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DEA as an Alternative Instrument of Performance Measurement: A Case Study of Five Sidoarjo Small-Sized Enterprises on December 2018

B. Budiarto & F.R. Djumadi
University of Surabaya, Surabaya, Indonesia

ABSTRACT: DEA, as a linear programming development, is based on the technique of measuring the relative performance of multiple inputs and outputs. DEA is now one of the alternative instruments that is often used in measuring the performance of economic activity units. The indicator is technical efficiency. Technical-efficiency is done by comparing the weights of inputs and outputs, not negative and universal. Assuming that each unit of economic activity will choose a weight that maximizes the efficiency ratio. The study was conducted on five Small-sized Enterprises (SE) samples in Sidoarjo Regency in December 2018. In conclusion, it is known that there were 3 units of economic activity that have carried out their production efficiency, and 2 are inefficient. Of the 3 units of economic activity that have carried out the production process efficiently, it turns out that not all of them can be used as a reference by inefficient units of economic activity.

Keywords: Performance, efficiency, DEA.

1 INTRODUCTION

To maintain the sustainability of an Economic Activity Unit, one that must be maintained is performance. Performance is the overall status of the organization. The performance of a SE is multidimensional. Performance must be seen from various size profiles; economy, effectiveness, or efficiency. Bearing it in mind, it can be said that efficiency is important because efficiency is one of the performance indicators. Efficiency has two forms, namely, economic efficiency and technical efficiency. To measure the performance of a SE, the efficiency used is technical efficiency. Technical efficiency is a combination of the capacity and ability of economic activity units to produce maximum output levels using a number of inputs and technology.

The Now several efficiency measurement techniques have been developed; simple partial ratio, done by calculating the ratio simultaneously. Then there is also a simple regression analysis, which is done by comparing the actual output and estimated output. The result is an efficiency rate relative to average performance. Next is the technique of measuring the efficiency with DEA. DEA is the development of linear programming based on the measurement of the relative performance of multiple inputs and outputs. This method was introduced by Charner, who conducted a study using several study motorcycle taxis, which were considered to have the same characteristics (Charner et al. 1978).

This study focuses on the discussion of the use of DEA as a performance measurement tool for five SEs in the Sidoarjo Regency in December 2018. This research used many inputs and outputs. The final result expected from this performance measurement is to obtain the efficiency position of five SEs in the Sidoarjo Regency as a SE; the minimum efficiency that occurs in December 2018. The ability to produce maximum output with existing inputs is a measure of expected performance (Rahmatika 2016).

Paying attention to several performance measurement tools, now there are several performance measurement tools, one of which is DEA. DEA is a procedure specifically designed to regulate the relative efficiency of a unit of economic activity that uses many inputs and outputs. This combination of input and output is not possible. Relative efficiency is the efficiency of one SE compared to other SEs using the same type of input and output type. The weighted total output divided by the total weighted

input in the SE plays a role in determining the weights for each input and output.

SE must be able to use the same set of weights to evaluate the ratio, and the ratio cannot be more than one. Weights must be able to meet the two conditions required; a). Not negative, and b). Universal value. This concept can be written as follows:

$$Efficiency = \frac{TotalWeightedOutput}{TotalWeightedInput} \quad (1)$$

In essence, we will find weights for each output and input in the SE. The SEs in this study were 5 SE in Sidoarjo Regency in December 2018. Furthermore, the nature of the weights is twofold; not negative value and is universal. The underlying assumption of DEA, SE will tend to choose weights that maximize the efficiency ratio. One of the DEA advantages is the ability to handle multiple inputs and output and does not require relationship assumptions functional between input and output variables (Dewiyani 2007). DEA is used not only in goods' companies but also in services. Borge & Naper (2005) analyzed efficiency in primary schools in Norway using the values of the main subjects like Mathematics and English as the output variable. This can be understood because production is a process activities carried out by the company to change the input to output or product (Pindyck & Rubenfield 2001). Gaspersz (1999) instead of Sukimo (2003) said production as an activity in the company industry in the form of value-added creation from input to output efficiently and effectively, so the product as the output of the process of creating added value can be sold at a competitive price.

One effort to increase economic development is to develop the industrial sector, which is a long-term effort to improve economic structure (Sukimo 2003). While, Arsyad (1999) said that input used in the long run is a variable input and does not include fixed input. The formation of the DEA formulation can be approached with images, but this approach has limitations in the number of inputs and outputs. Maximum of two, according to the axis in the curve. However, its advantage is being able to show efficient frontier lines, points of efficiency and inefficiency will also be seen, so that the picture of the lowest points (low enveloped) will be seen.

From this, the name DEA actually appears. In the mathematical formulation, assuming there are a number of n SEs to be compared, each SE uses a number of m inputs to produce a number of s outputs, and if this assumption is followed then RMij> 0 is the number of inputs i used by SEj, while MTrj> 0 is the number of outputs r produced by SEj. Furthermore, if Vik is the weight at input i (i = 1,2, ..., m) from SEk, while Urk is the weight at output r (r = 1,2, ..., s) of SEk, then Vik and Uik are decision variables. The level of efficiency using the DEA method produces a relative efficiency value between 1 and 0, where if the relative efficiency value is DMU 1, it is said to be efficient and inefficient if the value of efficiency is other than 1 (Wang & Yang 2005). The objective function of the fractional linear program for SEk, following Silkman (1986) instead of Wang & Yang (2005) is as follows:

$$Maximization \quad hk = \frac{\sum_{r=1}^{s} U_{vk} MT_{rk}}{\sum_{r=1}^{m} V_{rk} RM_{rk}} = \frac{\sum_{r=1}^{s} U_{vk} MT_{rk}}{\sum_{r=1}^{m} V_{rk} RM_{rk}} > 1 \quad (2)$$

where j = 1,2,3, ... , n. According to the DEA assumption, the selected weight cannot be negative, so Urk> 0; r = 1, 2, ..., m.

2 RESEARCH METHODS

According to the Central Agency on Statistics, the classification of industries based on the number of employees is as follows: up to 4 workers are called home industries, 5 to 9 workers are called small industries, then 10 to 20 workers are called medium industries, the rest are large industries. In this study, the SE that is compared is the industry with 4 to 11 workers.

The By using primary data from the acquisition of questionnaires, the study was conducted on five SEs as samples in Candi District of Sidoarjo Regency in December 2018. As stated earlier, that unlike in the formation of econometric models, the formation of the model must be based on a theory that has been empirically tested or based on previous empirical studies, so in the DEA, there is still a long debate until now to determine the diversity of input and output variables. In this study, the data for input and output variables came from five SEs in Sidoarjo Regency that produce several leather products like shoes, bags, belts, hats, and so on. Table 1 is the acquisition of data from the distribution of question-

naires in 5 SEs in the Candi District of Sidoarjo Regency in December 2018.

Table 1. Inputs and outputs of five SEs in Sidoarjo in December 2018

Economic Activity Unit	Input		Output	
	L	Y	S	T
SE-1	5	14.000.000	90	40
SE-2	8	15.000.000	50	70
SE-3	7	12.000.000	40	90
SE-4	2	8.000.000	30	50
SE-5	11	19.000.000	50	30

Source: primary data. L = number of workers employed in December 2018; Y = total salary received by all workers in December 2018; S = total shoes and sandals produced in December 2018; Q = Total bags and other products besides shoes and slippers in December 2018.

Furthermore, to calculate the efficiency of the 5 SEs, the steps are to be formulated in 5 fractional linear programs first, as follows:

$$
\begin{aligned}
&Formulation \quad SE-1: Max-Z = 9S+4T \\
&Constrain, \\
&SE-1: 9S+4T = 5L-14Y \le 0 \\
&SE-2: 5S+7T = 8L-15Y \le 0 \\
&SE-3: 4S+9T = 7L-12Y \le 0 \\
&SE-4: 3S+5T = 6L-8Y \le 0 \\
&SE-5: 5S+3T = 11L-19Y \le 0 \\
&k-6: 5L+14Y = 1
\end{aligned}
\tag{3}
$$

The formulation of the fractional programming was conducted to five SEs, which were the object of the research. The K-6 notation in the formulation is a constraint to equalize the input value of the SE, which will maximize its output. The value is equal to one. The output value of SE ranges from zero and one. The point is one for efficient conditions and less than one for inefficient conditions. All can be seen in the value of the objective function in the attachment to the results of data processing. Paying attention to the formulation, through the help of W-DEA software, the results of performance measurements become faster and easier to know.

3 RESULTS AND DISCUSSIONS

By paying attention to the basic assumptions of DEA and armed with the help of W-DEA software, weighting values could be obtained, where the results can be seen in the following tables. December 2018.

Table 2. The level of technical efficiency of 5 small industries in Sidoarjo in December 2018

Economic Activity Unit	Efficiency (%)
SE-1	100,00
SE-2	77,33
SE-3	100,00
SE-4	100,00
SE-5	44,21

Source: results of data processing.

The efficiency of each SE varies greatly. Of the five SEs that were the objects of research, it turns out that two SEs did not carry out their production processes efficiently in December 2018. The two SEs were SE-2 and SE-5. Performance achievements, SE-2 has efficiency gains of 77.33%, and SE-5 has efficiency gains of 44.21%. Looking at the results of these calculations, SEs that are not efficient in the production process can emulate efficient SEs. However, inefficient SE must be careful in choosing an efficient SE to be used as a reference. Several criteria must be considered. DEA has provided this facility. Facility to choose and not choose SE as an example in conducting the production process. Not every efficient SE can be used as a reference or become a peer.

Table 3. Peers for inefficient SE

Economic Activity Unit	Peer 1	Peer 2	Peer3	Peer 4
SE-1	-	-	-	-
SE-2	SE-1	SE-3	-	-
SE-3	-	-	-	-
SE-4	-	-	-	-
SE-5	SE-1	SE-3	-	-

Source: results of data processing.

Furthermore, taking into account the simulation results of the DEA measurement, it can be seen that SE-1 has an efficiency level of 100.00%. This SE-1 is an example of a genuinely efficient SE, at least when compared to the other four SEs. All inputs used correctly can be targets of all input achievements, which is 100.00%. SE-2 has an efficiency level of 77.33%. SE-2 does an inefficient production process and not have good performance. A deficiency value of only 77.33% is one proof.

Noting the existing measurement results, it turns out that DEA is able to provide more information. The total workforce of 8 people, according to DEA calculations, is too many, where it should be enough with 6 workers only. This is indicated by the target number, which is only 5.9. If the SE manager wants the output according to what is in the DEA pro-

cessing results, but there are other alternatives; if the small industry manager still uses 8 workers, then the labor productivity can actually be increased to 25.8%. This is indicated by the figure 'to gain' results of DEA data processing of 25.8%. In this SE-2, the workforce performs the production process is not optimal. This variable has an efficiency gain of 74.2%. This can be seen in the 'achieved' column.

The same thing happened with the salary variable. It is known that it turns out that salaries received by workers at SE-2 are inefficient. At least this happened in December 2018. The total salary received was Rp. 15,600,000.00 for 8 people, according to the DEA analysis, was considered too high, which is enough with Rp. 11,600,000.00. Productivity is not optimal. Paying close attention to this, means that there is an excess salary paid by 22.7%, where workforce achievement was only 77.33%. The main factors causing this SE to make inefficient production processes are these two inputs. The DEA informs that there is no problem with the output variable. Shoes and bags have achieved 100% efficiency figures. This means that the output variables are optimal. The variables that need to be evaluated are input variables, namely total salary and total workforce.

Furthermore, as is the case with SE-1, SE-3, and SE-4 have an optimal efficiency level of 100.00%. SE-5 has a very small efficiency level of only 44.21%, meaning that there are many leaks or inefficiency. In this SE-5, at least if compared to other SEs that are both involved in the production process, the SE-5 labor force of 11 people used is too much. In fact, 3 people are enough. Such a large workforce should have greater productivity by 70.1%. Seeing this result, its productivity is only 29.9%. The problem in this SE is actually the same as another inefficient SE, which is the object of research, namely SE-2. The main problem is the use of inputs, both labor and salary that are both are too high.

The ideal total salary paid in December 2018 is Rp. 8,400,000.00, where this figure is much lower than what has been paid of Rp. 19,000,000.00. Workers have a salary of that size but do not show optimal productivity. Its productivity can still be increased by 55.8%. This is understandable. With a salary of Rp 19,000,000.00 received by 11 people, the productivity was only 44.22%. So in the production process, there are still many things that need to be addressed. SE-5 can refer to its peers, namely SE-1 or SE-3.

4 CONCLUSION

Based on the results of performance measurements in five SEs in Sidoarjo Regency during December 2018, it can be concluded that from the 5 SEs studied, there were 3 SEs, namely SE-1, SE-3, and SE- 4 with an efficiency level of 100.00% The other two SEs, namely SE-2 and SE-5 have varying degrees of efficiency, between 44.21% for SE-5 and 77.33% for SE-2. The performance of the input variables causes inefficiency in the production process. Inefficient SEs cannot refer to all efficient SEs. SE-4, even though it is efficient, cannot be used as a reference.

In SE-2, the number of workers employed is sufficient with 6 people. The fact is that SE-2 employs 8 workers, so there is inefficiency. SE-2 pays labor salaries inefficiently. There is a waste of 22.7%. Likewise, in SE-5, excess labor is quite a lot. Work that could be done by 3 people, was done by 11 people. This shows the inefficiency of 70.1%. As a result, the salary paid experienced a waste of 55.8%.

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