programs	21	20	3%	20	19	4%	20	19	5%
Number of Lecturers	220	201	9%	209	194	7%	194	182	6%
Number of Students	6231	5919	5%	6625	6348	4%	6493	6213	4%
Publication	4040	5349	-32%	4016	5541	-38%	3994	5740	-44%

Based on the result of data processing which had been conducted, it could be seen in the table above that the causative factor is in output variable which still needs adjustment because the input variable cannot be decreased. If decreased then it will influence the University Accreditation.

From year 2019 until 2021 all input variables were assessed too high until it needed to be decreased. Year 2019 can be decreased 5%, 6%, and 4% from the whole input. Year 2020 can be decreased 4%, 7%, and 4% of the whole input and year 2021 can be decreased 3%, 9%, and 5%. However this cannot be done considering if the number study program, the number of lecturer, and the number of students are decreased then it is similar to decreasing asset. Meanwhile a company, an organization, or any institution may not decrease their asset. Until the focus of this research is the output. Inefficiency occurs in the output side namely in publication factor. Efficiency improvement in publication can increase if the publication target in 2019 is increased to be 5740 from 3994. In other words, publication increase needs to be carried out 44% or amounted 1746. In 2020, publication target is increased to be 5541 out of 4016 or 38%. While in 2021, publication needs to be increased 32%.

CONCLUSION

DEA method shows that performance efficiency of Muhammadiyah University in Sumatera Area in 2019 were 4 universities in efficient criteria (100%). In 2020 and 2021 increased to be 5 universities with lowest inefficiency was at Muhammadiyah University of South Tapanuli.

Potential Improvement (PI) of Muhammadiyah University Performance in Sumatera Area in 2019 – 2021 was inefficient in output side namely in publication factor. The efficiency factor in publication can increase if the publication target is improved.

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