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Increasing Water Capacity Services for South Binjai Community Demand with Intake Pump

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A B S T R A C T

Indonesia is a country prone to water shortages. Water shortages can affect human well-being and cause disease. This happened in South Binjai Subdistrict, Binjai City, North Sumatra, Indonesia where clean water services were inadequate. Efforts to improve services need to be carried out. This study aimed to evaluate clean water service providers in South Binjai Regency. Evaluation is done by calculating the need for clean water with projected population and customer data. The feasibility analysis of service providers is calculated from the number of people served. So if it does not meet the national standard of 80%, then efforts must be made. The results of the evaluation of service providers in South Binjai District reveal that the coverage of clean water services in 2030 will only reach 17.946%, so service coverage still does not meet national standards. Service providers have limited water capacity. Therefore, the scope of services can be fulfilled by adding operational tools for taking clean water sources such as water pumps. The proposed strategy is to take water from the Bingei River with eight intake pump capacity of 6.25 l/s. The total cost of procuring these pumps in 10 years is IDR 1,529,280,000. Adding the intake pump can increase the water capacity up to 125%. The results of this study can be used as an effort to meet clean water needs in the future.

1. Introduction

Water is one of the main needs for humans to carry out daily activities [1], [2]. Adequate clean water needs in an area can increase productivity, welfare, health, and environmental quality. The need for clean water is one of the points of the Sustainable Development Goals (SDGs), which aim to ensure the availability of clean water for all by 2030 [3]. Unfortunately, in some parts of the world, the need for water is not fully met [4]. In the world, 1.8 billion people do not have access to clean water. This water scarcity affects at least 40% of the global population and is projected to continue to increase, including in Indonesia [3].

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Indonesia is a country that is prone to symptoms of a water shortage [5]. This happened in the South Binjai sub-district, Binjai City, North Sumatra, Indonesia. In this area, the existence of clean water service providers is still far from satisfactory. The community prefers to use groundwater sources as one of the main sources for obtaining water. Meanwhile, groundwater in South Binjai District has been polluted, so it is not good for health and can cause disease [6], [7]. In addition, the continuous use of groundwater can cause land subsidence. [8]. This occurs when water taken from the ground is unable to flow back into the soil quickly to fill the empty cavities beneath the soil surface. As a result, these cavities are filled with air causing the soil to sink. Subsidence can cause damage to buildings, infrastructure and the environment [9], [10]. Considering that the impact is quite large, it is necessary to have a proper service provider to meet the demand for clean water.

The government has cooperated with the private sector in efforts to provide clean water. However, differences in interests, regulatory uncertainty, and technical issues are quite a hindrance. The inability of the private sector to meet the water needs of an area is also very influential. On the other hand, population growth and rapid economic growth will increase the amount of water demand [11]. Therefore it is necessary to conduct a feasibility study of clean water service providers.

Research conducted by Yusuf revealed that the community is quite satisfied with the clean water service providers in the Kalumata Village, Ternate City. This is because the service provider is able to serve the needs of clean water in the area [12]. In contrast to Belawang District, Barito Kuala District, the demand for clean water cannot be met in 2028. This is because the capacity of clean water service providers is insufficient [13]. In overcoming the lack of water capacity, one effort that can be done is to add a pump. Many studies have been conducted, but most are limited to evaluating the need for and availability of clean water. Therefore, research is needed to reveal efforts to fulfill clean water services so that they can meet the needs.

The purpose of this study was to evaluate clean water service providers in South Binjai District. Evaluation is carried out by calculating the coverage of service providers standard using PP no. 122 of 2015. If the service coverage does not meet the standards, a cause analysis will be carried out as well as appropriate efforts to increase service coverage. So that with these efforts, the community's water needs are expected to be fulfilled in the future.

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2. Research Method

Research method used in this study is a descriptive qualitative research analysis method [14]. One of the drinking water service companies (Company M) in Binjai City is used as the object of this research. The research location is located in Binjai Kota District, Binjai City, North Sumatra. The research was carried out by means of literature reviews and field observations. Field observations were carried out to determine the location for data collection. The data used in this study include the number of regular customers of Company M in South Binjai Regency in 2019–2021, population of South Binjai Regency for 2017–2021, and the installed water discharge capacity and production of Company M in 2021. After obtaining the data, predictions of population growth and development of M company customers in South Binjai Regency are made using geometric and arithmetic methods. Evaluation of domestic and non-domestic clean water needs is carried out to find out whether company M has been able to meet clean water needs. PP No. 122 of 2015 is used as a reference where drinking water service companies must cover more than 80% of the total population. If it is not in accordance with the standard, efforts will be made to improve it.

2.1 Prediction Method

As indicated by the Guidelines for the Minister of Public Works Number 18/PRT/M/2007 concerning the Implementation of SPAM Development, there are several predictions systems used, namely:

1. The Geometric Method, This method assumes that development or population will automatically increase by itself and does not pay attention to the decline in population [15], [16]. The equation is:

   $$Pn = Po + (1 + r)n \quad (1)$$

   Pn is the population in year n, Po is the population in the first year, while r is the population growth rate, and n is a known year interval.
2. Arithmetic method this technique is suitable for areas with an increasing population. Arithmetic estimation strategies rely on the normal growth of the population making use of both recent and historical information [17], [18]. The equation is:

   $$Pn = Po + a.n \quad (2)$$

   $$a = (Po - Pt)/n \quad (3)$$

   Pn is the population in year n, Pt is the population base year, Po is the last year's population, while n is the known year interval, and a is the average population growth.

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2.2 Research Data

The primary data used includes the number of regular customers of Company M in South Binjai Regency in 2019–2021 and the installed water discharge capacity and production of Company M in 2021. Primary data is used to calculate how much clean water can be covered by company M. So that it can be known to calculate the proportion residents whose clean water needs have been met. Primary data obtained through: preliminary survey, water network survey, soil condition and structure survey, topology survey, environmental survey and hydrology/drainage survey.

Meanwhile, secondary data is data on the population of South Binjai Regency for 2017–2021 from the Central Bureau of Statistics for the City of Binjai. Secondary data is used to estimate the amount of clean water needed in South Binjai Village.

2.2.1 Population Data

The population data obtained are presented in the table below.

Table 1. Data on the Population of South Binjai District for 2017–2021.

No	Year	Number of Population (Person)	Population Growth (%)
1	2017	59,180	
2	2018	59,918	0,12
3	2019	60,640	0,12
4	2020	61,300	0,11
5	2021	61,950	0,11
	Average		0.012

Source: Central Bureau of Statistics City of Binjai.

Every year, the population in south Binjai city continues to increase, and until 2021, the total population obtained is 61,950.

2.2.2 Customer Data for Company M

Customer data for 2019 – 2021 at company M is presented in the table below.

Table 2. Number of Customers Data Company M in the South Binjai.

No	Customer Type	Year		
		2019	2020	2021
1	Special Social (House of worship, orphanages, health centers, etc.)	22	23	24
2	Household 1 (Type 21 residential house m^2)	1	1	1
3	Household 2 (Type 36 residential house 36 m^2)	9	8	8
4	Household 3 (Residential house type 54 m^2, small shops, private social foundations)	500	553	565
5	Household 4 (Residential type >54 m^2, motel or inn)	915	924	938
6	Household 5 (Luxury house type >100 m^2, shop)	63	63	67
7	Government agencies/TNI-Polri (dormitories, health centers, hospitals, offices)	352	352	351

Source: Company M Clean Water Management in Binjai City.

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2.2.3 Clean Water Production Capacity of Company M

Currently, Company M obtains the quantity of water sources it manages by empowering several available springs.

Table 3. Company M Production Capacity Data for 2021.

Name	Capacity (I/sec)		Water sources
	Installed	Production	
WTP Marcapada II	40	22	Binjai River

Source: Company M Clean Water Management in Binjai City.

2.3 Clean Water Needs

The calculation of water needs that is carried out includes domestic and non-domestic needs, water loss factor, maximum daily needs, and peak hour water usage [19].

2.3.1 Domestic and Non-Domestic Water Needs

Domestic water needs are the need for water for household purposes such as drinking, bathing, washing clothes, and cooking [20]. Meanwhile, non-domestic water needs include water needs for industrial, agricultural, and fishery activities [21], [22]. The need for water is calculated by multiplying the total population and the amount consumed by each person [23].

2.3.2 Water Loss Factor

Leakage is water loss due to technical and non-technical losses. Technical leaks occur in the distribution network and in production facilities, such as filter washing and water use in installations for adding chemicals, while non-technical leaks can occur due to meter recording errors, customer meter inaccuracies, or other administrative recording errors. The amount of water loss expressed as a percentage of production capacity and calculated using the following formula:

$$Ka = (Ap – At) / Ap \quad (4)$$

Where Ka is loss of water, Ad is produced water, and At is air sold (provides revenue)

2.3.3 Maximum Daily Needs

The average water requirement (SI) can be determined by the equation:

$$SI = (\text{Population Served x average used per day})/ \text{Time (Seconds)} \quad (5)$$

After getting the average water needs, then the next step is to calculate the maximum daily water needs.

$$Ss = f1 \times Sr \quad (6)$$

Where Ss is the maximum daily requirement, Sr is the total amount of domestic and non-domestic water needs, and f1 is 1,1.

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2.3.4 Peak Hour Water Usage

The peak hour factor is usually influenced by the number of residents and the level of urban development, where the larger the population, the more diverse the activities of the residents [24]. With the increasing activity of the population, the fluctuations in water usage are getting smaller. Based on the standards listed in Appendix III of Minister of Public Works Regulation No. 18 of 2007, the peak hour factor (fp) ranges from 1.15 – 3. In this research, the peak hour factor (fp) used as a design criterion is 1.75. Furthermore, the need for water at peak hours is also calculated to determine the highest water consumption at certain hours of the day. The similarities are:

$$Sp = fp \times Sr \quad (7)$$

Where Sp is peak hour water demand, and Sr is the total amount of domestic and non-domestic water needs.

3. Results and Discussions

3.1 Prediction of Total Population

The total population can be presented in the table below.

Table 4. Prediction of Total Population.

No	Year	Population Prediction (Person)
1	2022	62,425
2	2023	62,900
3	2024	63,376
4	2025	63,851
5	2026	64,326
6	2027	64,801
7	2028	65,276
8	2029	65,752
9	2030	66,227

Source: Author Analysis.

From the calculation results, it is estimated that the population of South Binjai District in 2030 will grow to 66,227 people.

3.2 Prediction of Addition Customers Company M

In estimating the number of Company M's subscribers in the South Binjai service area, the geometric method is used for the years 2022–2030. The calculation of the additional number of Company M customers is presented as follows.

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Table 5. Addition of Company M Customers in 2030.

Customer Type	Increase in Customers (SR/Customer)	Total Customers in 2030
Special Social	31	55
Household 1	1	2
Household 2	6	14
Household 3	819	1384
Household 4	1,011	1949
Household 5	81	148
Government/TNI-Polri	348	699

Source: Author Analysis.

From the table above, it can be seen that all types of customers will experience an increase in 2030. The average increase is 40 – 50%.

3.3 Clean Water Needs

The clean water demand is calculated based on the predicted population growth and the number of Company M's customers in the South Binjai service area.

Table 6. Prediction of Clean Water Needs.

Water Needs	Based Total Population (l/s)	Based on Customer Company M (l/s)
Domestic and Non-Domestic Water Needs	109.612 l/s	18,018 l/s
Water Loss Factor	21.922 l/s	3,604 l/s
Maximum Daily Needs	120.573 l/s	19,819 l/s
Peak Hour Water Usage	164.418 l/s	27,026 l/s

Source: Author Analysis.

Based on PP No. 122 of 2015 concerning drinking water supply systems [25], as much as 80% of the total population in an area is directed to use drinking water supply services for routine use. Meanwhile, 20% of the population can meet their needs for clean water independently through available water sources such as wells, springs, and so on. From the calculation results, the coverage of clean water services for Company M in South Binjai District in 2030 will only reach 17.946%, so service coverage still does not meet national standards.

According to **Table 3.**, Company M has limited water capacity with an installed capacity of 40 L/s and a production capacity of 22 L/s. Because of this, so that the need for clean water at Company M in South Binjai Regency can be fulfilled, the scope of services can be met by adding an operational tool for taking clean water sources, such as a water pump to increase clean water reserves.

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3.4 Strategy to Increase Service Coverage

The addition of pumps in an effort to increase the scope of Company M's clean water services is planned based on the specifications of the pumps used, the availability of water sources, operational costs, and evaluation of pump additions.

3.4.1 Availability of Water Source

The plan for taking the source of clean water is from the Bingei River with a water debit of 51 L/s. From the analysis of the continuity of the availability of the spring, it is found that raw water for clean water can be taken continuously with relatively constant fluctuations in discharge.

From the results of the interviews, the quantity and quality of water are adequate, so from the analysis conducted by company M, the water source can be used for spring water collection.

3.4.2 Specification Pump

The pump specifications planned for company M are as follows.

Table 7. Specifications of Pump.

Item	Pump Specifications
Capacity	6,25 L/s
Type	Intake
Pressure	0,7 bar
Electrical Power	1300 watt

Source: Author Analysis.

The table above represents the specifications for one intake pump. The raw water debit recorded is around 51 L/s, so with an intake pump capacity of 6,25 L/s, it requires the addition of around eight pumps.

3.4.3 Operational Cost

In planning, the cost calculation also needs to be done. The costs calculated are maintenance and repair costs, the cost of the electrical energy needed to operate the pump, and the cost of procuring spare parts in the event of damage to the pump.

Table 8. Operational Costs of Adding Intake Pumps.

No.	Item	Unit	Volume	Unit Price (Rp.)
I.	Pump Purchase	1	Piece	IDR 25.000.000
II.	Pump Maintenance	10	Years	IDR 40.000.000
III.	Pump Repair	10	Years	IDR 50.000.000
IV.	Electrical Energy	10	Years	IDR 56.160.000
V.	Spare Parts Procurement	10	Years	IDR 20.000.000
	Total			IDR 191.160.000

Source: Author Analysis.

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Based on observations in online stores, with the pump specifications mentioned in **Table 6.**, the purchase price for the pump is Rp. 25,000,000. Meanwhile, pump maintenance is carried out every 6 months with a maintenance fee of IDR 4,000,000 per year. The frequency of repairs is carried out every 2 years with a repair fee of IDR 10,000,000. The electricity consumption to operate a pump with 1300 Watts of electrical power for 8 hours per day is 10.4 kWh, with an electricity rate of IDR 1,500 per kWh. Meanwhile, the procurement of spare parts is carried out every 2 years at a cost of IDR 4,000,000

Based on this analysis, the cost of procuring 1 pump for the next 10 years is IDR 191,160,000. Meanwhile, if 8 pumps are needed, the total cost of procuring additional pumps within 10 years is IDR 1,529,280,000.

3.4.4 Evaluation of Pump Additions

Evaluation of the addition of pumps needs to be done to determine the impact that occurs. With the addition of 8 pumps with a capacity of 6.25 l/s each, a total installed capacity of 50 l/s is obtained. However, not all of these capacities can be produced. Looking at the pump that was previously installed on WTP Marcapada 2 in **Table 3**, the installed capacity is 40 l/s, and the production capacity is 22 l/s, the percentage of water that can be produced is 55%. So that the production capacity of the Bingei River is 27.5 l/s, the addition of this pump can increase the water capacity of Company M by 125%.

4. Conclusion

The results of the evaluation of service providers in South Binjai District reveal that the coverage of clean water services in 2030 will only reach 17.946%, so service coverage still does not meet national standards. Service providers have limited water capacity. Therefore, the scope of services can be fulfilled by adding operational tools for taking clean water sources such as water pumps. The proposed strategy is to take water from the Bingei River with eight intake pump capacity of 6.25 L/s. The total cost of procuring these pumps in a period of 10 years is IDR 1,529,280,000. Adding the intake pump can increase the water capacity up to 125%. The results of this study can be used as an effort to meet water needs in the future.

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