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Evaluation of Clean Water Network and Development System of Clean Water Supply in District of South Morotai in Morotai Island (Case Study: Pandanga Village)

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Abstract— *Pandanga Village is one of the villages in the sub-district of South Morotai Island, which is geographically located on the coast. Pandanga Village is one of the villages that difficulty in getting clean water. The purpose of this research is to know the existing condition of clean water network in the study location, to develop a clean water supply system to fulfill the needs of clean water in the next 15 years to 2033 and to find out the clean water tariffs of PDAM for the next 15 years. The results of the evaluation and development obtained that the pressure in existing condition is too small, then the pipe was replaced, the standard pressure is 0.5-8 ATM. and development on the reservoir with a water capacity of 135 m ³. Results of economic analysis obtained by the value of BCR 1.23, value B-C of 12, 945, 742, 85 IRR value of 14.80% The break-even investment occurred in year 12.6 ≈ 12 years 6 months and acquired water price amounting to Rp. 8.200.*

Keywords— *Clean water, clean water distribution network, Watercad V8i, water price.*

I. INTRODUCTION

Clean water is needed by all residents or a community in fulfilling all activities so that to fulfill the needs of clean water it needs to have a determination system of a sufficiency in water supplies, which is then disributed in water supply, which is then distributed to consumers. Most natural water

conditions or water from the source are not suitable for direct consumption or does not meet the criteria of a clean water, in general because of the activity of a community and the development of a city that is less attentive to the environment. To make the source of clean water that appropriate with the requirements, the water needs to be processed in a processing agency which is then distributed to serve a community or consumer by the Regional Water Company (PDAM).

Regional development in an area will cause water needs that continuously increase along with the rate of population growth. Fulfilling the food needs and activities of the population is always closely related to the needs of water. Such demands are inevitable, but must be predicted and planned utilization as possible. A frequent tendency is an imbalance between availability and water needs. To achieve a balance between water needs and water availability in the future, there is a need to study components of water needs, as well as water use efficiency. Increasing the need for clean water if not balanced with the increase in the production capacity of clean water will cause problems where the available clean water will not be enough for the needs of the community in the region. As happened in the developing area, like in Pandanga village of South Morotai District. Because of the importance of the need for clean water, it is natural if the clean water sector becomes the main priority of handling because it concerns the lives of many people.

Normatively the performance of clean water services is set in the Minister of Home Affairs decision which according to the Decree of the Minister of Home Affairs (Kepmendagri) No. 47 year 1999 concerning Guidelines for Performance Assessment of the Regional Water Supply Companies, namely performance is defined as the success rate of managing a clean water system in a specific book year. The level of success itself can be assessed from several aspects, namely financial operational aspects and administrative aspects. Each of these aspects has an indicator with their respective assessment.
The objectives of this research are as follows:

1. Knowing the existing condition of clean water Network in study location
2. Developing clean water supply system to meet the needs of clean water for the nxet 15 years
3. Knowing the price of clean water taps for the next 15 years

II. STUDY LOCATION

The Location of the study is Pandanga village which is one of the villages in Morotai Island Regency which still have problems with the distribution of clean water. Which is one of the village is in South Morotai sub-district, Morotai Island Regency. The village is having problems with clean water. Clean water condition in the village is very bad. Because the system and handling of the government is not good.

The study area of Pandanga village in South Morotai District precisely in Regency of Morotai Island. From the geographical aspects of the island Morotai has a strategic position because it is on the lips of the Asia Pacific trade line. The geographical position of Morotai Island Regency is at coordinates 2000 to 2040 LU and 128015 to 128040 BT. The administrative boundaries owned by this district are, as follows:

a. North : The Pacific Ocean

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b. West : Sulawesi Sea
c. East : Halmahera Sea
d. South : Morotai Strait

The District of Morotai Island has an area of 4,301.53 Km^2, with a land area of 2,330.60 Km^2 and an area of 4 miles area of 1,970.93 Km2. Coastline length 311,217 Km.

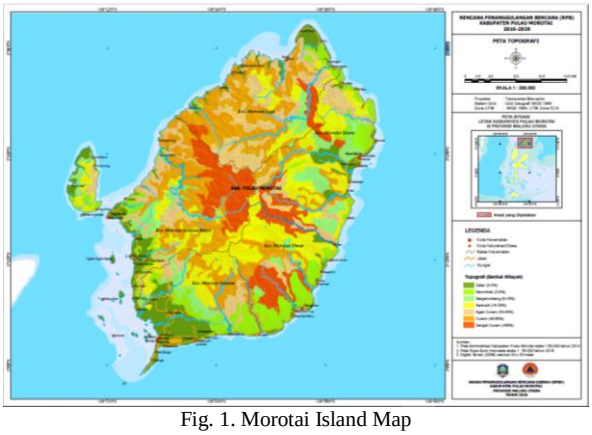

Fig. 1. Morotai Island Map

Fig. 2. Study Location

III. DATA COLLECTION

The data used in this research are as follows:

a. Population data
b. Data supply system for existing Water and development plan
c. Pipe network Data
d. Clean Water network location Map
e. Wage and material Unit price list

IV. DATA PROCESSING

1. Calculating the projection of clean water needs with three methods those are arithmetic, geometric and exponential methods. After that test to the population projection method
   $P_n = P_o (1 + r)^n$ ..... (1)
   $P_n = P_o (1 + r. n)$ ..... (2)
   $P_n = P_{o.} e^{r. n}$ (3) ..... (3)
2. Calculating how much water needs to reach the number of population until the year 2033 (15 years ahead)
3. Calculating the distribution of water needs in each Junction.
   a. Specified number of existing houses of residents served in each junction
   b. The presentation of the amount of service based on the existing house served in each junction
   c. After that the calculation is done at each junction, with multiplied number of service presentation with water needs. The result is to get the amount of water needed in each junction.
4. Analyzing the Existing network using WaterCad V8i application
   To analyze using the Watercad V8i application, the stages are as follows:
   a. Open the watercad V8i application
   b. Determining the stage for creating a file with an International Unit (SI)
   c. Determining the formula to lose high press Hazen Williams
   d. Creating a network layout such as the layout of the junction, Reservoir,Tandon, pipes, and water needs at Tiao-each Junction
   e. Inputting data on the water network such as:
      - Data pipes with include: Pipe dimensions, pipe type, pipe length
      - Junction Data with include: elevation, large water needs in each Junction or called Demand.
   f. After all the data in the input corresponds to the planned and then done run analysis to get the desired result.
5. Analyzing the Existing network using WaterCad V8i application
6. Analyzing the network for Clean Water development using WATERCAD V8i applications
7. Calculating the necessary RAB for planning and maintenance costs
8. Analyzing the economic feasibility of a clean water supply system development Project
   Benefit Cost Ratio (BCR)
   Calculation of BCR using formula (Giatman, 2007):

$$BCR = \frac{PV\ Benefit}{PV\ Cost}$$

   with:
   PV = Present Value
   BCR = Benefit Cost Ratio
   - Net Benefit (B-C) is the difference between the amount of Benefit and the cost.
   - Internal Rate of Return (IRR)
     The IRR value is calculated with the formula (Kodoatie, 2005):

$$IRR = I' + \frac{(B-C)'}{(B-C)'-(B-C)''}(I'' - I')$$

   with:
   I ' = interest rate with value (B-C) positive
   I " = interest rate with negative value (B-C)
   (B-C) ' = Net benefit (B-C) positive
   (B-C) "= Net benefit (B-C) negative

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- Break-even-point calculation formula of investments (Giatman, 2007):

$$k = \frac{\text{investasi}}{\text{annual benefit}} \text{ x time period}$$

with:

k	: Return period
Investments	: Used Capital
Annual Benefit	: Each yr profit
Time period	: Year

- Sensitivity analysis with the state of 10% decrease in benefits, 10% increase in costs, and delayed project completion

9. Determining the price of water that will be paid community users clean water. (The amount of water price quantity is carried out calculations by taking the amount of the price of the public with the spread of questionnaires. Then, the calculation of WTP (Willingnes to Pay) is taken by the average value.

V. Result and Discussion

Some of the results and discussions on this research are as follows:

1. *Population projection*

Based on the results of the calculation of population projection until 2033 is 7033. Using several methods, those are arithmetic, exponential and geometric method, which used and the results are close to + 1.

Based on the value of the correlation coefficient of three projection methods, the result is that the geometric method has a by approaching + 1. Thus the geometric method was chosen for calculation for the next 15 years

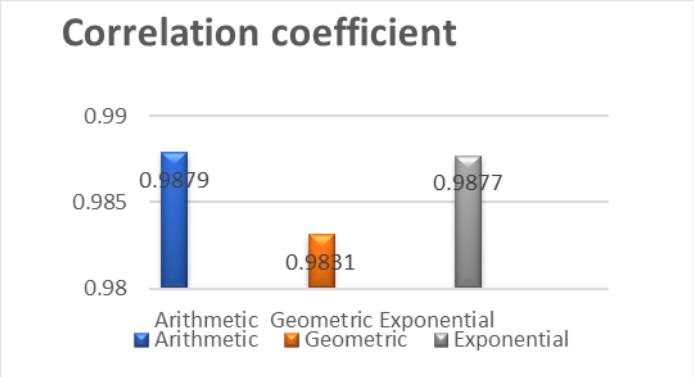

Fig. 3. Correlation Coefficient with Three Methods

2. *Water needs analysis*

Here is the calculation of the need for clean water in view village until the year 2033
Domestic Water demand of 6.51 ltr/s
Non-domestic Water requirement of 1,302 ltr/s
Water needs at peak hours of 15,238 ltr/s

3. *Evaluation and development of clean water network with Watercad V8i Program*

a. Existing condition network simulation result using auxiliary program Watercad V8i. On The network simulation development condition, USING PVC pipe type With Hazen Williams 150 . At a very high need at peak hours is at the maximum speed is the case of pipe 23 is 1.79 m/s, while the lowest pipe occurs at the 18 pipe is 0.001 m/s. Simulated results at Junction on the picture 2. Correlation coefficient with three methods peak hours are the smallest pressure of 7.0 m H2O on juction 13 and the largest pressure of 18.7 m H2o On juction 4. The network on the eksisitng uses PVC pipe 190 on the transmission network and PVC Pipe 90 on the distribution network. For condition of existing in network simulation.

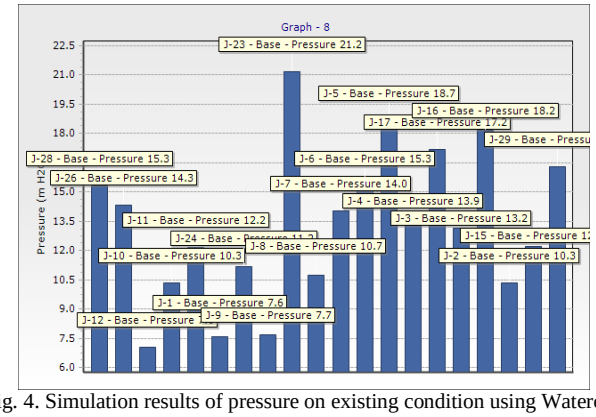

Fig. 4. Simulation results of pressure on existing condition using Watercad V8i

b. Development done on the network that the addition of pipelines in the study site and carried out pipe substitution using PVC pipe 90 in transmission network, and in the distribution network pipe used are PVC pipe 63 and 50, then carried out the development of the Reservoir development with a capacity of 135 m^3. In the flow system is carried out gravity system because the location of the water source is in a higher area. For simulated results of clean water network development conditions can be seen in the figure 5

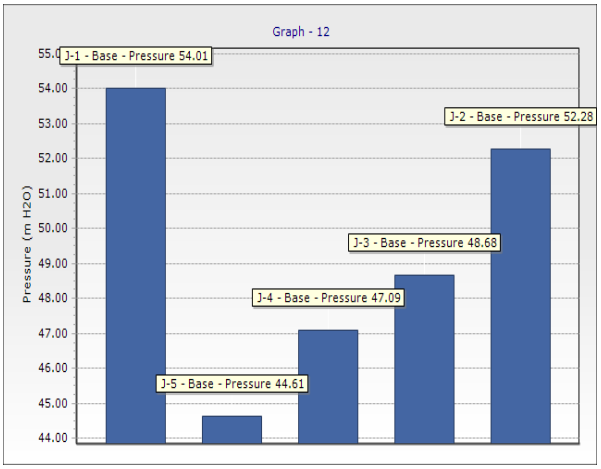

Fig. 5. Pressure simulation results on developing conditions with Watercad V8i

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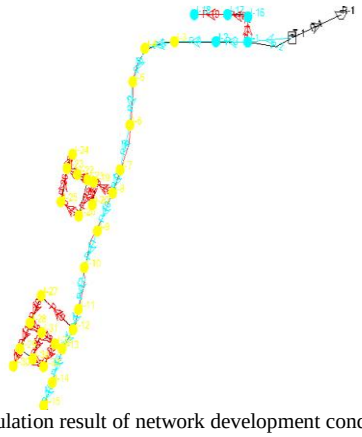

Fig. 6. Simulation result of network development condition using Watercad V8i

4. Economic Analysis

The cost of economic analysis on the following Clean Water network development project:

1. In this development the total number of projects issued is registration:

   For direct cost under issued amounting to Rp. 430.779.250.00 and indirect costs of 44,154,873.13. Total under Project Rp. 474,934,123.13

   Based on the economic analysis of the development project with the interest used 6%, it is reviewed with Benefit Cost Ratio (b/C), Net Benefit (b-C), Internal Rate of Return (IRR), breakeven-point investment (Payback period). Obtained the following values:

   a. BCR Value at interest rate 6% = 1.23. The value is said to have economically layaks because BRC > 1
   b. Value B-C of 12, 945, 742, 85 the value is feasible because the B-C value is positive
   c. IRR value of 14.80%, greater than the interest rate, with a value of 6% interest rate. So it can be said that the project is profitable
   d. Breakeven Investment occurred in the year 12.6 ≈ 12 years 6 months (year 2030)

Based on the results of economic analysis, this clean Water network project is well-established

5. Water pricing and water pricing based on willingnes To Pay

From The Results of economic analysis obtained water price of Rp. 8,200, whereas the value of WTP is Rp. 4,500. While in economic analysis acquired value of Rp. 8,200. Therefore, there is a cost subsidy from the government so that people can buy water.

VI. CONCLUSION

From the results of the calculation obtained the following results:

1. Existing network condition of simulation by using WATERCAD Auxiliary program V8i. In simulation network condition development using PVC pipe type with Hazen Williams 150 . At a very high need at peak hours is at the maximum speed is the result of pipe 23 is 1.79 m/s, while the lowest pipe occurs at the 18 pipe is 0.001 m/s. Simulated results at Junction at peak hours is the smallest pressure of 7.0 m H2o On juction 13 and the largest PRESSURE of 18.7 m H2O on juction 4. The network on the eksisitng uses PVC pipe 190 on the transmission network and PVC Pipe 90 on the distribution network
2. Development done on the network, which is adding pipe at the study location and pipe replacement is carried out using PVC pipe 3 inc in Transmission network, and in the distribution network pipe used are PVC pipe 1.5 inc, and 2 Inc then carried out the development of Reservoir development with capacity 135 m3. In the flow system is carried out gravity system because the location of the water source is in a higher area.
3. In this development the total number of projects issued is registration:
   a. For the direct cost of the fee incurred Rp. 430.779.250.00 and indirect costs of 44,154,873.13. Total under Project Rp. 474,934,123.13
   b. Based on economic analysis of the development project with interest used 6%, is reviewed with benefit Cost Ratio (b/C), Net Benefit (b-C), Internal Rate of Return (IRR), breakeven Investment point (Payback period). Obtained the following values:
4. BCR Value at interest rate 6% = 1.23. The value is said to have economically layaks because BRC > 1
5. Value B-C of 12, 945, 742, 85 the value is feasible because the B-C value is positive
6. IRR value of 14.80%, greater than the interest rate, with a rate value of 6%. So it can be said that the project is profitable
7. Breakeven Investment occurs in the year 12.6 ≈ 12 years 6 months (year 2030)
   a. Based on the results of economic analysis, this clean Water network project is worth building
8. From the results of economic analysis acquired water price of Rp. 8,200, whereas the value of WTP is Rp. 4,500. While in economic analysis acquired value of Rp. 8,200. Therefore, there is a cost subsidy from the government so that people can buy water. If the local government cannot subsidize the cost of the water, the PDAM can do so by seeking a partner or cooperate with the local company for the financing.

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