Economic Feasibility Study Of The HIPAM Clean Water Network System, Genting Village, Merjosari Village, Lowokwaru District, Malang City

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Abstract.
The need for clean water for the community is urgently needed, therefore the HIPPAM (Drinking Water Users Association) was formed which is a legal forum according to government regulations and regulations to manage the supply of clean water to the community. There were many obstacles that occurred during operation, one of which was the regional regulation of East Java Province which required HIPPAM to pay groundwater withdrawal tax which ultimately affected the increase in the price of clean water. One area that was realized from the existence of this regulation was Genting Village, Merjosari Subdistrict, Lowokwaru District, Malang City. Given these problems, the purpose of this study is to analyze the economic feasibility of determining the price of clean water in the area. The results of this study show economic feasibility based on bank interest of 9%, Benefit Cost Ratio = 2.44, Net Present Value = Rp. 16,069,451,606, Internal Rate of Return = 13.99%, payback period = 13 years, and sensitivity analysis with IDR prices. 1,000/m3 and a 25% increase every 4 years following inflation.

Keywords: *HIPPAM, Clean Water, and Economic Feasibility*

I. INTRODUCTION

Water is one of the most important basic needs for life and human life or in other words as long as there is life as long as water is still needed, both for carrying out daily activities and for drinking humans themselves.[1] This comparison between the population and the need for water results in water scarcity due to the lack of water supply compared to the demand.[2]The need for clean water for the community is urgently needed considering the increasingly limited vacant land to accommodate rainwater which has turned into a residential area for the community, plus sanitation in the community is getting closer between one house and another [3], as happened in Genting Village, Merjosari Subdistrict, Lowokwaru District. Malang City.At the location of this study, the local community uses water from the HIPAM (Community Water Users Association) group, starting from distributing, maintaining and repairing facilities and infrastructure, to determining the selling price of the water. [4] In accordance with statutory regulations, HIPAM's operational activities can charge fees to the people who use managed clean water. In implementing HIPAM, which is a social community organization, it does not emphasize profit as a source of income.[5] And it was found that several obstacles occurred, namely the cost of electricity expenses which continued to increase, there were arrears in contributions by HIPAM members, there were extortion under the pretext of money for security facilities and infrastructure [6], and especially in the study area, namely in the East Java Province, HIPAM required to pay a tax for taking underground water.

Soil In connection with determining the price of water distributed to HIPAM members, it is necessary to carry out an economic feasibility study in determining the price of clean water so that it covers all production, operational and water costs according to the ability of the community members of HIPAM. According to Sutikno, et all [7] in his journal which analyzed the economic feasibility study of the clean water network system in Junrejo District, Batu City using 3 alternative types of materials, namely galvanized pipe material, an IDR investment is required. 2,495,821,000, PVC pipe material requires IDR investment. 1,181,910,000, and HDPE pipe material requires IDR investment. 3,158,436,000. For economic feasibility obtained based on 9% interest and planning indicators that occur in alternative galvanized pipes with a value of B/C = 1.01, NPV = IDR. 2,756,400,000, IRR = 9.50%, pay back period = 5.99 years and the sensitivity analysis under normal conditions is constant. The tariff for water sold to HIPAM consumers is in accordance with the calculation of its economic feasibility, namely IDR. 1,200/m3, and there is an IDR increase. 150/m3 for 4 years.Therefore, in this study an economic feasibility analysis will be carried out to determine the price of clean water which can be used as a reference for the Merjosari Village HIPAM in setting the price of clean water. This study will also carry out further economic analysis by considering the Benefit Ratio Value (B/C).

II. METHODS

For the calculation of population growth projections in this study using geometric, arithmetic and exponential methods which are commonly used to predict population development in the future [8]. For determining the selected criteria method based on the largest correlation coefficient value and the smallest standard deviation value, the percentage of population growth in the study area [9].

Arithmetic Method

The number of population growth using this method is formulated as follows (Muliakusumah, 2000) [10]

$$P_n = P_0(1 + rn) \quad (1)$$

Dimana,

P_n = population at the end of the nth year (people)

P_0 = population in the year under review (people)

r = population growth rate per year (%)

Geometric Method

By using the geo metric method, the development of the population of an area can be calculated using the following formula (Rusli, 1996) [11]. This method can be formulated as follows:

$$P = P(1 + r)^n \quad (2)$$

Dimana,

P_n = population at the end of the nth year (people)

P_0 = population in the year under review (people)

r = population growth rate each year (%)

n = number of projected years (years)

Exponential Method

Estimates of the population based on the exponential method can be approximated by the following equation (Rusli, 1996) [11] :

$$P_n = P_0 + e^{r.n} \quad (3)$$

Dimana,

P_n = population at the end of the nth year (people)

P_0 = population in the year under review (people)

r = population growth rate each year (%)

n = number of projected years (years)

e = natural logarithmic number (2.7182818)

Economic Analysis

Comparison of Benefits and Costs (Benefit/Cost or B/C) Benefit Cost Ratio (BCR) is a comparison between the present value (present value) of benefits (benefits) and the present value of costs (cost). In general, the formula for calculating BCR is (I Nyoman Pujana, 1995) [4]:

$$BCR = \frac{PV\ Manfaat}{PV\ Biaya} \quad (4)$$

Dimana,
PV = Present Value
BCR= Benefit Cost Ratio

$$IRR = \frac{I' \times NPV \times (I'' - I')}{(NPV' - NPV'')} \quad (5)$$

Dimana,
I' = Interest rates provide a positive NPV value
I" = Interest rates give a negative NPV value
NPV = Difference between present value of benefits and the present value of costs
NPV' = NPV positiVE
NPV" = NPV negative

After that, the Sensitivity Analysis is calculated, it will be possible to estimate the impact that will occur if the actual conditions that occur after the project are not the same as the initial estimate [13]. The reason for conducting a sensitivity analysis is to anticipate changes in them:[14]

a. There is a cost overrun, namely an increase in project and production costs.
b. Decreased productivity
c. Delayed project implementation schedule

After conducting the analysis, it can be seen how far the impact of these changes has been on the feasibility of the project and at what level the project is still feasible.

III. RESULT AND DISCUSSION

Population Growth Analysis

The provision of clean water in an area needs to be known in advance about the condition of the current population and projections of future population growth, so that the calculation results can be used to calculate the maximum water demand and predict the development of the clean water supply system in the projected year.[15]The growth and rate of population and population density in Genting Village, Merjosari Subdistrict, Lowokwaru District, Malang City. Based on the calculation results, it is known that the annual population growth rate in Genting Village, Merjosari sub-district, averages 1.13% per year with an even population density in each hamlet. The following is the result of calculating population growth analysis in **Table 1**.From the calculation results of the three population growth projection methods, it is found that the arithmetic method is closer to the reality of population development in the study location. Thus the method chosen for projecting the number of residents in Genting Village, Merjosari sub-district until 2040 is the Arithmetic method.

Projection of Clean Water Needs

In order to design water structures, transmission pipes and networks to provide raw water, it is necessary to know how much clean water is needed in the study area. Factors that affect the projection of water demand are fluctuations in water usage, clean water demand standards as the basis for calculating domestic and non-domestic water needs as well as water loss factors.In 2040 the average need for clean water in Genting Village, Merjosari sub-district is estimated to be 12.90 liters per second, the maximum daily need for clean water is 14.83 liters per second and the need for clean water during peak hours is 23.135 liters per second. The graph of the average clean water demand in Genting Village, Merjosari sub-district can be seen in **Figure 1**.

Effective Volume Analysis, Reservoir Dimensions and Reservoir Water Simulation

Calculation of reservoir capacity is done by using the mass curve. In the clean water distribution network system for Genting Village, Merjosari sub-district, the planned reservoirs are one cube-shaped reservoir.

Table 1. Projection of the Population of Genting Village, Merjosari Subdistrict, 2020-2040

No.	Years	Number of Population (People)	Projection Method (People)		
			Arithmetic	Geometric	Exponential
1	2016	6,537	-	-	-
2	2017	6,549	-	-	-
3	2018	6,567	-	-	-
4	2019	6,584	-	-	-
5	2020	6,597	6,597	6,597	6,597
6	2021	-	6,635	6,598	6,600
7	2022	-	6,672	6,600	6,603
8	2023	-	6,710	6,601	6,606
9	2024	-	6,747	6,603	6,609
10	2025	-	6,785	6,604	6,612
11	2026	-	6,823	6,606	6,615
12	2027	-	6,860	6,607	6,618
13	2028	-	6,898	6,609	6,621
14	2029	-	6,935	6,610	6,624
15	2030	-	6,973	6,611	6,627
16	2031	-	7,011	6,613	6,630
17	2032	-	7,048	6,614	6,633
18	2033	-	7,086	6,616	6,636
19	2034	-	7,123	6,617	6,639
20	2035	-	7,161	6,619	6,642
21	2036	-	7,199	6,620	6,645
22	2037	-	7,236	6,621	6,648
23	2038	-	7,274	6,623	6,651
24	2039	-	7,311	6,624	6,654
25	2040	-	7,349	6,626	6,657

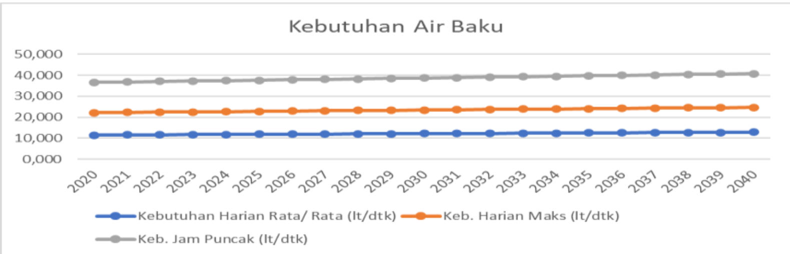

Fig 1. Raw Water Needs

This reservoir building was built so that the discharge that will flow from the water source to the transmission is more stable. If the source discharge is directly channeled to the needs of hipam, it sometimes exceeds the capacity, therefore it will temporarily be accommodated in the reservoir to the extent that the discharge is to fulfill the needs of hippam users. The following is the calculation of the reservoir operation pattern in **Table 2**.

Table 2. Reservoir Operation Pattern

Hour	Source Debit	Operation Tank	Standard Consumer Load Factor	Corrected Consumer Load Factor	Corrected Consumer Load Factor Percentage
1	0	0	0.30	0	0
2	0	0	0.37	0	0
3	0	0	0.45	0	0
4	1	0	0.64	0	0
5	1	0	1.15	0	0
6	1	1	1.40	1.40	0.10
7	1	1	1.53	1.53	0.10
8	1	1	1.56	1.56	0.09
9	1	1	1.42	1.42	0.09
10	1	1	1.38	1.38	0.08
11	1	1	1.27	1.27	0.08
12	1	1	1.20	1.20	0.07
13	1	1	1.14	1.14	0.07
14	1	1	1.17	1.17	0.07
15	1	1	1.18	1.18	0.08
16	1	1	1.22	1.22	0.08
17	1	1	1.31	1.31	0
18	1	0	1.38	0	0
19	1	0	1.25	0	0
20	0	0	0.98	0	0
21	0	0	0.62	0	0
22	0	0	0.45	0	0
23	0	0	0.37	0	0
24	0	0	0.26	0	0
		Total		15.78	0

Pipeline System Analysis

In accordance with the existing source discharge capacity of 24 ltr/second, the effective reservoir volume capacity, the topographical conditions of the study area and the distribution of residential locations. The transmission pipe network system for the Hipam unit, Genting Village, Merjosari sub-district, starts from the Junrejo source with a transmission pipe diameter of 100 mm (4 inches) with a galvanized pipe type of transmission length of 2,815 km.

Cost Budget Plan Analysis

The Budget Plan is the costs required for materials and labor wages based on certain analysis and other costs related to the implementation of the work. The purpose of making a budget is to provide an overview of the form of construction, the amount of costs and methods of implementation. This budget plan will later determine the cost (initial capital) that must be incurred by Hipam. Calculation of the Budget Plan can be seen in **Table 3**.

Table 3. Recapitulation of Pipe Optimization Results Using Galvanized Pipes

No	Works	Vol	Unit	Price (IDR)	Total (IDR)
I. Broncape Work					
1.	Excavation of Rock Soil in 1 m area of 1 m2	60.00	m3	121,750.00	7,305,000.00
2.	Install 1 m3 of mixed stone foundation 1sp : 3pp	8.00	m3	373,500.00	2,988,000.00
3.	1m3 concrete quality c=12.2 Mpa (K.150)	2.40	m3	890,758.00	2,137,819.50
	Sub Total 1				12,430,819.50
II. Pipework from Source to Reservoir					
1.	Rock Soil Excavation in 1 m	655.68	m3	121,750.00	79,829,040.00
2.	Installation of 1m Dia.4" Galvanized Pipe	2,185.59	m	312,500.00	682,996,875.00
	Sub Total 2				762,825,915.00

III. Water Reservoir Work					
1.	Rock Soil Excavation in 1 m	36.00	m3	121,750.00	4,383,000.00
2.	Fill 1 m3 of soil with piled sand	5.40	m3	23,750.00	128,250.00
3.	Install 1 m3 of mixed stone foundation 1sp : 3pp	36.00	m3	373,500.00	13,446,000.00
4.	1m3 concrete quality c=12.2 Mpa (K.150)	17.28	m3	890,758.13	15,392,300.40
5.	Make 1 m3 of reinforced concrete foundation	17.28	m3	312,500.00	5,400,000.00
	Sub Total 3				38,749,550.40
IV. Installation of Network Pipes					
1.	Rock Soil Excavation in 1 m	36.00	m3	121,750.00	4,383,000.00
2.	Installation of 1m Dia.3" Galvanized Pipe	515.15	m	312,500.00	160,984,375.00
3.	Rock Soil Excavation in 1 m	36.00	m3	121,750.00	4,383,000.00
4.	Installation of 1m Dia.1" Galvanized Pipe	1,619.99	m	312,500.00	506,246,875.00
	Sub Total 4				675,997,250.00
	TOTAL				1,490,003,534.90

Economic Alternative Analysis and Sensitivity

The profit or benefit (benefit) of the project is the increase in net income (Net Incremental Benefit), namely the difference between future net income with the project and without the project including the decrease in net losses, namely the difference between future losses. Following are the results of calculating alternative water prices in **Table 4.**

Table 4. Alternatives to Setting Water Prices

Year	Alternative Price I (IDR)	Alternative Price II (IDR)	Alternative Price III (IDR)	Alternative Price IV (IDR)	Alternative Price V (IDR)
2020	750	1,000	1,250	1,500	1,750
2021	750	1,000	1,250	1,500	1,750
2022	750	1,000	1,250	1,500	1,750
2023	750	1,000	1,250	1,500	1,750
2024	938	1,250	1,565	1,875	2,188
2025	938	1,250	1,565	1,875	2,188
2026	938	1,250	1,565	1,875	2,188
2027	938	1,250	1,565	1,875	2,188
2028	1,175	1,565	1,960	2,345	2,735
2029	1,175	1,565	1,960	2,345	2,735
2030	1,175	1,565	1,960	2,345	2,735
2031	1,175	1,565	1,960	2,345	2,735
2032	1,470	1,960	2,450	2,935	3,419
2033	1,470	1,960	2,450	2,935	3,419
2034	1,470	1,960	2,450	2,935	3,419
2035	1,470	1,960	2,450	2,935	3,419
2036	1,838	2,450	3,065	3,670	4,273
2037	1,838	2,450	3,065	3,670	4,273
2038	1,838	2,450	3,065	3,670	4,273
2039	1,838	2,450	3,065	3,670	4,273
2040	2,300	3,065	3,835	4,590	5,342
2040	2,300	3,065	3,835	4,590	5,342

From the results of the above calculations, the water setting price is IDR. 1,000/m3 and analyzed the interest rate is 9%/year, the internal rate of return is 13.99, the present value benefit is IDR. 16,069,451,606, the present value cost is IDR. 6,889,907,831, benefit cost ratio of 2.33, and payback period of 13 years.From the design of the Merjosari HIPAM distribution network within a period of 20 years of use, criteria were produced that could be accounted for with each different material, namely;With Galvanized pipe material the maximum results are in alternative 5 with the initial rate of IDR water prices. 1,000, the Present Value Benefit requirement is IDR. 16,069,451,606 with an NPV of IDR. 6,573,866,566, IRR = 13.99%. B/C = 2.44

payback period of 13 years. Furthermore, the determination of alternative 1 water prices is burdensome for investors while the initial water price alternatives 2, 3 and 4 from a people's economic perspective are very burdensome for water users because the IRR value > agreed interest, B/C > 1. Furthermore, the determination of water prices can be chosen or determined by considering HIPAM's financial soundness independently with affordable and reasonable water prices acceptable to the community. Therefore the suggestion from the author is to use water pricing with alternative 4, namely the selling price of water at the beginning of the year to year 4 of IDR. 1,250/m^3.

From the design of the Merjosari HIPAM distribution network within a period of 20 years of use, if the operating conditions are normal but the income has decreased by 10%, it still produces criteria that can be accounted for with galvanized pipe material, namely; Maximum results in alternative 2 with the initial price of IDR water. 1,000, the required investment is IDR. 1,624,103,853 with a Present Value Benefit of IDR. 16,069,451,606 with an NPV of IDR. 6,573,866,566, IRR = 13.99%. B/C = 2.44 payback period of 13 years. Furthermore, the determination of alternative 1 water prices is burdensome for investors while the initial water price alternatives 2, 3, 4 and 5 from a people's economic perspective, are very burdensome for water users because the IRR value > agreed interest, B/C > 1. Furthermore, the determination of water prices can be chosen or determined by considering HIPAM's financial soundness independently with affordable and reasonable water prices acceptable to the community. Therefore the suggestion from the author is to use water pricing with alternative 3, namely the selling price of water at the beginning of the year to year 4 of IDR. 1,750/m^3.

IV. CONCLUSION

Based on the feasibility study that we have carried out for the provision of clean water which is expected to provide recommendations in the development of the HIPAM network to be built, it can be concluded that:The pipe diameter is adjusted to the hydraulic parameters of the transmission pipe in the Merjosari HIPAM clean water network system after an economic feasibility study with a distribution diameter of 4 inches for the network from source to reservoir 2.185 meters long with a source discharge of 24 liters/second. The required investment costs and benefits obtained from the clean water distribution network system project at the Merjosari HIPAM type Galvalis pipe material require an investment of IDR. 1,624,103,853.

For the economic feasibility of the plan to provide the Merjosari HIPAM clean water network system based on a bank interest of 9% and the planning indicators that occur in alternative 2 with the type of Galvanized pipe material are Benefit Cost Ratio (B/C) = 2.44, Net Present Value (NPV) = IDR . 16,069,451,606, Internal Rate of Return (IRR) = 13.99 %, investment breakeven point (pay back period) = 13 years and sensitivity analysis under normal conditions, namely the benefits and costs are fixed at the initial rate of the price of water sold to HIPAM consumers so that it meets project investment standards is in alternative 2, namely at the price of IDR. 1,000/m^3 and there is a 25% increase every 4 years following inflation.

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