Analysis of Production Cost Efficiency of Local Government-Owned Drinking Water Supply Companies (PDAMs) in West Java

Review of Integrative Business & Economics Research

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ABSTRACT

In 2015, as many as 15.4 million people in West Java Province lacked access to safe drinking water. Evidently, 21 local government-owned drinking water supply companies (PDAMs) continue to struggle to cope with this problem. One of the many challenges faced by PDAMs lies in production cost efficiency. An efficient PDAM is expected to increase service coverage.

This research uses the statistical cost method to measure cost efficiency. Specifically, two models are adopted: (1) Model 1 measures production cost efficiency by investigating the relationship between average cost and drinking water production through regression equation; and (2) Model 2 determines production cost efficiency with specific independent variables. Of the two, the second model is more appropriate. Result shows that 47.6% of all PDAMs are inefficient, and 52.4% are efficient. The most influential factors related to the efficiency cost of production are energy cost (electricity), maintenance cost, and non-revenue water (water loss). These factors should be the focus of PDAMs for improving their performance. The efficient PDAMs have the opportunity to expand their business, whereas the inefficient ones must increase their efficiency before expanding. About half of the PDAMs in West Java lack the strength to take advantage of opportunities in the drinking market. This situation adversely affects the access to safe drinking water in West Java.

Keywords: cost efficiency, statistical cost method, drinking water access

1. INTRODUCTION

In 2015, the number of households in West Java with access to safe drinking water was 67%. Such accessibility level is below the national average of 71%. According to these data, as many as 15 million citizens continue to lack access to safe drinking water. This number is the highest in Indonesia. Local government-owned

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drinking water supply companies (PDAMs) play an essential role in improving the accessibility to safe drinking water. The provision of access to safe drinking water through a pipeline system is generally deemed the safest from a health perspective; it is also essential to ground water conservation because it prevents the individual and uncontrollable exploitation of ground water.

By 2014, 23 PDAMs had been established in 26 districts/municipalities in West Java Province. According to the data from the Ministry of Public Works, the total number of customers was 1.17 million, and the installed production capacity was 19,054 liters per second. During this period, 21 “safe” PDAMs, 1 “unsafe” PDAM, and 1 “problematic” PDAM were operating in the region. Exactly 20 PDAMs earned profit, and 3 PDAMs incurred losses. The percentage of citizens who received service in areas with established infrastructure was at 38.3%. When this value is compared with the total number of citizens in the respective administrative region, only 19.3% of the citizens had benefited from the service. These data reveal the large market potential for PDAMs in West Java. Moreover, the demand for drinking water through pipeline systems and ground water conservation is increasing because of the growing urban area in West Java.

Table 1. West Java’s PDAM performance in 2012–2013

	2011	**2012**	**2013**
Safe	16	21	21
Problematic	5	1	1
Unsafe	1	0	1
Profit	*14*	*20*	*20*
Loss	*1*	*2*	*3*
Service area coverage (%)	29.5	37.3	38.3
Administrative region coverage (%)	19.7	18.8	19.3

Source: Ministry of Public Works and Public Housing (2014) (Processed data)

Despite the good performance of the PDAMs, as determined by the Ministry of Public Works and Public Housing, these companies continue to face considerable internal and external challenges that require immediate attention.

2. RESEARCH PROBLEM

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Considering the expected role of PDAMs in providing drinking water services, we can infer that the performance of PDAMs is far from ideal. Their ability to expand their service coverage tends to be slow and stagnant. This shortcoming may be due to limitations in capital, source water supply, and inefficient operation. The limitation in capital may be caused by (1) limitations in the ability to obtain capital because of the minimum profit earned, which is insufficient for expansion, (2) lack of support from the local government in capital provision, and (3) operations that may not be efficient. Source water supply is also a significant factor because, for example, the source water supply is obtained from other regions or is generally lacking.

In addition to external factors, internal factors, particularly the production cost efficiency of PDAMs in West Java, require attention. A good comprehension of acceptable efficiency levels will open a path toward the attainment of a high leverage for the expansion of PDAMs and their service coverage in West Java. This objective is the basis of the management and optimization strategy of PDAMs, particularly in West Java.

3. THEORETICAL FRAMEWORK

3.1. CHARACTERISTICS OF PDAMs

PDAMs operate in a monopolistic market. PDAMs are the only suppliers of pipeline system-based drinking water, which they distribute directly to their customers. Consequently, the rate of the services of PDAMs is controlled by the government. Other parties who provide pipeline system-based water supply cannot easily obtain such power. Nevertheless, the monopoly is relatively open because people are still able to access drinking water from other sources, such as wells, rivers, and others. The role of the government in the provision of drinking water supply has become increasingly prominent because of the abrogation of Act No.7 Year 2004 on water resources. When the monopoly is driven by natural factors, the existence of PDAMs may be attributed to government policy.

In a monopoly, the producer generally has full control over all or some dominant parts of the market share. Consequently, a monopolistic producer controls the price and the quantity of products in a given market. Another characteristic of a monopoly is the existence of a high entry barrier, which allows a monopolistic company to retain its position. Such right to monopolize can be granted by the government through a license. The negative impact of this system is market exploitation, which is potentially disadvantageous for costumers and causes inefficiency in production. Theoretically, a

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monopolistic company can cause deadweight loss. Hence, a monopolistic company is usually controlled by the government through the use of a regulation instrument, such as price under the control of the government. According to Greer (1992), a government's regulation of a monopoly is due to the following:

> *The reasons for regulation can be divided into four categories: (1) natural monopoly, (2) conservation of publicly owned natural resources, (3) destructive competition, and (4) sharp public indignation against "unfairness." Regulations are grounded on several rationales. Natural monopoly justifies the regulation of local electricity, water, gas, and telephone service, in which economies of scale seem to stretch the full range of demand.*

The operation of a monopolistic company theoretically leads to loss, which is most commonly referred to as deadweight loss. Specifically, a monopolistic company can set the price and quantity of products in the market that are disadvantageous for customers. Consequently, a monopoly tends to be banned, limited, or controlled by the government. Such governmental control is theoretically rooted in a balanced objective between customer service and ensuring a company's sustainability, as stated by Greer (1992).

> *The objective is to allow the utility with sufficient revenues to pay its "full" cost plus a "fair" return on the "fair" value of its capital. Stated differently, the main objective is to strike a reasonable balance between the interests of consumers (who should not be gouged by monopoly exploitation) and the interest of the utility investors and operators (who should not be cheated by overzealous commissions or who, in more legalistic language, should not be deprived of their property without "due process of law"). Annual flows of total revenue cover the annual flow of "full cost," including depreciation, plus a "fair" or "reasonable" return on capital value, no more and no less. The objective of regulation is to lower the price level below the monopolist's profit maximizing price.*

Setting an accurate regulation requires a good comprehension of costs. An efficient company can increase output at a low cost. Consequently, all companies (including monopolistic ones) need to acquaint themselves with production costs to make accurate business decisions.

3.2. COST AND EFFICIENCY ESTIMATION

Cost and efficiency estimation is used to identify a cost curve. According to Carlton and Perloff (2000),

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> *A cost curve summarizes an enormous amount of information. A firm's average cost may remain constant, rise, or fall as its output expands. If average cost falls as output increases, the firm is said to have economies of scale (or increasing return to scale). If a firm enjoys economies of scale at all output levels, then it is efficient for one firm to produce the entire market output.*

An efficient cost is related to economies of scale. Once a cost curve is identified, a company's economies of scale can be revealed. This scale aids in the process of making decisions related to the production of the optimum number of products with minimum average cost. This condition can serve as an indicator for the setting of a price and quantity of a product. Carlton and Perloff (2000) describe the relationship between cost curve and economies of scale as follows:

> *Economists often estimate firms' cost curves and economies of scale. Because economies of scale refer to cost savings that arise as output increases, it is important in any study of economies of scale to verify that output is the only variable accounting for cost differences among firms (or for the same form over time). Large firms differ from small firms in many ways, for example, they may produce more products or perform different functions, such as marketing. To maximize profit, a firm must minimize the cost of producing a given level of output. A cost function shows how much it costs the firm to produce various amounts of outputs. A cost function depends not only on the output produced but also on the price of factors of production, such as wages of workers and the price of raw materials.*

3.3. MEASURING PRODUCTION EFFICIENCY

The utilization of the cost curve in measuring production efficiency can be done through benchmarking. Benchmarking is the comparison of one party with others with the intention of providing an assessment standard. In a business, benchmarking is usually employed to improve a company's performance. Thus, benchmarking is adopted in the current study. Theoretically, the benchmark to use can be based on four methods, as cited by Lipczynski and Wilson (2004):

a) *Engineering Cost Estimates: a calculation based on experts' prediction in terms of production cost on various output levels on some particular technology.*
b) *Statistical Cost: a calculation based on actual data. For instance, data are attained from homogenous companies and are then plotted on a figure and*

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calculated using regression equation. This method is relatively the most employed one.

c) *Survivor Technique: a calculation that is based on surviving companies operating among nonoperational companies within a particular industrial class. These surviving companies are used as the standard.*
d) *Rate of Return: a calculation based on the assumption that a company's performance is contingent on its size and economies of scale. The bigger the size is, the more likely its potential to profit will be. In other words, there is an efficiency of average cost.*

In this study, the calculation of average cost efficiency is achieved through the use of a statistical cost method. This method is an obvious choice because (1) it is commonly used because of its practicality; (2) available data are adequate, including the number of companies to be scrutinized; and (3) the process could be done in a timely manner.

4. RESEARCH METHOD

4.1. RESEARCH OBJECT

The object of this research is the cost of drinking water production in 23 PDAMs in West Java from 2012 to 2013.

4.2. MODEL

The research method used is a quantitative method, the basic models of which are as follows:

Model 1: measuring production cost efficiency by investigating the correlation between average cost and the quantity of production through the following regression equation:

AC = f(Q) (1)

Model 2: measuring production cost efficiency by scrutinizing influential variables using the following regression equation:

AC = f(BK, BE,BP, BA, KA, KP) (2)

Notes:

AC: average production cost (in Rp/m^3)

Q: quantity of PDAM's drinking water production (liter per second)

BK: the cost of chemicals needed for water source processing (Rp/m^3)

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BP: maintenance cost (Rp/m^3)

BA: ratio of general administration cost to income (includes employees cost)

KA: percentage of non-revenue water; taken into consideration because the rate of non-revenue water among PDAMs in West Java is considered significant (29%)

KP: population density; the denser the population, the more likely that the service cost per household will be less

To determine whether a PDAM is efficient or inefficient, we use Equations (1) and (2).

$$\boldsymbol{Efficient} = \frac{AC}{ACest} < 1 \qquad \textbf{(3)}$$

$$\boldsymbol{Inefficient} = \frac{AC}{ACest} > 1 \qquad \textbf{(4)}$$

5. ANALYSIS

5.1. PDAM PROFILE

The data of 23 PDAMs are the average data from 2012–2013. Some PDAM data for the succeeding periods were not available. All data were obtained from the Ministry of Public Works and Public Housing. The region with the highest number of customers was the Bandung Municipality PDAM with 150,657 customers, and the region with the least number of costumers is the Depok Municipality PDAM with 7,004 customers. The installed production capacity of the West Java PDAM was 19,705 liters per second, which was deemed able to serve 1.6–2.4 million customers. The highest production capacity was attributed to the Bandung Municipality PDAM with a capacity of 2,792 liters per second. Conversely, the Depok Municipality PDAM had the lowest production capacity at 69 liters per second. Overall, the water production was at 14,570 liters per second or approximately 73.9% of the maximum installed capacity. The highest utilization of production capacity was attributed to the Depok Municipality PDAM with 100% utilization, whereas the lowest utilization was attributed to the Sumedang District PDAM with 38.4% utilization. The number of customers of the PDAMs in West Java obviously varied during the given period.

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Table 2. PDAM Profiles in West Java 2013

Districts/ Municipalities	Number of customer (household)	Production capacity (liter per second)	Production Capacity (liter per second)	% Actual Production
Districts				
Bandung	71,619	872	725	83.1
Bekasi	177,211	2,330	1,705	73.2
Bogor	145,214	2,449	1,974	80.6
Ciamis	21,554	316	175	55.4
Cianjur	34,322	738	311	42.1
Cirebon	30,988	341	292	85.6
Garut	40,060	687	338	49.2
Indramayu	82,220	975	740	75.9
Karawang	57,567	785	687	87.5
Kuningan	32,653	483	317	65.6
Majalengka	19,432	266	159	59.8
Purwakarta	21,921	407	230	56.5
Subang	33,577	477	300	62.9
Sukabumi	26,665	525	275	52.4
Sumedang	26,571	568	218	38.4
Tasikmalaya	35,555	358	342	95.5
Municipalities				
Bandung	150,657	2,792	2,244	80.4
Banjar	10,065	150	120	80.0
Bekasi	20,798	450	391	86.9
Bogor	118,424	2,050	1,659	80.9
Cirebon	56,118	1,046	981	93.8
Depok	7,044	69	69	100.0
Sukabumi	19,338	571	318	55.7
Total	**1,239,573**	**19,705**	**14,570**	**73.9**

Source: Ministry of Public Works and Public Housing (2014)

The cost of goods production that is used to measure average production cost is

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based on PDAMs' cost, which includes non-revenue water. On average, the PDAM cost of goods production in West Java was Rp. 4,144/m^3. The highest cost of goods sold was observed in the Depok Municipality PDAM with Rp. 8,939/m^3; the lowest one was achieved by the Cirebon Municipality with Rp. 2,699/m^3.

The cost for chemicals is the amount of money used for the provision of chemicals that are needed source water processes. Source water from the surface, such as from rivers and lakes, tends to be unhygienic, hence the relatively high processing cost. By contrast, source water from springs and wells does not require chemicals to process. The average cost for chemicals per m^3 of production quantity among the PDAMs in West Java was Rp. 106.19/m^3. The PDAM with the highest spending for chemicals was the Indramayu District with Rp. 448.42/m^3. The PDAM in the Tasikmalaya District achieved the lowest spending for chemicals at Rp. 6.9/m^3. Notably, Depok Municipality showed the cost of Rp.0/m^3 possibly because of loss of data or because they did not use chemicals.

Energy cost is the amount of money spent for providing fuel and electricity. It is used for processing, pumping, and other types of operations. The location of the source water, location of the processing site, and customers' location affect energy cost. Elevated and far locations require high energy cost. The average energy cost per m^3 among the PDAMs in West Java was Rp. 230.69/m^3. The PDAM with the highest spending for energy was the PDAM in Indramayu District with Rp. 554.19/ m^3. The PDAM in the Cirebon District achieved the lowest spending for energy at Rp. 15.29/m^3. The PDAM in the Depok Municipality showed an energy cost of Rp.0/m^3 possibly because of loss of data or because they did not use energy.

Maintenance cost is the amount of money spent for maintaining all systems for drinking water provision. It is used for cleaning the installation, minimizing leakages, changing meter sets, and others. The average maintenance cost per m^3 among the PDAMs in West Java was Rp. 201.17/m^3. The PDAM with the highest spending for maintenance was the PDAM in the Subang District with Rp. 365/ m^3. The PDAM in the Bekasi Municipality showed the lowest spending for maintenance at Rp. 70/m^3. The PDAM in the Depok Municipality showed maintenance cost of Rp.0/m^3 possibly because of loss of data or because they did not perform any maintenance.

The ratio of the general administration cost comprises the administrative costs and the cost for employees relative to the income in the same year, which is a fixed cost. The ratio for the given period was approximately 46.51%, which can be inferred as the income allocated for fixed cost. The PDAM with the highest cost ratio at 67.38% was that in the Sukabumi Municipality; the PDAM with lowest one was that in the Depok

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Municipality at 14.65%.

The level of non-revenue water indicates the percentage of water that cannot be sold because of loss or leakage. The causes for such leakage comprise technical factors, such as faulty equipment, or non-technical factors, such as error in taking notes of household water consumption and others. Unlike in other industries, the level of non-revenue water is rather significant because it reaches 30%. Hence, this factor also affects production cost. On average, the percentage of non-revenue water among the PDAMs in West Java was 29.65%. The PDAM with the highest level of non-revenue water was that in the Sukabumi Municipality with 60.16%. The PDAM in the Depok Municipality showed the lowest level of non-revenue water at 14.65%.

Population density is generally considered influential to investment and operation cost. A high population density can result in a relatively low transmission cost. Conversely, a low population density results in a dispersed center, thus increasing the operational cost. The average number of population density in West Java was 3.312 inhabitants/km^2. The highest density was observed in Bandung with 13.952 inhabitants/ km^2, whereas the lowest density was noted in the Sukabumi District with 588 inhabitants/ km^2.

Table 3. Average Costs and Variables

Districts/ Municipalities	**Cost of Goods Production**	**Chemicals cost**	**Energy Cost**	**Maintenance Cost**	**General Cost/ Revenue**	**Non-revenue Water**	**Population Density**
	Rp/m^3	**Rp/m^3**	**Rp/m^3**	**Rp/m^3**	**%**	**%**	**Pop/km^2**
Districts							
Bandung	3,740	61.36	125.88	169	49.78	33.61	1,974
Bekasi	5,654	163.18	440.30	306	45.75	29.85	2,027
Bogor	3,892	93.65	368.01	190	38.70	29.62	1,389
Ciamis	3,559	161.36	313.21	251	51.11	28.29	849
Cianjur	4,457	26.43	199.82	164	66.90	31.06	577
Cirebon	5,316	146.69	222.26	384	52.12	25.15	2,087
Garut	3,056	11.00	296.21	105	29.53	27.65	710
Indramayu	4,228	448.42	554.19	229	30.83	24.09	897
Karawang	3,515	90.00	380.94	143	22.00	31.97	1,149
Kuningan	3,121	59.11	108.74	152	58.79	32.24	1,002
Majalengka	3,178	130.77	169.05	271	49.26	20.99	1,029
Purwakarta	3,616	122.29	194.27	289	55.79	23.24	1,024

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Districts/ Municipalities	Cost of Goods Production	Chemicals cost	Energy Cost	Maintenance Cost	General Cost/ Revenue	Non-revenue Water	Population Density
	Rp/m^3	Rp/m^3	Rp/m^3	Rp/m^3	%	%	Pop/km^2
Districts							
Subang	4,081	76.04	387.39	365	50.24	22.34	812
Sukabumi	4,940	133.95	304.46	236	50.87	31.94	588
Sumedang	4,447	109.14	274.00	212	53.53	28.27	725
Tasikmalaya	3,941	6.90	30.14		30.65	32.10	643
Municipalities							
Bandung	3,960	174.80	66.67	342	50.40	33.98	13,953
Banjar	3,818	98.36	431.66	164	34.38	32.31	1,661
Bekasi	3,186	208.12	286.48	70	48.94	16.20	11,524
Bogor	3,862	102.79	32.11	190	43.18	34.01	8,291
Cirebon	2,699	7.84	15.29	232	56.02	38.13	8,462
Depok	8,939	0.00	0.00	87	33.50	14.65	8,148
Sukabumi	4,108	10.14	104.68	76	67.38	60.16	6,652
Average	**4,144**	**106.19**	**230.69**	**201.17**	**46.51**	**29.65**	**3,312**
Variance Coefficient	**29.83**	**88.44**	**65.84**	**48.03**	**25.08**	**29.20**	**118.12**

Source: Ministry of Public Works and Public Housing (2014)

The level of difference or disparity among the PDAMs in West Java shows that (1) despite the high difference in the numbers of customers, the production costs are relatively similar. Moreover, (2) the spending for chemicals among the PDAMs in West Java relatively varies. The differences between energy cost and maintenance cost also vary. The differences in the ratio of revenue and non-revenue water among the PDAMs are relatively similar. The population densities are significantly different. These differences are analyzed to determine the efficiency of the PDAMs in West Java.

5.2. ESTIMATED AVERAGE COST ON QUANTITY OF PRODUCTION

In this section, we estimate the production cost efficiency between average cost and the water quantity of production, as shown in the following regression equation:

$$AC = 0{,}0012Q^2 - 2{,}7756Q + 4.941{,}7 \quad \textbf{(5)}$$

$R^2 = 0{,}0975$

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According to Equation (5), the appropriate model for estimating production cost is a quadratic equation. This model is suitable to the pattern of cost curve, which is generally U shaped. Therefore, a large water production equates to a low average cost until the production reaches 1,156 liters per second. In the case in which the production limit is reached, a large water production equates to a high average production cost. Unfortunately, the value of R square is too low, which means that the first model is not appropriate for the cost efficiency model.

5.3. ESTIMATED AVERAGE COST BY COMPONENTS

According to Equation (2) and the data from the 23 PDAMs in West Java, 2 PDAMs, namely Tasikmalaya Municipality and Depok Municipality PDAMs, lacked complete data. Consequently, the data from the two PDAMs were not analyzed, leaving 21 observations to be observed. Through the utilization of the average cost equation, the regression result was attained as follows:

AC = 13.01 + 0.77BK + 3.25BE + 4.02BP + 23.24BA + 34.24KA -0.003KP **(6)**

(0.991) (0.716) (0.073)* (0.037)** (0.157) (0.103) (0.955)

F = 0.068*

R^2 = 0.53

Out of six variables that expectedly influence average production cost, two significant variables were identified: energy cost and maintenance cost. The least significant variable is population density. Nevertheless, the path of coefficient is correct, that is, it is inversely correlated. We can infer that in densely populated areas, the average production cost is low. However, the effect is not adequately significant to influence average production cost. Concurrently, all independent variables are significant in influencing average production cost. The coefficient of determination is rather high, or the variation of the average production cost is rather strong, as determined by the variation of independent variables. To fix such equation, we excluded the chemical cost and population density from the equation, thereby leaving the following equation:

AC = 13.01 + 3.25BE + 4.02BP + 23.24BA + 34.24KA **(7)**

(0.991) (0.008)*** (0.019)*** (0.128) (0.087)**

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F = 0.015**
R^2 = 0.52

According to the reduced equation, energy cost and maintenance cost significantly influence the formation of the average production cost. Moreover, the non-revenue water variable significantly influences the average production cost, whereas the ratio of revenue on income is slightly significant. Collectively, all variables exert a significant influence on the formation of average production cost. The coefficient of determination is relatively similar to that in the previous equation. The result of Equation (6) is used to calculate the level of average production cost efficiency.

Table 4. Efficiency Level of PDAMs

No	Districts/Municipalities	Actual AC	Estimated AC	Efficiency Ratio	Category
	Districts				
1	Bandung	3.740	3.444	0.92	Inefficient
2	Bekasi	5.654	4.897	0.87	Inefficient
3	Bogor	3.892	3.992	1.03	Efficient
4	Ciamis	3.559	4.298	1.21	Efficient
5	Cianjur	4.457	3.994	0.90	Inefficient
6	Cirebon	5.316	4.455	0.84	Inefficient
7	Garut	3.056	3.113	1.02	Efficient
8	Indramayu	4.228	4.444	1.05	Efficient
9	Karawang	3.515	3.533	1.00	Efficient
10	Kuningan	3.121	3.477	1.11	Efficient
11	Majalengka	3.178	3.599	1.13	Efficient
12	Purwakarta	3.616	3.985	1.10	Efficient
13	Subang	4.081	4.818	1.18	Efficient
14	Sukabumi	4.940	4.317	0.87	Inefficient
15	Sumedang	4.447	4.054	0.91	Inefficient
	Municipalities				
16	Bandung	3.960	3.984	1.01	Efficient
17	Banjar	3.818	4.094	1.07	Efficient
18	Bekasi	3.186	3.010	0.94	Inefficient
19	Bogor	3.862	3.065	0.79	Inefficient

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20	Cirebon	2.699	3.611	1.34	Efficient
21	Sukabumi	4.108	4.249	1.03	Efficient
22	Tasikmalaya	3.941	2.354	0.60	Inefficient
23	Depok	8.939	3.181	0.36	Inefficient

Source: Data Analysis

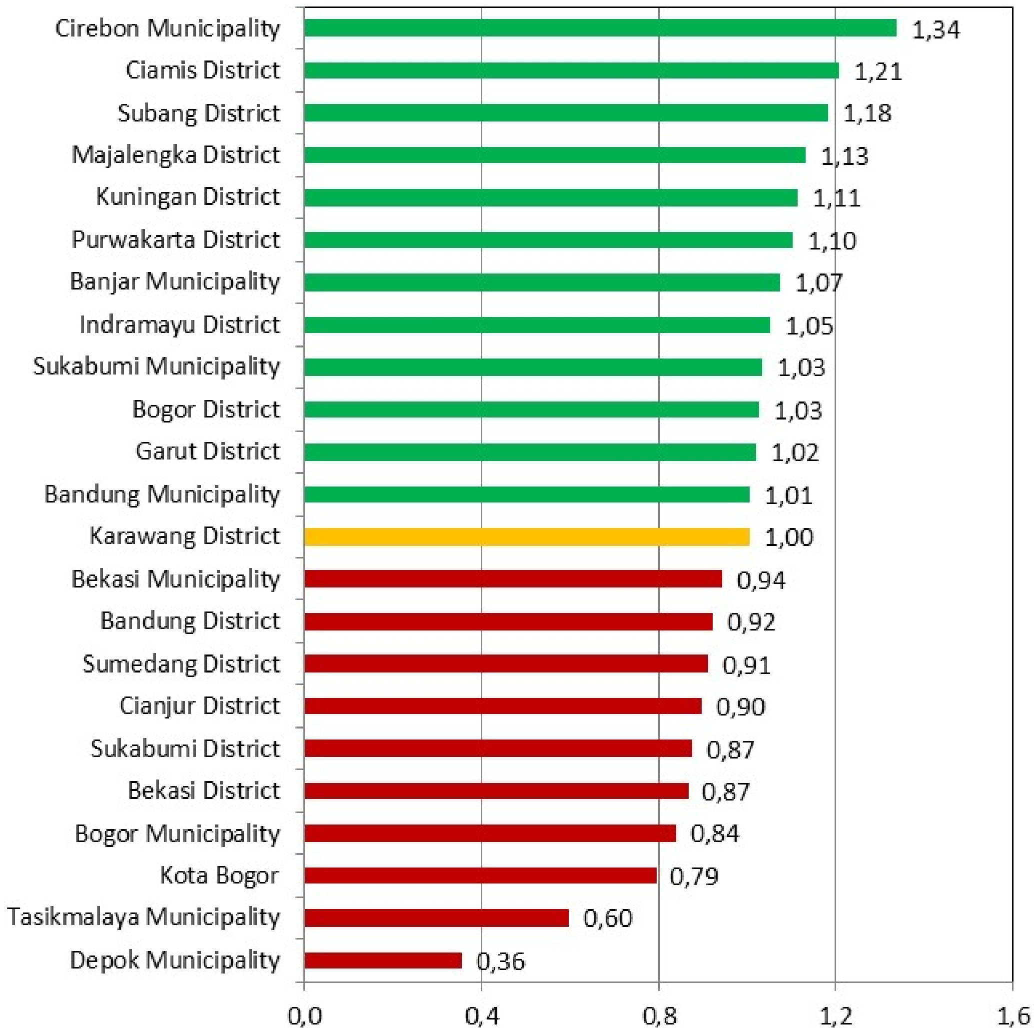

Figure 1. Ranking of efficiency level of average production cost of PDAMs

The above figure shows 10 inefficient PDAMs (47.6%) and 11 efficient PDAMs (52.4%). The five most efficient PDAMs are the PDAMs of Bogor Municipality, Ciamis, Subang, Majalengka, and Kuningan District. The most inefficient PDAMs are the PDAMs of Depok and Tasikmalaya Municipalities. However, we must be cautious with regard to the PDAMs with efficiency levels near 1, such as Bandung Municipality, Garut District, Bogor District, and Sukabumi Municipality. In a medium or long-term

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horizon, the performances are dynamic. The efficient PDAMs need to start expanding their service coverage plan but inefficient PDAMs need to put efficiecy program first.

6. CONCLUSION AND SUGGESTIONS

6.1. CONCLUSION

1. This research model can be used to analyze the efficiency of PDAMs in West Java. As many as 11 PDAMs (52.4%) are efficient in terms of their average production cost, whereas 10 PDAMs (47.6%) are inefficient.
2. The most influential factors that affect the level of efficiency of the PDAMs in West Java are energy cost (the use of electricity), maintenance cost, and non-revenue water.
3. About half of the PDAMs in West Java lack the strength to take advantage of opportunities in the drinking market. This situation affects the access to safe drinking water in West Java.

6.2. SUGGESTIONS

1. All PDAMs in West Java can improve their efficiency by reducing their energy cost. Consequently, a technology audit is required to determine the critical elements that require energy efficiency. Focus should be directed to production systems and utilities that can minimize the use of energy. Collectively, the PDAMs in West Java can propose specific electricity tariff to the National Electricity Company because their business is not purely profit-oriented but is based on full cost recovery. Perpamsi (Association of PDAMs) or the West Java Province can initiate and facilitate this collective process.
2. All inefficient and indecisive PDAMs should increase their efficiency by first reducing energy cost, maintenance cost, and non-revenue water.
3. Further studies on panel data analysis based on the PDAMs in West Java should be conducted to determine the fundamental and consistent causes of production cost efficiency.

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