Estimating Opportunity Cost as A Tool to Evaluate Water Loss Management of Non-Revenue Water at PDAM Tirta Khatulistiwa

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Abstract. Water loss or Non-Revenue Water (NRW) is a national problem PDAMs, including PDAM Tirta Khatulistiwa. In fact, with a high level of water loss, there is a significant potential loss of income. This study aims to implement opportunity cost calculation as a managerial tool for PDAM Tirta Khatulistiwa in making investment decisions to improve water loss management. This research was conducted by collecting information from financial, managerial, and local government equity participation reports. Then the data reduction is carried out and calculated based on the gross margin, net profit margin, and the opportunity cost. This study indicates that the capital investment provided by the Pontianak City’s government has increased, followed by an increase in the number of consumers. However, it was not followed by an increase in the company’s profit. This is due to the opportunity cost or lost income during the business process amounting to Rp31,218,673,384.64 in 2019 with a potential income to Rp222,663,258,365.00 if it manages to suppress distribution leakage to the level of 20%. This potential income is worthy of consideration for PDAM Tirta Khatulistiwa to start water loss management in the NRW reduction program.

Keywords: opportunity cost, NRW, water loss

1. Introduction

Indonesia’s capital in the drinking water sector has existed since 1968, with a capacity of 9,000 liters per second at that time [1]. Until now, the Indonesian Government continues to strive to meet the needs of drinking water for all its people. This task is carried out by PDAM (Regional Drinking Water Company). Based on BPPSPAM data in 2019, out of 380 BUMDs (Regional Owned Enterprise) which are implementing SPAM (Drinking Water Management System), as much as 224 are considered as “healthy”, 102 are “unhealthy”, and 54 others have “sick” performance based on four aspects such as finance, service, operations, and human resource.

However, despite the number of “healthy” performances, the average water loss in Indonesia is 33.16% nationally. In trend, this number is higher than the previous years [2]. Even PDAMs considered “healthy” are still having problems with water leakage, such as PDAM Tirta Khatulistiwa. PDAM Tirta Khatulistiwa is responsible for providing drinking water in Pontianak City and got a performance score of 3.88 and made it into the top 20 of the National Drinking Water Management System (SPAM) in 2019. The performance evaluation of PDAM Tirta Khatulistiwa was consistently considered as “healthy” from 2016 to 2018. However, PDAM Tirta Khatulistiwa still facing water loss or non-revenue water...
(NRW) respectively from 2016-2019 as much as 31.67%, 29.87%, 28.25%, and 32.12%, higher than the allowed number of 20%.

NRW is a severe problem that must be addressed because it relates to the fulfillment of services that PDAM should do. There are two objectives in implementing a drinking water supply system. First is the availability of drinking water services to meet the needs of the people, and second, to achieve quality drinking water management and services at affordable prices. Therefore PDAM should guarantee the quality of its services in the form of decent water (quality), producing in large quantities (quantity), and being able to supply water continuously for 24 hours to customers (continuity), which is called 3K. Any problems with NRW may cause the PDAM to be unable to fulfill its 3K responsibility.

Previous research [3] revealed that the quality of services offered by PDAM, to fulfill 3K, must consider the element of water loss reflected in the calculation of the cost of quality. The cost of quality must also calculate the opportunity cost as one of the instruments in the PAF method (Prevention, Appraisal, and Failure)[4]. Opportunity cost itself has been used quite widely as a managerial tool in the accounting field. Opportunity cost is the maximum value forgone when a course of action is chosen. Because of the limited resources owned by the company, it is necessary to use a tool to help assist them in considering the best decisions to achieve company goals. That is why the need to consider opportunity costs is pervasive in decision-making [5].

Addressing the water loss problem is complex in developing countries because of several problems: intermittent supply system, poor infrastructure, non-revenue water, water metering policy, supply hours and system pressure, poor record-keeping, and community behavior. Therefore, the performance indicator that needs to be prioritized is investments [6]. In carrying out the investment process, it is necessary to be clearly measured to ensure that the investment returns provide a good performance improvement for the company. In the PDAM Tirta Khatulistiwa case, they must be able to achieve the responsibility of fulfilling 3K. This achievement is blocked due to NRW or water leakage and ensures proper measurement in dealing with the problem.

2. Materials and Method

2.1. Location of the Study
The object of this research is PDAM Tirta Khatulistiwa. PDAM Tirta Khatulistiwa is own by the Pontianak City Government. The total area of Pontianak is 107.82 km² with the total population in 2019 as much as 669,169 people, while the population of family head is over 186,699 people. The raw material used for the production process is sourced from the Kapuas river and the Landak river by going through a filtering process four times before entering the processing stage. Currently owned production units are located at five areas of Imam Bonjol, Sungai Jawi Luar, Selat Panjang, Parit Mayor, and Penepat. Meanwhile, the Raw Water Reservoir is located in the Parit Adam and Kuala Mandor areas.

2.2. Data Collection
Collecting data from the object of this research starts with collecting the financial report and management reports. The data used from a financial statement such as balance sheets, income statements, and the equity reports for three years of observation, namely 2017-2019. In addition, data on government equity participation by the local government and others are also used in this research as the form of financial performance measure that will be carried out.

The research procedure was carried out with the literature studies to find a suitable and appropriate concept for this research. Some basic concepts must be considered, such as understanding the basis of regional investment. For example, PDAM used the local government's capital deposits and then analyzed its financial performance. Furthermore, the necessary data collection is carried out for data reduction and interpreted data. The type of data used in this study is primary data, which is directly sourced from the object of research, and secondary data, the additional data obtained and collected in the process of concluding.
2.3. Literature Review

Every organization must have a goal to be able to increase company productivity and earn profits. Therefore, companies need to find out what actually needs to be done in their organization to provide the best service and have a good financial performance. Financial performance is one measure of the achievement of an organization. In this case, the local government uses resources to achieve the organization's goals [7].

2.3.1. Local Government Equity Participation

Generally, the form of local government equity participation is in the form of investment. Based on Government Accounting Standards, investment is an asset intended to obtain economic benefits such as interest, dividends, and royalties, or social benefits. In order to increase the government’s ability to provide services which is the main responsibility of the government to its society [8]. Even when the government invests in providing social benefits to the community through intermediaries such as BUMD, local governments also need to invest as expenditures and obtain future benefits [9]. It is because the government’s equity participation is followed by the hope that BUMD can provide PAD (original regional income) to the government from the results of the company’s operations as mandated by Law Number 5 of 1962.

2.3.2. Gross Margin and Net Profit Margin

Gross margin or gross profit is the main performance measurement for the company. This value is obtained from reducing the cost of goods sold and divided by the number of sales.

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Gross\ Margin = \frac{Sales - Cost\ of\ Good\ Sold}{Sales}
\]

All costs must be covered by gross profit, and any income earned is the remaining balance of these costs. Gross profit varies between industries, depending on competition and differences in production factors of the company. Performing analysis of changes in sales and cost of goods sold is useful in identifying key drivers from gross profit. Changes in gross profit are caused by an increase or decrease in sales volume, selling price per unit, and cost per unit. While net profit margin is a function of the selling price per unit of a product or service compared to the cost per unit of bringing the product or service to market or customer who needs it [10].

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Net\ Profit\ Margin = \frac{Net\ Profit}{Sales}
\]

2.3.3. Opportunity Cost

In general, opportunity cost is a managerial tool to assist management in deciding to take a project among others [11]. The concept related to the use of opportunity costs to calculate the potential loss of income is related to quality. Many companies are aware of the magnitude of the hidden cost of losing customers and lead to losing revenue due to several problems related to quality. For example, the Xerox company examines lost opportunities in three areas. First, revenue (loss of sales due to quality problem), the company’s business processes to find incompetence of business process, and the last is the burden of checking waste and business overload. However, it should always be ensured to consider the return on quality. It often happens when the company focuses on improving quality ends with disappointment in financial results. So it is essential to carry out economic control and testing during the quality improvement movement. Some things to note are [12]:

1. Using reliable estimates. Precise measurement can be too costly to perform.
2. Use total quality management measures for indications during the process.
3. Use a team approach in determining the limits of measurement
4. Remember that rhythm of reporting may vary from day to year. Most companies option for longer reporting quarterly or annually.
5. Emphasize training, which is key to understanding the meaning of measurement
6. Establish measurements with natural business units such as subsidiaries, specific plans, or own division and keep those measurements in the operational program process
7. Set realistic expectation
8. Flexibility in determining the focus of improvement programs.

Opportunity cost can be part of the cost of the quality concept. It shows the number of lost income and profits that the company cannot obtain. This cost considers as inefficiency in material handling and delivery services. They were combined with the underutilization of infrastructure as a damaging factor. Therefore the loss due to these two factors is generally considered as an opportunity cost. Where the opportunity cost based on the pilot study shows, the cost of quality is higher than realized [13]. Any form of activity that does not perform well on time always causes losses to the organization. Opportunity cost is the loss that results from missing the opportunity to do something right in the first place. This is a measurement of internal inefficiency, and its analysis will provide excellent opportunities for improvement[14]. Suppose a company wants the opportunity cost to be a powerful tool. In that case, the company needs to continue this calculation by reporting the cost quality and running a total quality management program.

Currently, many studies have taken the opportunity cost as a measuring tool but not focusing on using it as a performance measurement tool for companies, especially PDAMs. The calculation of opportunity cost in PDAM Tirta Khatulistiwa can be done by multiplying the value of water lost during the production process by the cost of goods sold. Meanwhile, the opportunity cost during the distribution process is obtained by multiplying the NRW value of the distribution with the average selling price. The main focus is to find the amount of potential loss measured using monetary units to project income when the NRW reduction programs are carried out.

3. Result and Discussion
As a BUMD, the main source of investment for PDAM Tirta Khatulistiwa comes from the local government. The first step to collecting information on how much the regional government of Pontianak City has provided the capital investment is essential to describe the pattern of this capital participation. Then, the process of analyzing financial statements will be carried out based on the value of the gross margin and net profit margin based on the last three years.

Table 1. Source of Equity Participation for PDAM Tirta Khatulistiwa

| Year | Source of Funds from the Pontianak City Government (APBD) | Source of Fund from the State and Foreign Aid |
|------|----------------------------------------------------------|-----------------------------------------------|
| 2017 | Rp150,039,242,208.00                                      | Rp58,275,703,668.00                          |
| 2018 | Rp159,039,242,208.00                                      | Rp58,275,703,668.00                          |
| 2019 | Rp187,699,488,358.00                                      | Rp58,275,703,668.00                          |

During the years of observation, it can be seen that there was an increase in the paid-in capital by the local government in a row as much as Rp9,000,000,000.00 in 2018. Furthermore, an increase to Rp28,660,246,150.00 in 2019. An increase followed this capital increase in the number of customers. But they were not followed by an increase in company profits. Meanwhile, the number of sources of funds from the State and Foreign Aid did not increase.

Table 2. Revenue, Operating Expenses and Net Profit (Loss) After Tax

|                  | 2017                        | 2018                        | 2019                        |
|------------------|-----------------------------|-----------------------------|-----------------------------|
| Revenue          | Rp172,923,971,102           | Rp184,772,586,490           | Rp193,907,660,870           |
| Operating Expenses | Rp148,320,531,729           | Rp150,569,247,952           | Rp170,164,875,017           |
| Net Profit (Loss) After Tax | Rp61,891,181,147           | Rp29,092,568,111           | Rp17,664,567,140           |
Based on Table 2, it can be seen that the amount of revenue each year increase along with the increase in the company’s operating expenses. However, an increase of company profits does not follow it. For the record, in 2017, the company’s profit value was very high. However, the additional account, namely “The Net Profit (Loss) Account on Non-Principal Debts” is written off. The company includes the written-off debt as company profit in its income statement.

Meanwhile, its operating profit and loss were only recorded at Rp18,713,323,873.25. If the percentage is carried out, when PDAM Tirta Khatulistiwa was able to maintain the total increase in operating expenses by only 1.5%, the company was able to increase the company’s operating profit to 55% in 2018. However, in 2019, when the total Operating Expenses increased to 13%, the company could only get a profit of Rp17,664,567,140 or decreased by 39.28%.

Table 3. Total Customers and Water Sales

| Year | Total Customers | Water Sales (m³) |
|------|-----------------|-----------------|
| 2017 | 111,405         | 33,549,816      |
| 2018 | 119,459         | 36,116,326      |
| 2019 | 128,453         | 37,543,193      |

As previously mentioned, the company was able to increase water sales but could not generate more profit. This condition occurs because the company does not focus its investment on repairs to overcome the leakage. However, the capital investment is specially used to install tertiary pipes for low-income communities (referred to as MBR). Just adding a network will not have a positive impact on the company's profit if it does not try to fix the source of the leakage that occurs. This is will only lead to a cycle of waste and inefficiency[6]. Because the company is trying to increase sales by adding new networks, it does not solve the main problem causing the loss of water distributed but cannot be recognized as sales.

Table 4. Gross Margin and Net Profit Margin Ratio.

| Year | Sales       | Cost of Goods Sold | Income after Tax | Gross Margin | Net Profit Margin |
|------|-------------|--------------------|------------------|--------------|------------------|
| 2017 | Rp154,407,206,700 | Rp148,320,531,729 | Rp61,891,181,147 | 0.04         | 0.40             |
| 2018 | Rp168,281,432,400 | Rp150,569,247,954 | Rp29,092,568,111 | 0.11         | 0.17             |
| 2019 | Rp174,895,158,700 | Rp170,164,875,017 | Rp17,664,567,140 | 0.03         | 0.10             |

Financial analysis was conducted using gross margin and net profit margin ratios, as shown in Table 4. In 2019, PDAM Tirta Khatulistiwa could only maintain a gross profit of only Rp0.03 from every Rp1.00 of income generated. In 2018, when the company was able to suppress NRW from the previous year, with the increase of operating expenses, the company increased its gross margin to Rp0.11. Unstable gross margin can be caused by unstable production costs or applying a price policy that is too low. While the value of the net profit margin ratio shows that there is a drastic decrease from 2017 to 2019, which means that the net profit generated every time PDAM Tirta Khatulistiwa is only able to generate Rp0.1 every Rp1.00 of net income, or a net profit of 10% from the overall business processes carried out.

This analysis generally describes that the overall business processes that have been carried out are still less efficient. The company focuses on increasing customer need in the form of installing new pipelines for the community but at the same time is not focusing on network maintenance. Therefore, there is an increase in the operational expenses and lead to lower profit. At the same time, the main problem of NRW is getting less attention from the company. This problem causes income to decline,
and operating costs will continue to increase. This is described as the vicious NRW circle. Meanwhile, the step that should be taken is to implement the virtuous NRW circle[7].

Figure 1. The Vicious NRW Circle

Figure 2. The Virtuous NRW Circle

As mentioned in Figure 2, it is necessary to increase its operations at the NRW reduction program stage as a form of investment. PDAM Tirta Khatulistiwa can carry out programs by considering the use of opportunity costs as an essential consideration in deciding to invest in NRW reduction programs. As an example of its success in 2015, Manila assisted PDAM Bandung in reducing the NRW level from 59% to 23% in three months by repairing leaks and replacing water meters. Thus, it was found that the recovery of 134,400 liters of water per day is sufficient to serve 379 new households, which is equivalent to 1,590 people[16].

Table 5. Non-Revenue Water

|                  | 2017          | 2018          | 2019          |
|------------------|---------------|---------------|---------------|
| Production (m³)  | 50,405,159    | 53,280,171    | 57,506,477    |
| Distribution (m³)| 47,841,085    | 50,189,530    | 55,191,887    |
| Sales (m³)       | 33,549,816    | 36,009,472    | 37,465,875    |
| NRW Production (%)| 5.09%       | 5.80%        | 4.02%        |
| NRW Distribution (%)| 29.87%    | 28.25%        | 32.12%        |

During the production and distribution process, PDAM Tirta Khatulistiwa has lost more water than the allowable amount. In 2019, this number increased drastically from the previous year. Suppose the percentages of NRW production and NRW distribution are added up. In that case, the average water loss over the last three years is as much as 35%.

Table 6. Opportunity Cost cause by NRW of Production Stage

|                  | 2017          | 2018          | 2019          |
|------------------|---------------|---------------|---------------|
| NRW Production (m³)| 2,564,074    | 3,090,641    | 2,314,590    |
| COGS (Rp/m³)     | Rp3,678.21    | Rp3,532.49    | Rp3,698.82    |
| Opportunity Cost | Rp9,431,202,627.54 | Rp10,917,658,426.09 | Rp8,561,251,241.00 |
Table 7. Opportunity Cost cause by NRW of Distribution Stage

|                | 2017          | 2018          | 2019          |
|----------------|---------------|---------------|---------------|
| NRW Distribution (m³) | 14,291,269    | 14,180,058    | 17,726,012    |
| Average Price (Rp/m³)      | Rp4,602.33    | Rp4,673.25    | Rp4,668.12    |
| Opportunity Cost             | Rp65,773,136,056.77 | Rp66,266,956,048 | Rp82,747,131,405.80 |

Based on table 6 and table 7, the potential loss of income is very high because of the high number of NRW. Table 7 shows the opportunity costs if we take the real value without deducting the allowable amount of 20%. Loss of water that needs to be addressed is in the distribution process. Because the treated water is then distributed to customers at this stage, but there is water lost due to the leakage. There is two types of leaks during the distribution process at PDAM in general. The pipe leakage causes the water to return to the ground or river (if the pipe is in the river channel) throughout the distribution process. The second is administrative leakage due to water used by customers but not properly recorded cause of broken water meters and water theft [3]. Determination of the number of opportunity costs can be adjusted from the company’s managerial experience.

Table 8. Opportunity Cost cause by NRW of Distribution Stage in difference level

|                | 2017          | 2018          | 2019          |
|----------------|---------------|---------------|---------------|
| After deducted by 20% of the real value |              |               |               |
| NRW Distribution (m³) | 4,721,915.02 | 4,140,636.23 | 6,687,634.60 |
| Average Price (Rp/m³)      | Rp4,602.33    | Rp4,673.25    | Rp4,668.12    |
| Opportunity Cost             | Rp21,731,811,473.86 | Rp19,350,228,238 | Rp31,218,673,384.64 |

Table 8 shows the value of lost revenue during the year if the company takes a maximum figure of only 20%. This means the number used from 2017 to 2019 only as much as 9.87%, 8.25%, and 12.12%, respectively, as the basis for calculating the opportunity cost. This calculation can also be considered at an early stage of development in determining realistic values as the most accessible number to approach in determining costs and benefits in implementing the NRW reduction program. As consideration, the lowest NRW value ever recorded was 11% in 2016 by PDAM Adhya Tirta Batam.

Table 9. Potential Income at The Maximum NRW Level of 20%

|                | 2017          | 2018          | 2019          |
|----------------|---------------|---------------|---------------|
| Sales (m³)     | 38,272,868    | 42,987,635    | 47,698,712    |
| Average Price (Rp/m³)      | Rp4,602.33    | Rp4,673.25    | Rp4,668.12    |
| Revenue        | Rp176,144,368,582 | Rp200,981,968,062 | Rp222,663,258,365 |

Table 9 shows the projected income if PDAM Tirta Khatulistiwa can reduce NRW to the tolerance level of 20%. This figure is expected to be sufficient to provide an opportunity for PDAM Tirta Khatulistiwa to increase expenditures that are deemed necessary in order to run NRW reduction programs.

4. Conclusions

It is necessary to increase operational costs in the early stages of water loss management processes where an investment process is carried out to focus on the NRW reduction program. As seen in the capital investment devoted to MBR, which is able to increase the number of customers even though it does not have an impact on increasing income, PDAM Tirta Khatulistiwa should focus on capital investment in
the form of regional investment specially for handling NRW reduction programs because it will save more or less in the range of 30 to 80 billion rupiah. In consideration, the investment value will be large in the first year, as the theory of cost of quality goes. But this will also will be followed by an increase in revenue and decrease in operational costs over time when this program is implemented. During the NRW reduction program, projection is needed for each element and each cost group to ensure that the program is always carried out in the process to control every aspect of the program and reported periodically to show trends in the implementation of NRW reduction programs.

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