

ANALYSIS OF DEMAND FORECASTING ON THE CLEAN WATER NEED IN CLEAN WATER MANAGEMENT COMPANY (PPAB)

Rio J. M. Marpaung, Ifa Adina Yafiz

Abstract: The purpose of this study is to analyze the level of clean water sales forecast for approximately one year ahead by using the best analytical method, and then to formulate strategies that can be applied by Clean Water Management Company (PPAB) in Rokan Hulu District. The method used is the time series method that is moving average, Exponential smoothing, and trend projection. Then determine the best error rate of the method used through several approaches: mean absolute deviation (MAD), mean square error (MSE), mean absolute percent error (MAPE).

Index Terms: Forecasting, Moving Average, Exponential Smoothing, Trend Projection, Mean Absolute Deviation (MAD), Mean Square Error (MSE), Mean Absolute Percent Error (MAPE).

1 INTRODUCTION

Economic development of a country can be measured in various ways, one of them by knowing the level of development of the industrial world in the country, such as the drinking water industry. As the population grows, the amount of water produced and distributed continuously shows an increase in line with the increasing demand for clean water in the community. Water is one of the most important natural resources for human life, both to meet daily needs and for other purposes such as agriculture and industry. Therefore the availability of water in the community needs to be preserved and preserved for the survival of life. Everyone is well aware of the importance of water as a source of life. However, not everyone thinks and acts wisely in using water with all the problems surrounding it. Ironically, a community group is so difficult to get clean water, while a few other societies easily splash water (Narita, Kadek, et al, 2011). The need for the importance of water is not balanced with consciousness to conserve water, so that many sources of water are polluted by human actions themselves. Their irresponsibility makes the water dirty, such as dumping the river's loneliness so that the flow of the river becomes clogged and eventually causing floods during the rainy season, disposing the waste of the factory to the river that makes the water become polluted by hazardous materials, and so on. it needs water treatment that has been contaminated to be suitable for daily activities (Said, Nusa Idaman & wahjono, Heru Dwi, 1999). Clean water treatment is a technical undertaking to provide protection to water sources by improving the quality of water origin until it becomes desirable quality with the aim to be safely used by people consuming clean water (Narita, Kadek, et al 2011). Water treatment refers to the Regulation of the Minister of Health No.492 of 2010 (PERMENKES 492/2010), in which there are water requirements from the processing of cleansing in order to be consumed like drinking water.

To strengthen the governance and capacity of the Regional Water Company (PDAM) it is necessary to review the various tasks, processes and institutional accountability, in particular the head of Perusahaan Daerah Air Minum (PDAM). The central level should establish minimum standards of work for the Regional Water Company (PDAM) with monitoring, enforcement and incentive mechanisms. As the population grows, the amount of water produced continuously continues to show improvement in line with the increasing demand for clean water in the community. However, from time to time Indonesia experienced a clean water crisis, both in terms of quantity and quality. Rokan Hulu is one of the areas that exist in Riau, most of its territory consists of 80% of mainland. Most of the areas found in Rokan Hulu are also located in the highlands. As the number of people living in the Rokan Hulu area increases, the available water capacity is also limited due to the Rokan Hulu area in its entirety only by a few rivers, one of the largest rivers is Rokan river and Rokan river, and the rest there are only a few tributaries coming from the two great rivers. When the dry season arrives, some residents in Rokan Hulu District, Riau Province, complain about the very limited availability of water. The wells in the residents' houses are dry so they are very difficult to get clean water. As the only anticipation, residents was forced to buy clean water from the Clean Water Management Agency (BPAB) of Rokan Hulu regency under Rokan Hulu Office of Spatial and Cipta Karya (TRCK). Due to the large number of residents who rely on clean water from the Clean Water Management Company (PPAB), hundreds of residents have to queue to get water. Not only that, for the need for clean water, residents are forced to spend hundreds of thousands of dollars. In fact, in Rambah Samo sub-district, a water tank belonging to the Clean Water Management Agency (BPAB) can reach Rp. 250,000. This condition occurs in at least seven sub-districts in Rokan Hulu each subdistrict Rambah, Rambah Samo, Rambah Hilir, Ujungbatu, Tandun, Kota Lama, and Tambusai sub-district. This also becomes more difficult because the procurement of clean water tank vehicles owned by the company is very limited. For residents who want to buy clean water in the Clean Water Management Agency (BPAB), they have to queue for two to three days to get water. This is because the number of people who buy clean water in the company. The queue happens because the order of the citizen happens at the time simultaneously, while the fleet owned by the Water Management Agency (BPAB) is still limited. Forecasting the

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estimated amount of water produced to meet the needs of the community is very necessary, due to human nature that can not be far from the water as a source of need. For state-owned enterprises (SOEs) such as PDAM or Water Supply Company (PPAB), the forecasting activity is necessary to know how much water the community or its customers need and how much raw water capacity available in the field to be used as effectively and efficiently as possible, and the aim is to avoid the depletion of raw water sources available for the foreseeable future. In forecasting there are several methods, for example by using the method of time series forecasting. Time series forecasting is a method used to analyze data sets that are a function of time. In forecasting time series is subdivided into several methods of naive approach method, which is a forecasting technique that assumes the demand of the next period is equal to the demand in the last period. The next is the moving average method, which is a forecast that uses the average of the last period of data to predict the next period. And the last is the exponential smoothing method, which is a moving average forecasting technique with weighting where the data points are weighted by the exponential function. From the above method, the writer will calculate the error rate by using some approaches: mean

absolute deviation (MAD), mean square error (MSE), and mean absolute percent error (MAPE). After performing calculations on available data then the authors will draw conclusions in the form of the best method what is most close to accurate and also has the smallest error rate. Clean water for everyday purposes is a major requirement for the community. To meet the needs of clean water, it is necessary to build a clean water management managed by State Owned Enterprises (BUMN) example Perusahaan Daerah Air Minum (PDAM). Clean water management in Rokan Hulu Regency is currently handled by one of PDAM branches namely Water Management Company Clean (PPAB) Ujung batu unit. In this study the authors specialize on clean water management at the installation in Rokan Hulu District to provide clean water where the raw water comes from the Rokan river, which is one of the largest rivers found in Rokan Hulu district. This installation is in charge of providing clean water and distributing it to people whose housing areas are difficult to get water like hilly areas, and some are distributed to government and social institutions such as schools, mosques and other places of worship. Here are some data that the authors get to do this research are:

Table 1.1 Data on Total Number of Customers in Clean Water Management Company (PPAB) In Kabupaten RokanHuluTahun 2010-2016.

No	Type	Customer	Year (customer)						
			2010	2011	2012	2013	2014	2015	2016
1		commerce	95	99	152	160	162	163	170
2		Non Commerce	180	187	451	546	639	667	975
3		Government	3	3	8	8	8	8	11
4		Social	2	2	5	6	7	7	14
		Amount	280	291	616	720	816	845	1170

Source: PPAB All of Rokan Hulu Regency Year 2016

Based on the above data, the authors will conduct research on demand forecasting on the amount of clean water produced by Clean Water Management Company (PPAB) throughout Rokan Hulu district as one way to predict demand forecasting for the amount of raw water capacity available in the next year, will greatly affect the capacity of the distribution pipes of clean water to all of the company's customers. Based on the above description of the background, then the formulation of the problem of research are:

1. How is the forecasting of water demand using moving average, exponential smoothing, and projection methods?
2. What is the error rate of the forecasting approach in use of is mean absolute deviation (MAD), mean square error (MSE), and mean absolute percent error (MAPE)?

2 LITERATURE REVIEW

Drinking Water Company (PAM) is a company that handles clean water with piping system. According to the Central Bureau of Statistics (1995), the status of drinking water companies in Indonesia consists of: Perusahaan Daerah Air Minum (PDAM) is a water utility (drinking water) company for the needs of more than 60 liters/ person/day carried by the government area. Water and PAM are considered eligible as a source of clean water. Understanding. Forecasting is a business function that seeks to estimate sales and use of products so that they can be made in a fixed quantity

(Gaspersz, 2004). Forecasting is the art and science of predicting future events. Until the last decade, forecasting most of the art, but now has become a science as well. While managerial judgments are still required for forecasting, current managers are assisted by advanced mathematical tools and methods (Schroeder 2007: 214). Handoko (2008: 260), states the essence of forecasting is to predict future events at a later date on the basis of past patterns and the use of policies against projections with patterns in the past. According to Rosnani Ginting (2007: 31), forecasting is the beginning of a decision-making process. Before doing the forecasting must be known in advance what exactly the problem in decision making. In production activities, forecasting is done to determine the amount of demand for a product and is the first step of the production planning and control process. According to Jay Heizer and Barry Render (2010: 162) in his book says that forecasting is the art and science to predict future events.

3 RESEARCH METHODOLOGY

Quantitative Forecasting Method

Jay Haizer and Berry Render in the book Operations Management (2010: 170-175), the quantitative methods consist of:

- 1) Naive approach (naïve approach). It is a forecasting technique that assumes the demand for the next period

equals the demand in the last period. For some types of products, this naïve approach is the most effective and cost efficient objective forecasting model. At least this approach provides a starting point for comparison with other more sophisticated models.

- 2) Average (Moving Average). Moving forecasting uses a number of past actual data to generate forecasting. The moving average is useful if we can assume that market demand will be stable over the time we forecast. Mathematically, simple moving averages (predicting future demand for demand).

When there are trends or patterns detected, weights can be used to place more emphasis on the current values. The selection of weights is uncertain because there is no formula to establish them. Therefore, the termination weights employ requires experience. For example, if months or past periods given too heavy weight, forecasting can illustrate an unusually rapid change in demand or sales patterns.

- 1.) Average Moving Average (weighted Moving Average)

When trends or patterns are detected, weights can be used to place more emphasis on the current values. In this approach on each element of the data, we can give weights. The selection of weights is uncertain because there is no formula to assign them. Therefore, the termination weights required requires experience. For example, if the last month or period is weighted too heavily, the forecast can describe an unusually fast change in the normal demand or sales pattern.
- 2.) Exponential Smoothing

Exponential Smoothing is a sophisticated moving average forecasting method, but it's still easy to use. This method uses very little past data recording. The basic exponential smoothing formula can be shown as follows:

$$\text{New forecast} = \text{forecasting last period} + \alpha (\text{actual request} + \text{last period} - \text{forecasting last period})$$
 Where α is a weights or refinement constants that can be chosen by forecasters having values between 0 and 1.
- 3.) 1.) Exponential Smoothing with Trend Adjustment (Exponential Smoothing with Trend)

The exponential smoothing model is more complicated and can adapt to existing trends. The idea is to calculate the average trend of exponential smoothing data, then adjust for a positive or negative lag on the trend. With an exponential smoothing with trending adjustments, the average estimate and the trend is smoothed. This procedure requires two smoothing constants, α for averages and β for trends. Then, we calculate the averages and trends for each period.
- 4.) Trend Projection (Linear Regression)

Trend projection is a method of forecasting that matches the trend line in a series of past data, then projects the future line for medium or long term forecasting. If we make the trend line straight with statistical methods, we can apply the least squares method. This approach produces a straight line that minimizes the sum of squares of the vertical deviation of the line on each actual observation result.

Data Analysis

The data analysis used by the writer to analyze the research is by using descriptive quantitative method, that is a method that

explains or explains and discusses the data associated with the theories related to the object of research, to further drawn a conclusion. In this data analysis will be presented moving average formula, exponential smoothing, and trend projection.

4 RESEARCH RESULT AND DISCUSSION

Forecasting Distribution of Clean Water

After analyzing the distribution of clean water in the Clean Water Management Company (PPAB) in Rokan Hulu District using three methods as described above, it can be found that the forecasting result for 2017 is 944 customers using the moving method average, and get a result of 2.261 with the use of trend projection method. And the following is a table of calculations using exponential smoothing method Table 5.13: Comparison of Forecasting Results for 2016 with Exponential Smoothing Method.

A	FORECASTING RESULT
0,1	504 customer
0,2	684 customer
0,3	812 customer
0,4	904 customer
0,5	971 customer
0,6	1.023 customer
0,7	1.066 customer
0,8	1.103 customer
0,9	1.137 customer

If it is assumed that in 2017 there will be a decrease in the number of customers in Clean Water Management Company (PPAB) Rokan Hulu District, the authors take the results of the can of exponential smoothing method is on the calculation of $\alpha = 0.9$ as a reference results close to accurate . This is because the data on the number of clean water users in the Clean Water Management Company (PPAB) in Rokan Hulu District in the previous year is 2016 of 1,170 subscribers, so the number of 1,137 with error rate using the method of mean absolute deviation (MAD) with an error rate of 956 and with an average value of 159, mean square error method (MSE) with a total error rate of 247.182 and with an average value of 41.197, and with a method of absolute percent error (MAPE) with a total error rate of 123 values an average of 20.5 is the right number to use as a reference. Comparison of Water Distribution with Available Capacity at this Time. As mentioned earlier, the main problem in the distribution of water at the Clean Water Management Company (PPAB) in Rokan Hulu Regency lies in the magnitude of the pipes for the distribution of clean water to all customers. As explained earlier, the pipeline is only capable of distributing 36 m3 of fresh water per hour, while the company's day-to-day operation is 7 hours. If multiplied then in a day the company is only able to distribute 252 m3 of water or about 252,000 liter only. If averaged by the number of customers until 2016 then the water in the customer can be about 0.461 m3 or 461 liters of water. From table 5.6 it can be seen that the number of customers in Clean Water Management Company (PPAB) of Rokan Hulu Regency if taken from the moving average method that is as much as 529 customers, then the water distributed to customers is still in the usual amount of about 0.472 m3 or about 472 liters of water. But if we look at the calculation of forecasting using the trend projection method that is equal to 616 customers. And if the average it again with the amount of water distributed by the company in a day that is 250 m3 or 250.000 Liter of clean

water, the less water is in get by one customer that is about 0.405 m³ or more 405 Liter water. So can be concluded that the company has problems in the distribution of clean water because very little water is distributed to customers. Comparison of Water Distribution with Available Capacity 2017 In order to distribute clean water to all its customers, the Clean Water Management Company (PPAB) of Rokan Hulu Regency has planned the development of a subsidiary as has been previously described. the author will explain the development of the subsidiary. After the authors conduct further research on the company, the author can know that the development of the subsidiary is in the process of workmanship. It is estimated that the construction process will be completed in 2017 and ready to be run in the same year that is 2017. The development process is the company adds machine at new raw water source location, Substitution of pipes and also company undertakes construction of new reservoir . The reservoir will be made in the company as a source of new raw water that will be distributed to customers after experiencing the clarification process. The company also added new pipes that must have a larger diameter compared to previous pipes. The goal is that the distributed water becomes bigger in volume. The company will also add the operational hours of distribution of clean water to all its customers that is to be 24 hours per day or in other words the distributed water will continue to be channeled indefinitely. Error Level (error) of Forecasting Method Used

After calculating demand forecasting for Clean Water Management Company (PPAB) of Rokan Hulu Regency by using moving average method, exponential smoothing, and projection trend, the writer also get the error rate from the method used. In calculating the error rate of forecasting method used, the writer uses several methods namely mean absolute deviation (MAD), mean square error (MSE), and mean absolute percent error (MAPE) method. In the calculation using the moving average method, the writer gets the error rate (ie error) in the method of mean absolute deviation (MAD). In the calculation using the moving average method, the writer gets the result of the error rate that is in the mean absolute deviation (MAD) method with the total error rate of 464 and the average value of 116, using the mean square error method (MSE) with a total error rate of 60,356 and an average value of 15,089, and a mean absolute percent error (MAPE) method with a total error rate of 93 and an average value of 23. In the calculation using exponential smoothing method, the writer get the result of the best error rate (mean) in mean absolute deviation (MAD) method by using $\alpha = 0,9$ with amount of error 297 with average value 49,5. In method mean square error (MSE), writer get error level with error count equal to 24,047 with average value equal to 4.008. In method mean absolute percent error (MAPE), writer get error level with amount of error equal to 67 and an average score of 11.

5 CONCLUSIONS AND SUGGESTIONS

Based on the results of research conducted on Clean Water Management Company (PPAB) Rokan Hulu District, then there are several conclusions as follows:

- 1) Based on calculation using forecasting method that is moving average method, exponential smoothing, and projection trend, then the demand for adequate distribution of water by customer to Clean Water Management Company (PPAB) of Rokan Hulu Regency

can not be fulfilled with the capacity of distribution pipes water that is available today, where the water distributed daily to the customer is only about 252 m³ or 252.000 Liter, which means if the average, the customer only get about 0.215 m³ or about 215an Liter of clean water every day. While the water is in need for daily needs more than that amount.

- 2) Based on calculations using several methods of moving average method, exponential smoothing, and projection trend, the authors conclude that the best method in use is exponential smoothing method with the calculation of $\alpha = 0.9$, this is because of the forecasting results has been calculated, the number of calculations using the exponential smoothing method is the most accurate of the number of customers in Water Supply Company (PPAB) Rokan Hulu regency the previous year is in 2016 of 546 customers. And the result of forecasting for the year 2017 that amounted to 544 customers.
- 3) Based on calculations using several methods of moving average method, exponential smoothing, and projection trend, the authors can calculate the error rate (ie error) using moving average method, and exponential smoothing only. And the writer can conclude the best error rate that is found in the exponential smoothing method, this is because in the case of using the method of smoothing, the error rate is the smallest among all calculations with the method in use.
- 4) With the new development program under construction, the taste will be enough to meet the needs of clean water in 2017. Obviously with the requirement that the company adds capacity of new pipes with a larger diameter in comparison pipe distribution of clean water long.

SUGGESTIONS

- 1) The researcher suggested that Clean Water Management Company (PPAB) of Rokan Hulu Regency should be able to add new pipes which will be used for distribution of clean water to customers so that there will be no shortage of clean water demand. And also increase the operational hours of distribution of clean water longer every day.
- 2) Researchers also hope that Clean Water Management Company (PPAB) Rokan Hulu regency can realize all the development plans of subsidiaries in accordance with the schedule that has been set. So that the operation of the distribution of clean water to customers can be done optimally and well, so that the water crisis clean which happens today can be minimized not even happen again.
- 3) The Clean Water Management Company (PPAB) of Rokan Hulu Regency is also urged to solve the problems that can trigger a temporary discharge to the distribution of clean water to all customers due to some damage in the field such as pipe breaks and so forth.

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