Combinatoric Efficiency Model of Clean Water Companies for Strategic Governance in Indonesia

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The market share of clean water companies in Indonesia (PDAMs) are very small compared to the demand growth as well as threat of scarcity of clean water occur. The clean water companies market share is around 28.85%. Many of companies are not able to provide drinking water services that meet the standards, as clean water companies in Indonesia are still inefficient Therefore, fundamental solutions are needed to increase efficiency. This research aims to develop a comprehensive model of efficiency measurement of clean water companies in Indonesia and develop it's generic strategy to reduce inefficiency, based on two models by using multiple regression techniques with data from 398 companies. Model-1 categorises the efficiency level of the company using standard and frontier equations based on cost curve, and Model-2 uses factors that determine cost efficiency based on four clusters of scale production. The results of the look at display that many organizations are inefficient due to the have an impact on of manufacturing scale and different affecting elements in every cluster, mainly administrative elements, trendy expenses and water loss/ leakages. This is a essential hassle because easy water production is capital in depth with standardised generation. For practical tips, companies need to boom production manufacturing through growing new potential or thru mergers & acquisitions among small size organizations. To support the strategy, each employer additionally desires to solve its own micro-partial problems. For government and groups affiliation, it's miles recommended a coverage to cope with many elements to growth efficiency, which includes variations in the production scale and the big number of inefficient companies. The health of the operational system requires careful management when implementing institutional reforms which emphasize increased governmental responsibility. The strategic focus on these sectors enables smooth water companies to boost operational efficiency apart from self-performance improvement. additionally make a contribution to the critical intention of making sure sustainable get admission to to smooth water for all of Indonesia.

Keywords: Business Governance, Clean Water, PDAMs, Efficiency, Frontier's Efficiency.

Introduction

Efficiency in providing clean water is under investigation by policymakers, research communities, regulators and business (Benito et al., 2019; Wuijts et al., 2021). In Indonesia, the clean water companies market share is around 28.85% (Friana, 2022) from a total of 91.05% access to national, and concentrated in urban areas. Those companies called PDAMs as commonly owned by local governments. In many national acts and academic literature, the implementation of efficient water prices can cause redistributive and social problems, so they must be handled by public authorities (Reynaud, 2016). The marketplace proportion of PDAMs are very small as compared to the call for boom as well as risk of scarcity of clean water occur, exacerbating the city water disaster (Sedlak, 2023). Ministry of Public Work and Public Housing evaluated the overall performance as many as 389 from 401 the groups in 2022. The result confirmed as 60.Ninety three% groups are in "healthful", 25.96% in "moderately unhealthy", and 13.11% in "dangerous" conditions. Besides that, lots of agencies have no longer been able to offer ingesting water services that meet the standards, as easy water businesses in Indonesia are nonetheless inefficient (Sukartini & Saleh, 2016). The provision of water is an essential determinant of the welfare of a nation (Dinka, 2018). The efficiency and productivity of the industries has been increasing (Abbott & Cohen, 2009), and therefore it's important to be measured (Carlton & Perloff, 2000). Unfortunatelty, efficiency is very important aspect and related to the right pricing policy. Pricing for water services is implemented through full cost recovery by implementing efficient water prices and is considered the cornerstone of any policy related to sustainable water management (Massarutto, 2007). Thus, the problem of inefficiency in clean water companies in Indonesia must be address seriously through good governance practices (Umami et al., 2022). Poor corporate governance will have implications for a worsening performance, which in turn can disrupt access to clean water (Nur et al., 2018). Otherwise, effective governance of water contributes to establishing distinct and sustainable goals and targets for water policy across various levels of government, implementing those goals and achieving the desired objectives or targets (OECD, 2018). Fundamental efforts are required to enhance the efficiency of clean water companies to increase performance comprehensively.

This research aims to develop a comprehensive model of efficiency measurement of clean water companies in Indonesia and develop it's generic strategy to reduce inefficiency. The novelty of this research are : *firstly*, use macro-model including all companies data in Indonesia, when other related studies usually use micro-model with single company data, or case study; *secondly*, including not only cost component variables, but also management and techninal variables, and *finally*: build a combinatoric models of efficiency to formulate the strategic governance for inefficiency reduction all PDAMS individually. The research results will be useful for : *firstly*, companies (PDAMs) individually; *secondly*, associations (PERPAMSI) of companies for sinergy and collaboration to improve their performance; *thirdly*, central and local governments policy and facilitation on national clean water access development in Indonesia; *finally*, researchers for having comprehensive and generic reference on companies (PDAMs) study which is very limited in Indonesia. This research are structured in an introduction, review of literature, method, results and their discussion, as well as conclusions and policy recommendations.

Review of Existing Literature

Water serves diverse functions across extraordinary sectors of society, including however no longer constrained to drinking, waste management, waste dilution, manufacturing items, agricultural activities, energy manufacturing and consumption (Gleick, 1998). Clean water is one of the most basic critical needs in human lifestyles, and clean water ought to be available in sufficient quantity and fine with assured continuity. Consuming smooth water also can be a method to improve the welfare of lifestyles thru fitness popularity. The provision of water that meets appropriate requirements is an crucial determinant of the welfare of a network; consequently, such provision assumes paramount significance inside the development and advancement of a nation (Dinka, 2018). The provision of smooth water with restricted amount and terrible satisfactory will bring about the emergence of financial and non-monetary influences on society. Referring to the enjoy of Canada, which has similarity with Indonesia in time period of huge of region and a low populace density at rural region, as well as similarity in shape of presidency responsibility inside the smooth water region. The important (federal) government also presents investment and policy and regulatory oversight. In the simular circumstance, management of and get admission to to secure consuming water, equitable governance structures are need to be evolved (Irvine et al., 2020). Furthermore, accessibility issues continue to be a trouble for national governments and a few neighborhood governments. Accessibility is the degree of courting among one region and some other that may be measured by way of the quantity, price, distance and time (Howard et al., 2003). The primary characteristic of smooth water industry is this is incredibly capital-intensive nature (Molinos-Senante et al., 2020). Therefore, manufacturing of easy water via businesses in Indonesia suggests a pattern of growing returns to scale or the capacity for greater efficient use of factors of manufacturing if the quantity of manufacturing is extended (Umami et al., 2022).

Referring to the numerous problems in supplying clean water mentioned above, from the supply facet, interest inside the productiveness and performance of the wastewater industries and water deliver has been growing (Abbott & Cohen, 2009). Therefore, many research have been achieved at the efficiency of clean water corporations. In wellknown, efficiency is measured the use of 4 strategies: the least rectangular regression manufacturing model or price function, overall component productiveness index, records envelopment analysis (DEA) and stochastic frontier (Thanassoulis, 2000; Woodbury & Dollery, 2004; Coelli et al., 2005; García-Sánchez, 2006; Umami et al., 2022). Among the embodiments of this method, namely, the efficiency measurement is carried out by estimating the cost curve, as well as for estimating economies of scale, where cost savings decrease and output increases (Carlton & Perloff, 2000), in a cubical cost curve (Erfie, 2014) which is influenced by single as well multiple factors determine cost production (Abbott & Cohen, 2009; Umami et al., 2022). Therefore, a cost function estimation model for the basis of efficiency measurement can be built using two models, which are outlined in the following Figure 1.

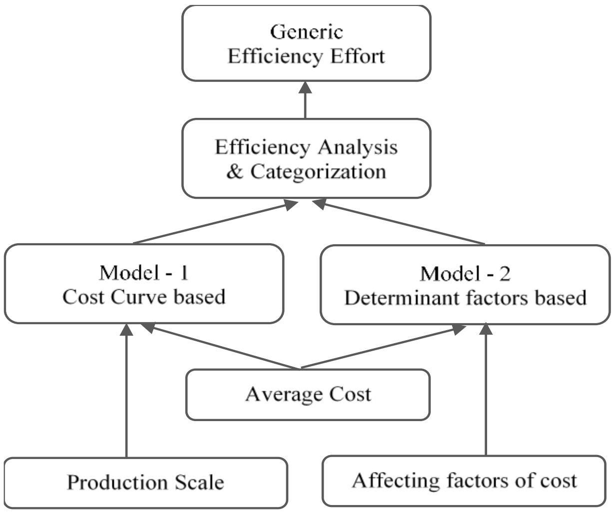

Figure 1: Framework Efficiency Model and Effort Formulation.

It is very important for management to understand performance primarily based on the economies of scope and sclae that may result in cost discount (Novelli & Spina, 2024), confer with revel in in Spain. Economies of scale and efficiency doubtlessly reduce charges (Petkovšek et al., 2021). Moreover, make the control of cost is essential, as they effect at once at the very last tariff charged to clients (Mbavarira et al., 2021; Islam et al., 2024). Fundamental efficiency answers are constructed on efficiency evaluation and performance categories. The categorisation is acquired from a combination of two common price fashions: the version shaped based on influencing factors and the model shaped primarily based on cost curve. The two fashions are constructed with econometric technique. The advantage of the econometric technique while as compared with different non-parametric estimation techniques which includes index numbers. DEA is that the econometric technique is extra together with variables (Molinos-Senante et al., 2020; Miao et al., 2022; Maziotis & Molinos-Senante, 2024). The mixture of the two models is accomplished on efficiency stage classes. Literature references for each models are described as follows:

Model 1

This first model analyses the companies' efficiency level based on the average cost through a cost function as a relation between average cost and volume of production. In this cost function, volume of production is related to economic of scale (Crain & Zardkoohi, 1978; Fox & Hofler, 1986; Schmit & Boisvert, 1997; Estache & Rossi, 2002). Given the variation in the geographic extent and clients served by water companies both domestically and internationally, studies on economies of scale are pertinent to the water industry (Abbott & Cohen, 2009). The results show that on a small production scale, economies of scale increase when production increases. However, on a large production scale in England and Wales show a tendency towards diseconomies of scale, although many studies have shown the economies of scale in water sector is shown in many studies (Bhattacharyya et al., 1994; Renzetti, 1999; Garcia & Thomas, 2001; Ashton, 2000, 2003; Shih et al., 2006; Nauges & van den Berg, 2007; Umami et al., 2022).

Model 2

This model analyses the giant elements affecting the average value. Those elements are as observe. First, chemical cost for processing raw water into a general of exceptional (Mizutani & Urakami, 2001; Anwandter & Ozuna, 2002; Ashton, 2000, 2003; Fraquelli & Giandrone, 2003; Garcia & Thomas, 2001; Umami et al., 2022). Second, energy fee, which consists of strength and gas (Anwandter & Ozuna, 2002; Ashton, 2000). Third, preservation fee (Schmit & Boisvert, 1997; Woodbury & Dollery, 2004; Umami et al., 2022). Fourth, management and widespread cost, which includes wage, salary and management fee (Ashton, 2000, 2003; Aubert & Reynaud, 2005; Bottasso & Conti, 2003). Fifth, water loss from discrepancies in production and distribution volume and Sixth, return on equity for the opportunity to growth overall performance (Sauer, 2005; Sawkins, 1996; Woodbury & Dollery, 2004).

The companies' efficiency efforts are based on a combination of two efficiency model analyses. The combination of fundamental aspects of efficiency will lead to efficiency efforts of all those companies to increase national clean water access in Indonesia. Companies' pursuit of efficiency stems from a strategic amalgamation of two distinct efficiency models. By integrating essential components of efficiency, these companies aim to enhance their collective efforts to achieve widespread access to clean water and promote national water conservation in Indonesia. Refer to the experience in Welsh and English, this type of research can assist policy makers to implement or design effective policies to enhance the efficiency of the water industry (Molinos-Senante et al., 2020). This holistic approach, encompassing core efficiency principles, serves as a foundation for driving efficiency initiatives across all participating companies. This collaborative endeavour contributes to the broader objective of safeguarding the country's water resources, ensuring their sustainable utilisation and fostering a greener future for Indonesia.

Research Methodology

Research Approach

This studies makes use of quantitative method with the value approach as the idea for measuring efficiency on smooth water organizations in Indonesia. The populace length is 401 corporations, on the whole owned via nearby-governments. The quantity of samples studied turned into 389 agencies or ninety seven% of the populace, which cowl almost all members of populace. The statistics had been accrued from Ministry of Public Works and Public Housing audited record from 2019-2022, and converted into go-section information. This studies was designed by means of estimating the level of value performance with the Cost model in an U-shape curve, and the Cost version stricken by multiple figuring out factors.

Technique of Analysis

The first model of Cost is using production volume as the independent variable, designed in a U-shape cubical function or frontier efficient model for four categories of company efficiency level. The second model of Cost is using multiple affecting factors on cost. Because the high variation of companie's volume of production, hence it's grouped into four clusters as shown in Table 1. From the second model, we can identify significant factors affecting the cost for every cluster, and then categorized into two level of efficiencies. The clusters of companies are as follows:

Table 1: Mean Production Level of Clusters over 2018–2021 Period (liter per second).

Cluster	Production Capacity	Average Production Capacity	Variation Coefficient (%)	Number of Companies
All		415	312.80	389
I	>1,000	3,369	120.03	25
II	350<-1,000	545	31.38	66
III	190<-350	257	17.51	79
IV	<190	94	52.13	219

Source: Ministry of Public Housing and Public Works (data processed).

Above efficiency fashions are achieved the usage of regression equations with the subsequent model specifications:

Model 1: We calculate performance levels on the basis of a quadratic cost characteristic via the use of common fee and extent of manufacturing (Carlton and Perloff, 2000) as follows:

lnY = bo +b1.lnX +b2.lnX2 + e (1)

in which

Y denotes common cost (IDR/m3) and X represents manufacturing vloume (million of mthree)

The expected line of the above equation shows value efficiency fashionable that rely upon quantity of production. Moreover, the improvement of version (1.1) primarily based on minimal value at special ranges of output which suggest the excellent performance amongst organizations as a frontier version (Abbott & Cohen, 2009). Furthermore, all corporations are labeled into 4 classes, depending upon the position of the above equation and the frontier model which is given as follows:

1. Efficient: the actual Yi is less than the estimated price from [(1) – 0.5 ((1)- (1.1))]
2. Light green if the estimated value of Y £ actual Yi is less than estimate fee of Y.
3. Slightly inefficient; if the estimated fee of Y from 1 £ actual Yi is less than estimated price of Y through [(1) + 0.5 ((1)- (1.1))]
4. Inefficient: in case if real Yi is greater than estimated fee of Y through [(1) + 0.5 ((1)- (1.1))].

Model 2: The groups performance degrees are calculated on the basis of the characteristic between the mean fee and the affecting elements in each firm cluster as shown in the equation (2)

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + e \quad (2)$$

Where,

Yi shows average cluster cost X_{1i} denotes chemical fee, X_{2i} represents electricity value, X3i denotes upkeep value and X4i management & preferred value of i cluster, all measured in IDR/mthree. X_{5i} measures water loss and X_{6i} calculates the return on fairness of cluster (both measured in %)

This model is used to categorize company's efficiency level, by making a comparison between its actual and estimated cost. It is namely efficient companies if actual cost $Y_i < \widehat{Y}_i$, and vice versa, inefficient companies if actual cost $Y_i > \widehat{Y}_i$. Each cluster indicates significant factors affecting the average costs. Equation (1) and equation (2) in four clusters were tested with Classical Test, partial coefficient with t-test, multiple simultanous coefficient with F-test and the coefficient of determination with R^2. By combining the four efficiency categories based on Model 1 with the two efficiency categories from Model 2, resulting in eight efficiency categories as the key important information to generate strategic efficiency solutions for each company.

Research Findings

Model 1

The findings of model 1 which is a quadratic or U-shaped function are given as follows:

logY =(3.86)*** - (0.313)*** lnX + (0.118)***lnX^2 + e (1)

F(prob) = 0.000 and R square = 0.159

The above equation represents a highly significant production volume with average costs, with the value of R^2 0.159, which indicates different efficiency levels of the company. Moreover, the equation (1.1) is a frontier model of the three best companies as follows:

lnYf =(3.26)***-(0.236)***ln Xf + (0.1102)***lnXf^2 +e (1.1)

With F (prob) equal to 0.000 and R² equal to 1

The value of b_0 which represents the frontier efficiency level from the best companies is less in equation (1.1) (which is 3.2611) as compared to equation (1) (which is 3.8617).

Model 2

Capital-intensive businesses, more standardized technology, and production capacity reliant on local raw water supplies are characteristics of clean water production systems. In this case, the water production systems are decentralised according to the availability of raw water supply for more efficient distribution costs. However, because of the similar standards of technology - and capital-intensive companies, the governance of those companies can be carried out centrally by national level.

On average, all clean water companies produce 415 litres (per second) having more than three times larger value of standard deviation 1,298 litres (per second) as indicated by the coefficient of variation having the value 312.8% which shows a very large disparity in production scale among clean water companies in Indonesia. On the basis of the above four clusters, we calculate regression equations for average cost and the six explanatory variables, but not all of those explanatory variables are significant. Consequently, only significant explanatory variables were selected to include in the final model for every cluster. Those variables are selected determinants which affect the mean cost as the basis for efficiency estimation analysis. The outcomes of the regression are given below.

Cluster I

For cluster I, the outcomes of the equation (2) are given as follows:

Y = -1,055.7 + 2.225 +1.994.
(0.262) (0.008)** (0.000)**
+ 89.88.X5 + e (2.1)
(0.001)***

With F (prob) equal to 0,000 and adjusted R^2 equal to 0.723.

The highly significant factors in Cluster I which affect the average cost are general and administration costs, energy costs and water costs. These factors significantly impact the average cost, with a high value (0.723) for coefficient of determinantion.

Cluster II

The outcomes of regression for Cluster II are as follows

Y = -210.87 +(1.67). X2 +(2.23). X3 + (1.58). X4
(0.730) (0.000)** (0.006)** (0.000)***
+ 51.309. X5 - 44.546. X6 + e (2.2)

(0.000)**8 (0.021)*

With F (prob) equal to 0.000 and adjusted R^2 equal to 0.706

The highly significant factors in Cluster II which affect the average cost are general and administration costs, energy costs and water costs and maintanance costs and significant on a negative slope on return on equity. These factors significantly impact the average cost, with a high value (0.706) for coefficient of determinantion.

Cluster III

The result of the regression for Cluster III are given as follows:

$Y = -1{,}153.5 + 2.45.X1 + 1.52.X2 + 1.57.X3$

(0.021)* (0.011)* (0.000)** (0.015)*

$+ 1.8374.X4 + 64.365.X5$

(0.000)** (0.000)**

$- 42.033.X6 + e$ (2.3)

(0.005)**

With F (prob) equal to 0.000 and R^2 adj equal to 0.763

The highly significant determinants in Cluster III which positively affect the average cost include general and administrative costs, energy and water costs, maintanance and chemical costs and return on equity (having a nagative slope). The value of determination coefficient is 0.763 for Cluster III.

(1) The outcomes of regression for Cluster IV are given in equation (2.4) as follows

$Y = 2.59.X4 + 89.3.X5 + e$ (2.4)

(0.000)** (0.000)**

F prob = 0.000***

R^2 adj = 0.483

The highly significant variables which positively impact the average cost include general and administrative costs and water costs. The coefficient of determination has the value of 0.483 in this regression.

Discussion

Model 1

The average value of diverse production volumes is depicted in a U shape from equation 1, indicating a decreasing price as manufacturing volume increases until it approaches a minimum value and the later increasing fees as production extent increases. Taking the first derivative of the Equation 1, through $\ln Y = -0.3132 + 0.237X$, a minimal average fee of IDR three,324/m3 is received, happening at a manufacturing volume of fifty five.8 million m3. At a larger manufacturing capacity, the average fee additionally increases. Furthermore, Equation 1.1, which is formed from groups with frontier efficiency, has a U-formed curve sample as nicely. If the agency's common value lies underneath Equation 1, it is categorized as fee-green. The maximum green corporations (frontier role) are in curve of Equation 1.1, which are furthest function from Equation 1 curve. Conversely, if the average fee of a sure manufacturing quantity is higher than the value in Equation 1, the company is categorized as an inefficient company. Figure 2 illustrated the position of each company on the basis of equation (1) and equation (1.1)

Then, the ones fashions are broken down into 4 classes of efficient agencies so that every one groups may be classified as follows:

Table 2: Efficiency Categories of Companies.

Categories	Number of Companies	%
Efficient	25	6.4
Slightly efficient	162	41.6
Slightly inefficient	183	47.0
Inefficient	19	4.9
Total	389	100

Source: Research Calculation.

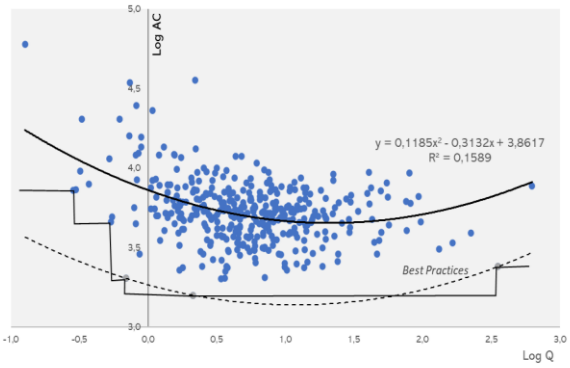

Figure 2: Efficiency Categories in Model 1.
Source: Research Calculation.

51.9% of organizations face efficiency challenges resulting in 47.0% mid-level inefficient companies (183) with another 4.9% severely inefficient companies (19). Right efficiency levels within the studied sector include 41.6% company low-end efficiency (162 businesses) and 6.4% high-end efficient (25 organizations), while Forty eight.Zero% organizations fit the category as shown in Table 2. Organizations producing below fifty five.8 million mthree can optimize their efficiency using increased production volumes according to equation 1. About 3.34% of the 389 companies agreed with volumes exceeding 55.8 million m3 which accounted for thirteen total organizations. The possibility for most groups to experience expense reduction stands at a highly promising level. Agencies operating below a usage scale of 55.8 million m3 will benefit from additional enhanced performance initiatives.

Model 2

Table 3 illustrates that different elements cause cost changes between clusters according to analysis.

Table 3: Determinant of Cost Efficiency.

Explanatory Variables	Mean or Average	Coefficient of variation (%)
Energy cost	457.2	82
Chemical cost	131.8	135
Admin & gen. cost	1,721.7	65
Maintenance cost	222.4	76
Return on equity	-3.4	739
Water loss	34	41

Source: The data is taken from The Ministry of Public Works and Public Housing.

Among cost factors the average cost of managing operations reaches1,721.7IDR/mthree representing the highest price among all factors yet groups demonstrate limited cost variation (sixty five%). The organizational prices distribute similarly throughout their operational regions. Being a capital-intensive organization this appears like an impractically high price. Energy fees represent the second major cost component at IDR 457.2/mthree but differ significantly between businesses (82%). Various energy patterns emerge between businesses regarding their extreme gas and electricity consumption versus their usage of gravity as a production method. Renovation expenses reach IDR 222.4/m3 marking the third largest cost segment though variation between businesses reaches 76%. The price issue shows the largest variation across its range. The chemical compounds cost at 131.8 IDR/mthree, with far larger variation level among companies (a hundred thirty five%). The utilization of uncooked water sourced from rivers with poor water quality differs markedly across groups when companies use springs and diversified unadulterated water sources for their water needs.

Several organizations lose 34% of their water supply through wastage because non-value factors have created major distribution inefficiencies. Their experience of significant water loss costs remains balanced between each group. An adverse production loss rate at 1/3 of manufacturing capacity leads to a 200% increase in average operating expenses therefore escalating total production costs. Although management would gain from ROE reductions, the current average price remains unfavorable. Agencies exhibit substantial variations in their return on equity ratios with 739 percent separating businesses experiencing substantial profits from those experiencing financial losses.

When organizations develop performance intentions these elements must serve as critical factors of assessment. Table 4 presents a summary of the determinant impacts and directional measures of variable relationships indicated through coefficients. Data from Table 4 shows that the combination of administrative and general fees generates the largest impact on average costs across all clusters despite their water usage percentage. Industrial companies utilizing a standardized production design alongside extensive capital requirements need to prioritize improvements towards addressing crucial administrative fees and popular costs. expenditure ought to be decreased. The variable of water loss price impacts the common fee enormously due to the very high rate of 34 percent. This water loss issue is therefore a significant factor to be resolve.

Table 4: Rank of Significant Factors.

Determinant Factor	Slope	Cluster I	Cluster II	Cluser III	Cluster IV
Chemical cost (IDR/m^3)	+			5	
Energy cost (IDR/m^3)	+	3	3	3	
Maintenance cost (IDR/m^3)	+		4	6	
Administration & general cost (IDR/m^3)	+	1	1	1	1
Water loss (%)	+	2	2	2	2
Return on equity (%)	-		5	4	

Source: Research Calculation.

The 1/3 vast component is electricity prices, specially in I, II and III clusters or large clusters, while other variables are fantastically comparable. Return on fairness and Maintenance fees are the 0.33 that have an effect on the mean value. It is anticipated that return on equity helps the organization's performance, although it isn't always sufficient to aid the organization circumstance. The chemical substances consumption has a considerable impact on third Cluster organizations.

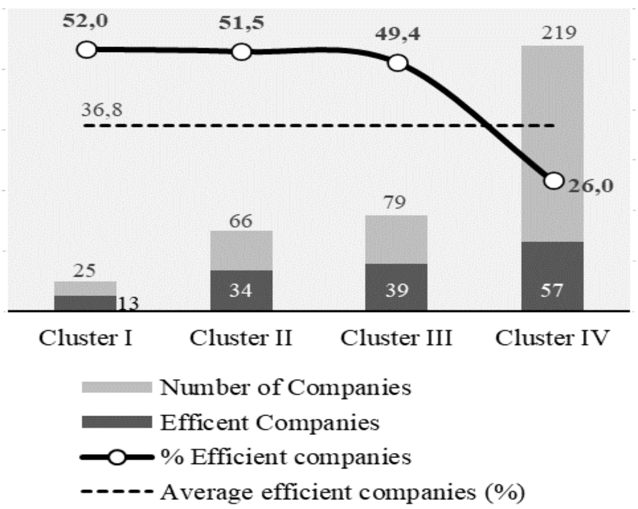

Figure 3: Efficient Companies' Proportion by Cluster.
Source: Research Calculation.

Deployment of clustering analysis confirms the complete impact of cost factors thereby validating multiple essential operational components that influence efficiency initiatives. Companies that produce on a larger scale generally experience a reduction in fundamental factors influencing their average cost values as shown in Figure 3. The smallest scale Cluster IV organizations demonstrate fewer problematic fundamental elements together with minimal issues in administrative costs and water management. An analysis of 389 companies reveals efficiency exists in only 36.8% of these companies. The total effort needed to improve efficiency becomes excessively weighty because Indonesia has numerous companies that need restructuring. The number of problems that must be tackled becomes larger as companies have smaller production volumes.Large scale producers within Cluster I demonstrate efficient operations at a rate of 52% while smaller scale companies increasingly fail to meet efficiency requirements. Only 57 out of 219 companies or 26.0% reach efficiency standards in production facilities belonging to Cluster IV size category. Efficient operations decrease as companies choose smaller production scales.

Implications

Solutions for Efficiency

Performance responses have become excessively complex since many elements contribute to poor company operation and manufacturing difference alongside limited agency efficiency levels. Single maturation towards efficiency can only be achieved through balanced operational and institutional efforts which business management requires absolute principal government engagement. Several fundamental methods to enhance group performance stem from a combined analysis of Model 1 and Model 2's business performance rankings shown in Table 5. Performance solutions are required by 76.1% or 296 of included businesses. The 4 popular performance solutions are found based totally on the combinatoric of version-1 and version-2 are as follow:

Table 5: Generic Efficiency Solutions.

Categories	Model 1	Model 2	Number of Companies	%	General Efficiency Solution
I	Efficient Slightly Efficient	Efficient Efficient	14 79	23.9%	No specific solution is needed
II	Efficient Slightly Efficient	Inefficient Inefficient	11 83	24.1%	Options for minor solution for efficiency on main affecting factors on cost.
III	Slightly Ineficient Inefficient	Efficient Efficient	46 4	12.9%	Increase efficient standard solutions on key factors affecting cost.
IV	Slightly Ineficient Inefficient	Inefficient Inefficient	137 15	39.1%	Increase major efficiency solutinos by structuring factors affecting cost totally.
	Total		**389**	**100%**	

Source: Studies Calculation.

Category One: When Model 1 identifies either green or barely efficient agencies while Model 2 shows efficiency then specific performance solutions are unnecessary for such businesses. The number of corporations in this classification totals ninety three entities among the entire 393 corporations studied.

Category Two: Based on these results the employer requires selection-making and minimal action on performance determinants once Model 1 indicates green or slightly efficient results while Model 2 shows inefficient operation. This class includes ninety four of ninety eight different organizations accounting for 24.1 percent of all companies.

Category Three: Any organization which performs marginally inefficient through Model 1 needs substantial performance upgrades to align with Model 2 standards. This sector includes 50 agencies out of the 388 which constitute 12.9% of the total agencies.

Category Four: Your employer must focus on primary performance solutions for restructuring critical elements after Model 1 identifies the organization's efficiency as slightly inefficient or inefficient yet Model 2 shows inefficiency. The 152 organizations make up 39.1% of all companies on this category.

Recommendations

Practical recommendations for inefficient companies is to increase volume of production by developing new capacity or through mergers and acquisitions between small size companies to decrease management costs. It is consistent with previous studies in Japan, which suggest the merging of larger units and small water utilities as a viable solution for reducing the unit costs and gain economies of scale (Liu & Fukushige, 2020). To strengthen the main strategy, each company also needs to solve its own partial problems, such as reducing water losses and cost of energy, maintenance cost for dan checimal cost. The combined efforts of local and provincial along with district government authorities in Indonesia alongside PERPAMSI industry organization work to respond to various factors impacting operational efficiency including differences in manufacturing size and multiple inefficient business operations. The operational efficiency solutions need to harmonize with institutional reforms in enterprise governance which require intensified involvement from the government. The intervention in these critical regions enables smooth water firms to improve their operational performance as well as assisting the essential mission of providing sustainable access to clean water throughout Indonesia. Future water enterprise development in Indonesia will lead to sustainable and prosperous outcomes in this field.

Conclusion

Analysis of 389 PDAM organizations using common price and production quantity relationships shows a U-shaped pattern that reduces costs between those variables. The U-shaped curve demonstrates cost minimization of IDR three,324 /mthree at 55.8 million mthree production volume which applies to ninety six.66% of organizations below this volume. The fashions demonstrate that 51.9% of corporations operate below their most efficient level. The main variables which determine average cost emerge from calculations using multiple regression produced for four production capability groups whereby administrative & standard costs and water loss show the greatest impact. Production of clean water faces serious operational hurdles because it needs large capital investments using basic standardized technology. According to this version 36.8% of firms demonstrate high efficiency rates but smaller manufacturing facilities correlate with less efficient operations.

Limitations

The limitation of this research is treating all companies homogeneously in which Indonesia have different geographical backgrounds. Due to the differences in geographic factors in Indonesia, further in-depth studies are needed by taking detail of geographic differences into account. This will support micro-partial problem solving efforts. Differences in geographic factors will have implications for technology choices, production and distribution operation as well as costs and management.

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