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Performance Measurement using DEA-Multipliers Method: A Case Study of Clean Water Companies in Indonesia

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Abstract: *Clean water companies (CWC) in Indonesia are companies that carry out procurement, purification, supply, and distribution of clean water directly through pipelines or tank cars to customers for households, industries, and other consumers for commercial purposes. With such an important role, it is necessary to evaluate the performance of CWC continuously. Therefore, CWC can run its business as much as possible to meet customer satisfaction. The purpose of this research is to measure the performance of CWC in Indonesia. The method used to solve this research problem is the DEA-Multipliers Method. This method introduced the utilization of weight multipliers as broad productivities by specifying limited levels of replacement. The research results indicated that 9% DMUs in the efficient category and 91% DMUs in the inefficient category. Three classification types (CTs) of 31 DMUs inefficient based on the efficiency value range as the following: Good_CT (19%), Average_CT (29%), and Poor_CT (52%).*

Keywords: DEA-Multipliers; Measurement; Performance

1. INTRODUCTION

Almost all companies have an interest in measuring the performance of their companies. With performance measurement, the company will be able to (i) identify the advantages and disadvantages of the company's business activities; (ii) better prepare the business so as to meet customer satisfaction; and (iii) have a reference to be able to increase the company's activities in producing new production processes, goods, and services [1]. Measuring company performance is very prominent in a company's establishment and development. Companies continuously measure their effort performance based on their strengths and weaknesses. The data envelopment analysis (DEA) method is powerful decision-making equipment for measuring companies' performance. DEA measures the comparative efficiency of a department or group as DMUs (decision-making units). It is as well forceful equipment for learning production restricts by utilizing many inputs and outputs. The DEA offers information about the way inputs can be optimized and outputs regenerated if the DMUs are efficient categories. In the other words, DEA is a guideline to increase productivity and performance by utilizing efficient boundaries. [2]. Performance measurement is required by the company to (i) measure the efficiency and economics of the company's operations in a sustainable manner; and (ii) provide information in the company's decision-making. Performance measurement is a method that is widely used to improve company performance. Data envelopment analysis (DEA) is one of the methods used to measure the company's performance. The DEA method is used to compare performance between decision-making units (DMUs). The large number of inputs and outputs in the DEA will result in the complexity of evaluating the company's performance. To overcome this problems, the dimensions of the data set can be reduced without disturbing the main features of the entire data set [3]. Traditional designs of data envelopment analysis (DEA) method consists of constant and variable returns-to-scale production techniques. In the multiplier DEA method, each optimal input and output weight built on these techniques is defined as very profitable for the decision-making unit (DMU) in the evaluation when the last is compared to the aggregate of

entire supervised DMUs [4]. The industrial field's role is important for the development of the national economy in Indonesia. It is a driving power of the economic establishment and the economic pillar. The industrial field can create overseas trade earnings from export aspects and its competence to support the labor strength. The significant features of the industrial field are as follows. First, it will support the labor force-intensive industry, asset-intensive industry, and industry that involves science-based and advanced technology. Next, it creates comparatively superior productivity. Last, it builds the capability to offer connection links and providers to different fields. The government policy guidance is to transfer and recover the national industries by way of the design of an industrial field through friendly facilities for stakeholders. It includes ligature logistic territory and specific economic zones [5]. Energy has a significant factor in the economic development of entire economies. The industry estimated 38% of the earth's latest energy usage and 24% of roundly CO2 emissions [6]. Water is one of life's highly primary demands because it is an important effect on society's health and life demands. Around 3% of the earth's water sources have benefits. There are presently water deficits in several territories. More than a billion people do not have a connection to clean drinking water [7]. Clean water companies in Indonesia are companies/businesses that carry out procurement, purification, supply, and distribution of clean water directly through pipelines or tank cars to customers for households, industries, and other consumers for commercial purposes. Clean water companies/businesses covered are drinking water companies, regional drinking water companies, and drinking water management agencies as well as other private companies/businesses [8]. The purpose of this research is to measure the performance of Clean Water Companies in Indonesia. The method used to solve this research problem is the DEA-Multipliers Method. This method introduced the utilization of weight multipliers as broad productivities by specifying limited levels of replacement.

2. MATERIALS AND METHODS

2.1 Performance Measurement

Performance measurement is important that a corporation business performs effectively in the circumstances of unceasing transformation of the work environment. Thus, it is the demanded purpose for the corporation's viability. The performance measurement is assigned as a significant way for the measurement of activities. It is based on capacity and achievement. In the structure of the performance, appraisalment is utilized effectively. It is assigned by the requirements and customer satisfaction. Several factors for performance measurement are as follows: (i) The stability of the work environment; (ii) Rivalry entity; (iii) Demands to develop the company both internal and external companies; (iv) Demands to get the rewards both nationally and internationally; (v) The company's work methods are changed to be more effective and efficient; (vi) Instability of the business environment; and (vii) Impacts of information development [9].

2.2 DEA Method

Data Envelopment Analysis (DEA) Method is a mathematical programming instrument that can be implemented for performance measurement and its analysis. Cooper and Zhu (2004) specify the DEA method as well as a comparatively data-orientated approach for appraising the accomplishment of peer entities set. It is called DMUs (Decision Making Units). DEA transforms multiple inputs into multiple outputs. According to them, DEA was presented in 1978 and has been appreciated as a distinguished methodology for performance measurement. Therefore, DEA has been utilized in appraising the performance of many distinct groups of company units in the subsequent years. The DMU designation was utilized to enable the method's implementation in an extensive variant of working, such as units and sub-units of companies, government, and non-profit businesses. The authentic CCR DEA method applies the concept of linear programming to generate an efficient evaluation for a DMU. It needs that the DMUs transform identical inputs into identical outputs and these can be measured [10]. DEA is a non-parametric procedure that transforms many inputs to many outputs. This procedure is utilized to evaluate the comparative efficiency of a group of identical units. It indicated as a decision-making unit (DMU). In several practices, the DEA method had implemented since its presence. Its utilization is in the sectors of schools, banks, and hospitals. For more than the last three decennaries, a great number of scholastic creations have expanded to cultivation. DEA is an efectual method to evaluate the comparative efficiency between each DMU. The benefits of this DEA method are as follows (i) easiness in counting because it is a part of mathematical programming procedures; and (ii) Applying many numbers of input and output. Input-oriented DEA Envelopment Model is a model where the input will be reduced/minimized and the output is reminded of the recent grade. This concept is presented in Equation 1 to Equation 5.

$$\begin{aligned} \theta^* &= \min \theta \\ \text{Subject to} \end{aligned} \quad (1)$$

$$\sum_{j=1}^n X_{ij} \lambda_j \leq \theta X_{io}, \quad i = 1, \dots, m \quad (2)$$

$$\sum_{j=1}^n Y_{rj} \lambda_j \geq Y_{ro}, \quad r = 1, \dots, s \quad (3)$$

$$\sum_{j=1}^n \lambda_j = 1 \quad (4)$$

$$\lambda_j \geq 0 \quad j = 1, \dots, n \quad (5)$$

In this equation, DMU_o is one of the n DMUs under measurement. x_{io} is the i th input-DMU_o. y_{ro} is the r th output-DMU_o. λ_j is unknown-weights (j has a value from 1 until n number. It represents the DMU number). θ is a decision variable indicating the DEA efficiency values. θ^* performs the best/optimal solution for DMUs. If the θ^* result is equal to one (1) then a DMU is the efficient DMUs category. If the θ^* result is not equal to one (1) then a DMU is an inefficient DMUs category [11].

2.3 DEA Multipliers Method

In the concept of DEA Multipliers Method, the weight multipliers are a primary aspect of DEA. It establishes this method differs from other characteristics of productivity and performance analyses. A part of the benefit of DEA is covering the concept of the brightness value of multiplier weights. DEA multipliers introduced the utilization of weight multipliers as broad productivities by specifying limited levels of replacement. The grades of DEA weight multipliers must be computed by applying one of the multiplier's linear programming (LPs). These weights hold many utilizes and treatments. LPs' abbreviation and implementation are significant DEA aspects [12,13]. DEA Multipliers method establishes effectiveness as the comparison between weighted outputs and weighted inputs. This concept is presented in Equation 6 to Equation 9.

$$\text{Maximum} \sum_{r=1}^s \mu_r Y_{ro} \quad (6)$$

Subject to

$$\sum_{r=1}^s \mu_r Y_{rj} - \sum_{i=1}^m V_i X_{ij} \leq 0, \quad j = 1, \dots, n \quad (7)$$

$$\sum_{i=1}^m V_i X_{io} = 1 \quad (8)$$

$$\mu_r, V_i \geq 0 \quad (9)$$

μ_r and V_i represent the decision variables. These are output multipliers, and input multipliers, respectively. The effectiveness grades are from zero to one. One represents the greatly efficient DMUs [14].

2.4. Clean Water Company in Indonesia

Clean water companies in Indonesia are companies/businesses that carry out procurement, purification, supply, and distribution of clean water directly through pipelines or tank cars to customers for households, industries, and other consumers for commercial purposes. Clean water companies/businesses

covered are drinking water companies, regional drinking water companies, and drinking water management agencies as well as other private companies/businesses. Workers and expenses for workers are people who work for clean water companies, both operational and maintenance workers and other workers. Expenditures for workers are all company expenses for workers, namely wages/salaries, overtime wages, gifts, bonuses, pension funds, accident benefits, and other expenses paid either in cash or in kind. Input costs are expenditures used for the purchase of chemicals, electricity, fuel, stationery and office supplies, spare parts, maintenance and minor repairs to production infrastructure, rental of buildings and machinery, and other services. The output value is the value of distributed clean water, electricity sold, and other receipts from non-industrial services [8].

2.5. Research Methodology

The performance measurement procedure of this research is presented in Figure 1. The four stages for performance measurement in this research are described as follows: (i) The stage of definition and design of performance measurement; (ii) The stage of preparation, data collection, and data evaluation which include (a) classification of input and output data and (b) determination of input, output, and DMUs (decision-making units) data; (iii) The stages of data processing. The initial step at this stage is setting the input, output, and DMUs data in Microsoft Excel Spreadsheets. This spreadsheet consists of columns (a) DMUs data and DMU data under evaluation; (b) Input and output data; (c) Constraints; (d) Efficiency value; and (e) the results of the input multipliers and output multipliers; and (iv) The stage of the analysis of research results. It determined the efficient and inefficient DMUs.

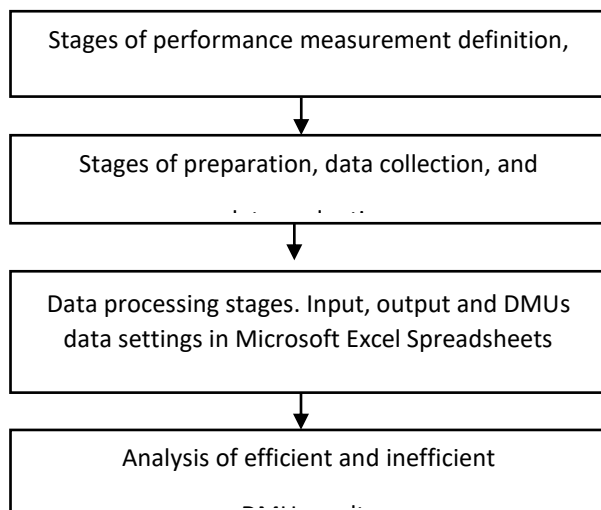


Fig. 1. Performance measurement flowchart

3. RESULTS

3.1 Input and Output Data

The data used in this research are the data of clean water companies (CWC) in Indonesia by the year 2020. The CWC is spread across 34 provinces as follows: Aceh (A), Sumatera Utara (SU), Sumatera Barat (SB), Riau (R), Jambi (J), Sumatera Selatan (SS), Bengkulu (B), Lampung (L), Kep. Bangka Belitung (KBB), Kep. Riau

(KR), DKI Jakarta (DJ), Jawa Barat (JB), Jawa Tengah (JTe), DI Yogyakarta (DY), Jawa Timur (JTi), Banten (B), Bali (Ba), Nusa Tenggara Barat (NTB), Nusa Tenggara Timur (NTT), Kalimantan Barat (KB), Kalimantan Tengah (KT), Kalimantan Selatan (KS), Kalimantan Timur (KTi), Kalimantan Utara (KU), Sulawesi Utara (SU), Sulawesi Tengah (STe), Sulawesi Selatan (SS), Sulawesi Tenggara (STg), Gorontalo (G), Sulawesi Barat (SB), Maluku (M), Maluku Utara (MU), Papua Barat (PB), and Papua (P). The data is presented in Table 1 [15].

Table 1. The data type of Indonesia CWC in 2020

Province	Type-1	Type-2	Type-5
A	211,554	1,331	158,695
SU	894,058	3,971	960,930
SB	579,634	1,599	344,803
R	89,403	986	86,512
J	959,991	1,253	185,147
SS	862,169	2,467	661,481
Be	90,049	516	79,828
L	86,220	606	80,395
KBB	31,058	313	40,149
KR	332,724	893	540,571
DJ	896,782	2,226	2,838,307
JB	1,878,000	7,562	1,976,089
JTe	1,804,587	6,347	1,781,953
DY	191,558	841	208,350
JTi	2,203,955	6,363	2,217,209
B	355,754	1,383	1,229,503
Ba	483,578	2,233	660,419
NTB	527,540	1,258	209,902
NTT	163,514	1,150	137,057
KB	269,744	967	315,386
KT	153,419	1,156	174,938
KS	484,336	1,582	680,195
KTi	499,130	2,342	951,766
KU	76,581	381	110,808
SU	110,848	960	111,573
ST	100,566	757	47,159
SS	517,722	3,423	588,890
ST	98,484	1,101	75,642
G	79,767	674	71,967
SB	65,233	341	35,815
M	59,513	514	53,093
MU	90,014	570	92,439
PB	26,508	213	29,503
P	71,999	358	86,618

Table 1 consists of five data types as follows: (i) Total number of water supply establishment customers (Type-1); (ii) Total number of workers of water supply establishment (Type-2); (iii) Potential capacity production of water supply establishment by province (Type-3); (iv) Quantity of cleaned water distributed of water supply establishment (Type-4); and (v) Value of

cleaned water distributed (Type-5). Based on these data types, then it can be determined 3 tables as follows: (i) Input variables (Table 2); (ii) Output variables (Table 3); and (iii) Decision-making units (DMUs) based on provinces (Table 4). Those tables describe (i) 3 inputs (I1, I2, I3) with 3 output variables (X1, X3, X3); (ii) 2 outputs (O1, O2) with 2 output variables (Y1, Y2); and (iii) 34 provinces (A to P) with 34 DMUs (DMU_A to DMU_P), respectively.

Table 2. Input variables

Input	Variable	Explanation
I1	X1	Total number of water supply establishment customers
I2	X2	Total number of workers of water supply establishment
I3	X3	Potential capacity production of water supply establishment (liter per second)

Table 3. Output variables

Output	Variable	Explanation
O1	Y1	Quantity of cleaned water distributed of water supply establishment (thousand m3)
O2	Y2	Value of cleaned water distributed (million rupiahs)

Table 4. Decision-making units (DMUs)

Province	DMUs	Province	DMUs
A	DMU_A	NTB	DMU_NTB
SU	DMU_SU	NTT	DMU_NTT
SB	DMU_SB	KB	DMU_KB
R	DMU_R	KT	DMU_KT
J	DMU_J	KS	DMU_KS
SS	DMU_SS	KTi	DMU_KTi
Be	DMU_Be	KU	DMU_KU
L	DMU_L	SU	DMU_SU
KBB	DMU_KBB	ST	DMU_STe
KR	DMU_KR	SS	DMU_SS
DJ	DMU_DJ	ST	DMU_STg
JB	DMU_JB	G	DMU_G
JTe	DMU_JTe	SB	DMU_SB
DY	DMU_DY	M	DMU_M
JTi	DMU_JTi	MU	DMU_MU
B	DMU_B	PB	DMU_PB
Ba	DMU_Ba	P	DMU_P

The linear programming technique is applied in the DEA Multipliers Method. Input and output data were arranged in a Microsoft Excel spreadsheet (Table 5). There are 5 columns and 4 rows of data settings in the spreadsheet. The five columns consist of structure as follows: (i) decision making units (DMUs); (ii) variable input (X1, X2, X3); (iii) variable output (Y1, Y2); (iv) constraints; and (v) efficiency value. The four rows consist of (i) weights; (ii) input and output multipliers; (iii) DMU under evaluation; and (iv) Efficiency. Furthermore, the

data is processed using the solver function. ThusTherefore, the efficiency value in each DMU will be known.

Table 5. Data in a spreadsheet of Microsoft Excel

DMUs	X1..X3	Y1,Y2	Cont.	Eff.
	X1	Y1		Value
DMU_A	212	56	-1.23	0.53
DMU_SU	894	325	0	1
DMU_SB	580	109	-2.04	0.65
DMU_R	89	18	-0.92	0.33
DMU_J	960	49	-3.87	0.40
DMU_SS	862	197	-2.25	0.77
DMU_Be	90	25	-0.54	0.53
DMU_L	86	18	-0.62	0.41
DMU_KBB	31	9	-0.34	0.42
DMU_KR	333	94	-0.97	0.83
DMU_DJ	897	495	-0.45	1
DMU_JB	1,878	420	-6.00	0.74
DMU_JTe	1,805	486	-7.84	0.62
DMU_DY	192	48	-0.56	0.75
DMU_JTi	2,204	722	-3.83	0.89
DMU_B	356	240	0	1
DMU_Ba	484	160	-2.00	0.66
DMU_NTB	528	81	-1.66	0.68
DMU_NTT	164	35	-1.65	0.34
DMU_KB	270	76	-0.99	0.67
DMU_KT	153	43	-0.75	0.58
DMU_KS	484	113	-2.11	0.69
DMU_KT	499	199	-0.56	0.95
DMU_KU	77	24	-0.43	0.58
DMU_SU	111	30	-1.24	0.40
DMU_STe	101	23	-1.31	0.34
DMU_SS	518	147	-2.14	0.63
DMU_STg	98	15	-0.80	0.33
DMU_G	80	22	-0.31	0.63
DMU_SB	65	9	-0.35	0.42
DMU_M	60	10	-0.55	0.31
DMU_MU	90	28	-0.30	0.69
DMU_PB	27	6	-0.17	0.49
DMU_P	72	21	-0.50	0.50
Weights	1			
Multipliers	0	0		
DMU under evaluation	34			
Efficiency	0.50			

Table 6 represents the results of input multipliers (I-M), output multipliers (O-M), constraints (C), and efficiency values. There are 3 input multipliers (X1, X2, X3), 2 output multipliers (Y1, Y2), and 34 constraints (C1 to C34). The efficiency value results of clean water companies in Indonesia are presented in Table 7. DMUs with values equal to 1 are effective/efficient and those less than 1 are considered ineffective/inefficient.

Table 6. Results of I-M, O-M, C and efficiency value

DMUs	I-M	O-M	Cont.	Eff.
	X1..X3	Y1,Y2	C1..C34	Value
	X1	Y1	C1	
DMU_A	1.2E	9.4E	-0.47	0.53
DMU_SU	0	3.1E	0.00	1
DMU_SB	0	5.9E	-0.79	0.65
DMU_R	2.3E	1.8E	-0.35	0.33
DMU_J	0	5.7E	-1.49	0.40
DMU_SS	0	3.9E	-0.87	0.77
DMU_Be	2.7E	2.1E	-0.21	0.53
DMU_L	1.9E	2E	-0.24	0.41
DMU_KBB	3.2E	4.8E	-0.13	0.42
DMU_KR	0	0	-0.37	0.83
DMU_DJ	0	1.2E	-0.17	1
DMU_JB	0	1.1E	-2.32	0.74
DMU_JTe	0	1.3E	-3.02	0.62
DMU_DY	0	1E	-0.22	0.75
DMU_JTi	0	1.2E	-1.48	0.89
DMU_B	3.4E	3.4E	0.00	1
DMU_Ba	5.3E	4.1E	-0.77	0.66
DMU_NTB	0	8.4E	-0.64	0.68
DMU_NTT	1.3E	9.8E	-0.64	0.34
DMU_KB	0	8.8E	-0.38	0.67
DMU_KT	1.1E	1.2E	-0.29	0.58
DMU_KS	0	0	-0.82	0.69
DMU_KT	0	3E	-0.21	0.95
DMU_KU	2E	2E	-0.16	0.58
DMU_SU	9E	1.3E	-0.48	0.40
DMU_STe	9.9E	1.5E	-0.50	0.34
DMU_SS	3.6E	3.7E	-0.83	0.63
DMU_STg	1.7E	1.8E	-0.31	0.33
DMU_G	3.7E	2.9E	-0.12	0.63
DMU_SB	0	3.1E	-0.14	0.42
DMU_M	0	1.9E	-0.21	0.31
DMU_MU	3.2E	2.5E	-0.12	0.69
DMU_PB	0	5.3E	-0.06	0.49
DMU_P	3.1E	2.4E	-0.19	0.50
Weights			1	

3.2 Efficiency Value Result Analysis

The efficiency results of the DMUs indicated that there are 3 DMUs in the efficient category; and (ii) 31 DMUs in the inefficient category. The percentages for each of these categories are as follows: (i) The efficient DMUs category is 9% ($3/34 \times 100\%$), and (ii) The inefficient DMU category is 91% ($31/34 \times 100\%$). Table 8 presents DMUs categories with efficient and inefficient categories. The 3 efficient DMUs consist of DMU_SU(1), DMU_DJ(1), and DMU_B(1). The 31 inefficient DMUs consist of DMU_A(0.53) to DMU_M(0.31).

Table 9 presents the province's categories with efficient and inefficient categories. There are 3 efficient provinces consisting of Sumatera Utara, DKI Jakarta, and Banten

and 31 inefficient provinces consisting of Jambi to Papua.

Table 7. Efficiency value of CWC in Indonesia

DMUs	Eff. Value	DMUs	Eff. Value
DMU_A	0.53	DMU_NTB	0.68
DMU_SU	1.00	DMU_NTT	0.34
DMU_SB	0.65	DMU_KB	0.67
DMU_R	0.33	DMU_KT	0.58
DMU_J	0.40	DMU_KS	0.69
DMU_SS	0.77	DMU_KT	0.95
DMU_Be	0.53	DMU_KU	0.58
DMU_L	0.41	DMU_SU	0.40
DMU_KBB	0.42	DMU_STe	0.34
DMU_KR	0.83	DMU_SS	0.63
DMU_DJ	1.00	DMU_STg	0.33
DMU_JB	0.74	DMU_G	0.63
DMU_JTe	0.62	DMU_SB	0.42
DMU_DY	0.75	DMU_M	0.31
DMU_JTi	0.89	DMU_MU	0.69
DMU_B	1.00	DMU_PB	0.49
DMU_Ba	0.66	DMU_P	0.50

Table 8. Category of efficient & inefficient DMUs

No.	DMUs category	DMUs name (EV)
1.	Efficient DMUs	DMU_SU(1), DMU_DJ(1), DMU_B(1).
2.	Inefficient DMUs	DMU_A(0.53), DMU_SB(0.65), DMU_R(0.33), DMU_J(0.40), DMU_SS(0.77), DMU_Be(0.53), DMU_L(0.41), DMU_KBB(0.42), DMU_KR(0.83), DMU_JB(0.74), DMU_JTe(0.62), DMU_DY(0.75), DMU_JTi(0.89), DMU_Ba(0.66), DMU_NTB(0.68), DMU_NTT(0.34), DMU_KB(0.67), DMU_KT(0.58), DMU_KS(0.69), DMU_KT(0.95), DMU_KU(0.58), DMU_SU(0.40), DMU_STe(0.34), DMU_SS(0.63), DMU_STg(0.33), DMU_G(0.63), DMU_SB(0.42), DMU_M(0.31), DMU_MU(0.69), DMU_SB(0.42), DMU_M(0.31).

Table 9. Category of province's efficient and inefficient

No.	Class. type	Province name
1.	Efficient Provinces	Sumatera Utara, DKI Jakarta, and Banten.
2.	Inefficient DMUs	Jambi, Sumatera Selatan, Bengkulu, Lampung, Kep. Bangka Belitung, Kep. Riau, Jawa Barat, Jawa Tengah, DI Yogyakarta, Jawa Timur, Bali, Nusa Tenggara Barat, Nusa Tenggara Timur, Kalimantan Barat, Kalimantan Tengah, Kalimantan Selatan, Kalimantan Timur, Kalimantan Utara, Sulawesi Utara, Sulawesi Tengah, Sulawesi Selatan, Sulawesi Tenggara, Gorontalo, Sulawesi Barat, Maluku, Maluku Utara, Papua Barat, and Papua.

Table 10. Inefficient DMU classification

No.	Class. type	Eff. value range	DMUs (EV)
1.	Good	0.70-0.95	DMU_KT(0.95), DMU_JTi(0.89), DMU_KR(0.83), DMU_SS(0.77), DMU_DY(0.75), DMU_JB(0.74).
2.	Average	0.60-0.69	DMU_MU(0.69), DMU_KS(0.69), DMU_NTB(0.68), DMU_KB(0.67), DMU_B(0.66), DMU_SB(0.65), DMU_G(0.63), DMU_SS(0.63), DMU_JTe(0.62).
3.	Poor	0.30-0.59	DMU_KT(0.58), DMU_KU(0.58), DMU_Be(0.53), DMU_A(0.53), DMU_P(0.50), DMU_PB(0.49), DMU_SB(0.42), DMU_KBB(0.42), DMU_L(0.41), DMU_J(0.40), DMU_SU(0.40), DMU_STe(0.34), DMU_NTT(0.34), DMU_R(0.33), DMU_STg(0.33), DMU_M(0.31).

3.3 Inefficient DMUs Classification

Table 10 presents the DMUs inefficient based on the efficiency value range. There are three classification types (CTs) of 3 DMUs inefficient based on efficiency value range as the following: (i) Good_CT (0.70-0.95);

(ii) Average_CT (0.60-0.69); and (iii) Poor_CT (0.30-0.59). The result of the DMUs' inefficient classification indicated that 6 DMUs in Good_CT, 9 DMUs in Average_CT, and 16 DMUs in Poor_CT. The percentages for each of these CTs are as follows: (i) The inefficient DMUs of Good_CT is 19% (6/31x100%); (ii) The inefficient DMUs of Average_CT is 29% (9/31x100%); and (iii) The inefficient DMUs of Poor_CT is 52% (16/31x100%). Inefficient DMUs with Good_CT consist of DMU_KT(0.95) to DMU_JB(0.74). Inefficient DMUs with Average_CT consist of DMU_MU(0.69) to DMU_JTe(0.62). Inefficient DMUs with Poor_CT consist of DMU_KT(0.58) to DMU_M(0.31). Table 11 presents province classification based on the DMUs' inefficient classification. Provinces with Good_CT consist of Kalimantan Timur to Jawa Barat. Provinces with Average_CT consist of Maluku Utara to Jawa Tengah. Provinces with Poor_CT consist of Kalimantan Tengah to Maluku.

Table 11. Province classification

No.	Class. type	Province name
1.	Good	Kalimantan Timur, Jawa Timur, Kep. Riau, Sumatera Selatan, and DI Yogyakarta, and Jawa Barat.
2.	Average	Maluku Utara, Kalimantan Selatan, Nusa Tenggara Barat, Kalimantan Barat, Bali, Sumatera Barat, Gorontalo, Sulawesi Selatan, and Jawa Tengah.
3.	Poor	Kalimantan Tengah, Kalimantan Utara, Bengkulu, Aceh, and Papua. Papua Barat, Sulawesi Barat, Kep. Bangka Belitung, Lampung, Jambi, Sulawesi Utara, Sulawesi Tengah, Nusa Tenggara Timur, Riau, Sulawesi Tenggara, and Maluku.

4. DISCUSSION

The research results of performance measurement using the DEA-Multipliers Method as a case study of clean water companies in Indonesia indicated that DMUs' provinces in the efficient category are 9% and DMUs' provinces in the inefficient category are 91%. There are three classification types (CT) of 31 DMUs' provinces inefficient based on efficiency value range. These are Good_CT (19%), Average_CT (29%), and Poor_CT (52%). Efficient DMUs have increased performance while inefficient DMUs have decreased performance. In general, the factors that cause the increase and decrease in the performance of clean water companies (CWC) in Indonesia are described below. The factors that cause CWC performance to improve, include: (i) The pattern of water usage from customers is quite high. This will make CWC's performance better because CWC is required to improve its performance both from a technical and operational perspective to meet customer needs; (ii) People's purchasing power for clean water is increasing. It will have an impact on the ability of raw water sources that must be provided by CWC to meet consumer satisfaction. This factor is support for CWC to improve

its performance; (iii) The potential of a large population can be a support to improve the performance of the CWC; and (iv) Increased customer service operating hours. The implementation of operational cost recovery and the development of clean water services or full cost recovery. The objectives of the implementation are (a) CWC will not go bankrupt, and (b) low-income people can afford subscription fees because these tariffs can be bridged with progressive tariffs and local government subsidies. Factors that cause CWC performance to decline include: (i) The rate of water loss (Non-Revenue Water); (ii) The effectiveness of billing and customer service is not optimal. Billing effectiveness is correlated with the service level. Good service will have an impact on good billing rates too; (iii) Availability of clean water production that is not balanced with the addition of customers; (iv) Limited human resources in the CWC environment compared to the service area; and (v) Limited quantity and quality of facilities and infrastructure. This condition can affect the quality and quantity of water produced to meet customer needs [16,17]. The Government of Indonesia strives to continuously improve the performance of the CWC. These efforts include: (i) Expanding house connection pipes in an effort to increase the number of customers and increase CWC's revenue; (ii) Determination of drinking water tariffs based on business principles so that CWC can benefit; (iii) Conducting training and technical guidance related to good management governance; and (iv) Implementing a partnership pattern to help CWC that performs inefficiently through improving human resources [18].

5. CONCLUSION

The results of this research indicated that provinces with the efficient DMUs category have a percentage of 9% and provinces with the inefficient DMUs category have a percentage of 91%. There are three classification types (CT) of 31 DMUs' provinces inefficient based on efficiency value range. These are Good_CT (19%), Average_CT (29%), and Poor_CT (52%). The classification indicates that there are 3 provinces (Good_CT), 9 provinces (Average_CT), and 16 provinces (Poor_CT). Efficient DMUs have increased performance while inefficient DMUs have decreased performance. In general, the factors that cause the increase and decrease in the performance of clean water companies (CWC) in Indonesia are described below. The factors that cause CWC performance to improve, include: (i) The pattern of water usage from customers is quite high; (ii) People's purchasing power for clean water is increasing; (iii) The potential of a large population can be a support to improve the performance of the CWC; and (iv) Increased customer service operating hours. Factors that cause CWC performance to decline include: (i) The rate of water loss (Non-Revenue Water); (ii) The effectiveness of billing and customer service is not optimal; (iii) The availability of clean water production that is not balanced with the addition of customers; (iv) Limited human resources in the CWC environment compared to the service area; and (v) Limited quantity and quality of facilities and infrastructure. The Government of Indonesia strives to continuously

improve the performance of the CWC. These efforts include: (i) Expanding house connection pipes in an effort to increase the number of customers and increase CWC's revenue; (ii) Determination of drinking water tariffs based on business principles so that CWC can benefit; (iii) Conducting training and technical guidance related to good management governance; and (iv) Implementing a partnership pattern to help CWC that performs inefficiently through improving human resources.

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