p-ISSN: 2723-6609 e-ISSN: 2745-5254
Vol. 5, No. 10, October 2024 http://jist.publikasiindonesia.id/

Optimization of Water Purification Infrastructures in Supiori Regency

Markus Sawaki[1*], Ira Widyastuti[2], Duha Awaludin[3], Bernathius Julison[4], Mujiati[5]
Universitas Cenderawasih, Indonesia
Email: markussawaki1803@gmail.com[1*], iwidyastuti09@gmail.com[2], duhaawaluddin@gmail.com[3], bjulison@ft.uncen.ac.id[4], mujiati.js@gmail.com[5]

*Correspondence

Keywords: Services; Clean Water; Supiori Regency; Community Perception

ABSTRACT

Clean water is one of the important aspects that must be prioritized in urban planning. The higher the standard of living of the community, the need for clean water will also increase. However, the fulfillment of adequate clean water needs in Supiori Regency is still not optimal. Based on the Minister of Public Works Regulation No. 14/2010, the coverage of drinking water services in Supiori Regency is classified as poor, with a clean water service level of less than 50%. Optimization efforts are needed to optimize and distribute clean water services in Supiori Regency meet the target of clean water services and create a sustainable community life. The research method uses three types of analysis. First, the ratio of clean water services in the settlements of Supiori Regency was analyzed using a calculation method that refers to the standard of clean water needs and availability. Second, the analysis of clean water services was conducted based on community perceptions. Third, this study analyzed the factors that influence clean water services using multiple linear regression. Descriptive analysis was used to identify optimization steps. The results showed that the ratio of clean water services in South Supiori District only reached 30.38%, while in East Supiori District, it was lower, at 19.78%. Based on community perceptions, 93% of the population in South Supiori District and 75% in East Supiori District have not used the Water Supply System. Regression analysis shows that in Supiori Selatan District, factors affecting clean water services include pipe distance, community participation, and number of family members. In East Supiori District, the influencing factors are pipe distance, management, and maintenance of clean water. So, there are optimization efforts that can be done, among others, through mapping services based on regional conditions. For areas that are difficult to reach by SPAM services, the community can utilize the nearest water source to meet their clean water needs independently.

Introduction

Supiori Regency is one of the cities along the coast. The capital of this district is Sorendoweri. Furthermore, approximately nineteen years since its opening in 2003, Supiori Regency has not been spared from obstacles, especially the need for clean water, which is very dependent on rainwater for daily needs and obtained by collecting rainwater. The geographical condition of the coastal area, which is very contoured and passed by many large and small rivers, strengthens it.

Clean water is a basic need that is vital for daily life and public health (Setioningrum et al., 2020). Limited access to clean water can increase the risk of infectious diseases such as diarrhea, respiratory infections and skin diseases (Kanda S & Widiastutie, 2024). This phenomenon can worsen people's quality of life, especially in remote areas such as Supiori. The efforts of the Supiori Regency Government are to provide and improve adequate facilities and amenities (Mansyur, 2022), one of which is to meet the needs of clean water supply infrastructure to provide maximum public services to the community. The efforts of the Regional Government are in line with the development of public infrastructure (Machmud, 2015), which has a vital role in realizing the fulfillment of the People's Basic Rights such as food, clothing, board, security, education, health and others to avoid socio-cultural and economic disparities in the community in villages and cities (Alfikri, 2016).

Based on the 2023 Supiori Regency Public Works Office Base data, the need for clean water in East Supiori District is 46.87 l/sec, and South Supiori District is 44.19 l/sec. Based on the Regulation of the Minister of Public Works Number 14 Tanun 2010, the standard of drinking water service has a poor classification, namely having a clean water service level of less than 50%. From the data on clean water services in East Supiori District, there are 10 villages with poor clean water services, including Yawerma Village (41%); Wambonda Village (42%); Marsram Village (46%); Duber Village (27%); Sauyas Village (43%); Wafor Village (38%); Sorendiweri Village (48%); Waryesi Village (38%); Dauwbo Village (43%); Syurdori Village (34%), while South Supiori District has 7 villages, namely Biniki Village (30%); Maryadori Village (6%); Fanindi Village (32%); Awaki Village (32%); Odori Village (48%) and Didiabolo Village (8%) (Pamuji, 2021).

In connection with the importance of fulfilling access to clean water that is evenly distributed and in accordance with service targets, research on the optimization of clean water supply infrastructure in Supiori Regency is very necessary. This research is expected to support the creation of a more sustainable life for the people in the region. Previous research by Shomad and Nurisna.(2019) examined water purification methods in the PRM 3 Banguntapan neighborhood. The results showed that filtering techniques using easily available and cheap materials can produce clearer, healthier, and disease-free water without the need for energy-consuming machines. After a laboratory water quality test, it was found that E. coli bacteria in the water was reduced by 85%, making it safe for consumption by the community. This method is considered effective in meeting the need for clean water at an affordable cost.

Another study by Sinaga et al. (2023) studied the optimization of water channel infrastructure in water reservoirs in Mbinanga Village. With a community service approach, this optimization succeeded in increasing the capacity of the water reservoir, so that the water needs of the local community could be met. Meanwhile, research by Pratikno et al. (2024) focused on optimizing access and quality of clean water in orphanages through filtration technology. The implementation of pipeline infrastructure and water filtration systems effectively improved access to clean water and the health of the orphanage residents, and reduced the risk of disease due to contaminated water.

Another study by Ardiminsyah et al. (2019) explores efforts to fulfill clean water in Pasir Pengaraian City through service optimization and SPAM development. This approach is carried out in stages, including short, medium and long term clean water infrastructure development. Some of the developments carried out include the construction of pipelines at the Water Treatment Plant (IPA), the development of intake locations in the Batang Lubuh River, and the development of reservoirs in various locations. The water distribution system is also supported by a computerized system, which facilitates monitoring and efficiency of water distribution.

The novelty of this research lies in its focus, namely the optimization of clean water supply infrastructure in Supiori Regency, which until now has never been the object of study. The results of this research are expected to make a significant contribution in adding insight, especially for local governments and related stakeholders, to improve access and quality of clean water for the community. This research is also expected to serve as a reference in the preparation of policies and long-term strategic planning related to clean water provision. Thus, the main objective of the research is to analyze the potential for water purification infrastructure development in Supiori Regency, as well as to provide optimization recommendations that can be implemented by the local government.

Method

Research location in Supiori Regency, East Supiori District, Warwesi Village and South Supiori District, Odori Village. The research area is located in Supiori Regency, which is administratively located at 134O67' - 136O48' East Longitude (BT) and 0O55' - 1O31' South Latitude (LS). Supiori Regency has an area of 634.24 km2 which is divided into 5 sub-districts, 38 villages.

The method used in the data collection technique is as follows:

1. Observation

   Observations were conducted directly in the field with a participant observation approach (Mappasere & Suyuti, 2019). Researchers were actively involved in observing the condition of clean water infrastructure, piping locations, and community access to clean water in the area under study. In addition, secondary data was also used to complement the observation results related to the physical condition of the water infrastructure.

2. Interview

   Interviews were conducted using semi-structured interviews, to aid flexibility in asking additional questions as the conversation progressed. Interview respondents included local government (such as the Public Works and Housing Agency), water service providers, and local communities who directly experienced water access problems. These interviews aimed to obtain more in-depth information on the challenges and solutions related to clean water services in Supiori District.

3. Literature Study

   The literature study included a review of government policies, such as the Supiori District RISPAM Document and Base Supiori District Public Works Office in 2023 as well as relevant academic studies related to clean water infrastructure and challenges in providing water services in remote areas. The literature used also includes reports and statistics from reliable sources regarding the fulfillment of clean water in the region.

4. Field Survey

   The survey involved a questionnaire for the community. The questionnaire was designed using a Likert scale to measure respondents' perceptions of the independent variables such as Piping Distance (X1), Participation (X2), Management and Maintenance (X3), and Number of people in the household (X4). The sample size used in this survey included a number of respondents representing areas experiencing problems related to clean water quantity, with a random or stratified sampling of 97 households.

In this writing, there are several stages of analysis, namely:

1. Analyzing the ratio of clean water services in East Supiori and South Supiori
2. Analysis of clean water services based on public perception
3. Analysis of factors affecting clean water services
4. Efforts to optimize clean water services

Results and Discussion

Identify Clean Water Needs

The identification of clean water needs in the research area is carried out by first knowing the number of residents in each village that has been determined and then adjusting to the service targets that have been set to obtain the number of people served. Furthermore, the number of served residents obtained is adjusted to the average consumption of clean water based on the standard of city size. The amount of clean water needed by the population can be determined by using the following formula (Marta, Yusman, & Harahap, 2021):

Domestic clean water needs = a x b x c

Description:

a : Total population (person)

b : Total domestic water demand based on area category (liter/person/day)

c : Percentage of clean water services in rural areas

Before the formula is used, it is first necessary to know the standard of clean water service and the standard of clean water demand of the average population based on the size of the city/area category. The policy for developing a clean water supply system in the research area refers to the direction and objectives of the national policy (Farhan & Rahman, 2024), namely the Sustainable Development Goals (SDGs), so that the service standard or target for clean water services in Superior District is 100%.

Based on the RISPAM of the Supiori Regency in 2023-2038, the average existing demand for drinking water in East Supiori and South Supiori Districts is 60 liters/person/day. Thus, the clean water needs of the population of each village in the study area can be analyzed as follows.

Table 1 Analysis of Residential Clean Water Needs in the Study Area

No.	Village	Total Population (population)	Service Level (%)	Total served (population)	Average Water Consumption (Lt/person/day)	Total Usage (Lt/day)	Total water demand (Lt/sec)
		[a]	[b]	[c]	[d]	[e]	[f]
East Supiori District							
1.	Yawerma	593	100	593	60	35.580	0,42
2.	Wambonda	536	100	536	60	32.160	0,37
3.	Marsram	957	100	957	60	57.420	0,66
4.	Duber	1.128	100	1.128	60	67.680	0,78
5.	Sauyas	1.088	100	1.088	60	65.280	0,75
6.	Wafor	750	100	750	60	45.000	0,52
7.	Sorendoweri	2.206	100	2.206	60	132.360	1,53
8.	Waryesi	1.211	100	1.211	60	72.660	0,84
9.	Dauwbo	734	100	734	60	44.040	0,51
10.	Syurdori	544	100	544	60	32.640	0,37
South Supiori District							
11.	Biniki	450	100	450	60	27.000	0,31
12.	Maryadori	393	100	393	60	23.580	0,27
13.	Warbefondi	383	100	383	60	22.980	0,26
14.	Fanindi	547	100	547	60	32.820	0,37
15.	Awaki	683	100	683	60	40.980	0,47
16.	Odori	669	100	669	60	40.140	0,46
17.	Didiabolo	421	100	421	60	25.260	0,29
Total							**9,18**

Source: Analysis Results, 2024

Description:

[a] = Total Population
[b] = Clean Water service level according to standard
[c] = [a] x [b]
[d] = Clean water demand standard according to city size category
[e] = [c] x [d]
[f] = [e]/(24 x 60 x 60) (change of liter/day unit to liter/second) (1 day = 86400 seconds)

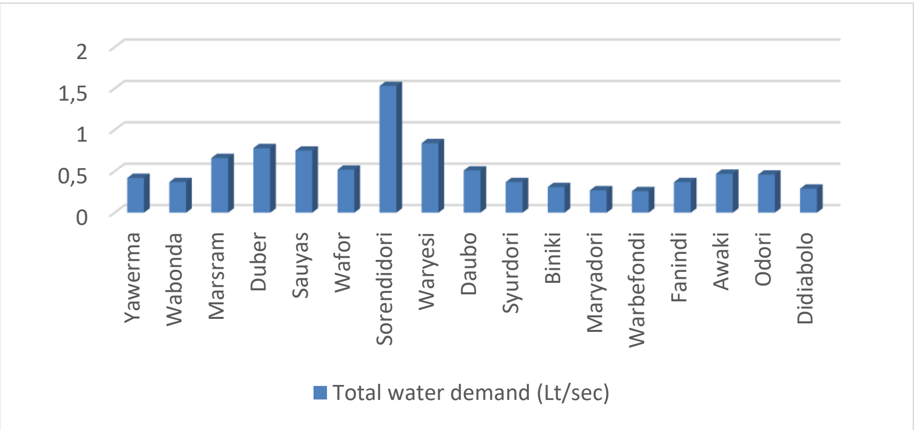

Figure 1. Clean water demand for each village

Table 1 above shows that the domestic demand for clean water in the study area is 9.18 liters/second. This need is calculated based on the Supiori District's clean water service level policy of 100% and the standard of clean water needs according to the city size category, which is in the small city category with a water consumption of 60 liters/person/day. The need for clean water for each village/sub-district varies considerably according to the population (Husein, 2016). In Figure 1, it can be seen that the highest clean water demand is in Sorendoweri Village, reaching 1.53 lt/dt. Meanwhile, the lowest clean water demand is in Warbefondi Village, with a demand of 0.26 lt/dt. Existing conditions in the field indicate the possibility of water loss/leakage. Until now, water leakage has been the main component of water demand. For the determination of water demand, water leakage analysis needs to be carried out so that the balance of service flow is not disturbed.

For policy, the level of leakage/loss of water distributed in the study area is around 30%. Thus, the additional clean water capacity of the population based on the permitted water leakage rate policy can be calculated as follows.

Table 2. Water Demand Based on Additional Capacity against Water Leakage Rate

No.	Village	Total water demand (Lt/sec)	(Net water demand) x (30% leakage rate	Demand-based on additional capacity against water leakage (lt/sec)	Needs-based on additional capacity against water leakage (^{m3} /month)
		[a]	[b]	[c]	[d]
East Supiori District					
1.	Yawerma	0,42	0,13	0,55	345
2.	Wombonda	0,37	0,11	0,48	1.261
3.	Marsram	0,66	0,19	0,85	2.234
4.	Duber	0,78	0,23	1,01	2.654
5.	Sauyas	0,75	0,23	0,98	2.575
6.	Wafor	0,52	0,15	0,67	1.761
7.	Sorendiweri	1,53	0,46	1,99	4.919
8.	Waryesi	0,84	0,25	1,09	2.864
9.	Doubo	0,51	0,15	0,66	1.734
10.	Syurdori	0,37	0,11	0,48	1.261
South Supiori District					
11.	Biniki	0,31	0,10	0,41	1.077
12.	Maryaidori	0,27	0,10	0,37	972
13.	Warbefondi	0,26	0,07	0,33	867
14.	Fanindi	0,37	0,11	0,48	1.621
15.	Awaki	0,47	0,14	0,61	1.603
16.	Odori	0,46	0,12	0,58	1.524
17.	Didiabolo	0,29	0,10	0,39	1.024
	Total			**11,93**	**30.276**

Source: Analysis Results, 2024

Description:

[a] = Total Clean Water Demand
[b] = (Keb. Clean Water) x (Permitted leakage rate of 30% (%))
[c] =[a]+[b]

After analyzing the water demand based on the addition of capacity to water leakage, it is known that there is an additional clean water demand of 20.01 lt/dt when compared to the initial clean water demand. The largest water demand, after adding the possibility of water leakage/loss, remains in Sorendiweri Village, while the smallest remains in Warbefondi Village.

Identification of Clean Water Availability

To obtain the production capacity, the availability of clean water production is analyzed. Increased water demand, if not matched by an increase in clean water production capacity (Pamudjianto & Sutiono, 2018), will cause problems where the available clean water will not be sufficient to meet the community's needs, so the calculation of production capacity is important in this study. Then, the amount is compared with the clean water demand that has been obtained previously to produce the clean water service ratio in each village and kelurahan in the study area.

Analyzing the availability of clean water in the study area is carried out by multiplying the standard clean water needs of the population according to the category of city size with the number of residents served by the pipeline network so as to obtain the amount of production capacity provided for each village. The number of people served by the piping network is obtained from the number of SR (House Connection) households that use the piping network multiplied by the average number of family members, namely 5 (five) people.

For the city category based on the Integrated City Infrastructure Development Program (P3KT) of the Regional Cipta Karya Public Works Office of Papua Province, the population in the research area at the end of 2023 was 12,625 people, so it was included in the sub-district city category (<20,000 people). Based on RISPAM Supiori Regency in 2021-2038, the average existing demand for drinking water in East Supiori and South Supiori Districts is 60 liters/person/day. The production capacity of each village in the research area can be seen in the table below.

Table 3 Production Capacity of Clean Water Provided per Village

No.	Village	Total Population Served (person)	Demand Standard (liters/person/day)	Production Capacity (liter/day)	Production Capacity (^{m3} /month)
		[a]	[b]	[c]	[d]
East Supiori District					
1.	Yawerma	615	60	36.900	1.107
2.	Wombonda	560	60	33.600	1.008
3.	Marsram	1.425	60	85.500	2.565
4.	Duber	1.720	60	103.200	3.906
5.	Sauyas	1.310	60	78.600	2.358
6.	Wafor	670	60	40.200	1.206

7.	Sorendiweri	1.775	60	106.500	3.195
8.	Waryesi	2.380	60	142.800	4.284
9.	Doubo	1.050	60	63.000	1.890
10.	Syurdori	545	60	32.700	981
South Supiori District					
11.	Biniki	605	60	36.300	1.089
12.	Maryaidori	280	60	16.800	504
13.	Warbefondi	365	60	21.900	657
14.	Fanindi	605	60	36.300	1.089
15.	Awaki	395	60	23.700	711
16.	Odori	670	60	40.200	1.206
17.	Didiadolo	245	60	14.700	441

Source: Analysis Results, 2024

Description:

[a] =Number of people served by PDAM piped network

[b] =Water supply standard according to city size category

[c] = [a] x [b]

[d] = ([c] x 30)/1000

The calculation table above informs the assumption of the amount of water demand provided or the capacity of water production provided every day for population consumption in each village. Furthermore, the liter/day unit is converted into m^3 /month to facilitate the next stage of analysis. When viewed by urban villages, the highest water production capacity provided is in Waryesi Village, which reaches 4,284 m^3 /month. This is because the population served in Waryesi Village is the largest when compared to other villages in the study area.

After knowing the need for clean water and the availability of clean water in the study area, the percentage of clean water services in the study area can be calculated by comparing the amount of clean water availability/production capacity with the amount of clean water demand of the population. Or, more clearly it can be formulated as follows:

$$\textbf{clean water service ratio} = \frac{a}{b} \times 100$$

Description:

a : Clean Water Availability/month (m^3 /month)

b : Population Clean Water Needs/month (m^3 /month)

To find out the results of the calculation of the level of clean water service coverage in the study area can be seen in the table below:

Table 4 Ratio of Clean Water Services in the Study Area

No.	Village	Total Population Served (soul)	Water Demand (m^3 /month)	Water Availability (m^3 /month)	Clean Water Service (%)
		[a]	[b]	[c]	[d]
East Supiori District					
1.	Yawerma	615	345	1.107	3,21
2.	Wobonda	560	1.261	1.008	0,8
3.	Marsram	1.425	2.234	2.565	1,15
4.	Duber	1.720	2.654	3.906	1,47
5.	Sauyas	1.310	2.575	2.358	0,92
6.	Wafor	670	1.761	1.206	0,68
7.	Sorendiweri	1.775	4.919	3.195	0,65
8.	Waryesi	2.380	2.864	4.284	1,50
9.	Doubo	1.050	1.734	1.890	1,08
10.	Syurdori	545	1.261	981	0,77
Supiori South District					
11.	Biniki	605	1.077	1.089	1,01
12.	Maryaidori	280	972	504	0,52
13.	Warbefondi	365	867	657	0,75
14.	Fanindi	605	1.621	1.089	1.01
15.	Awaki	395	1.603	711	3,70
16.	Odori	670	1.524	1.206	0,80
17.	Didiabolo	245	1.024	441	0,43

Source: Analysis Results, 2024

Description:

[a] = Total population per village

[b] = Needs based on additional capacity against water leakage (m3/month)

[c] =Production capacity

[d]=Level of clean water service = (c/b)*100%

The ratio of clean water services is the amount of clean water demand of the population compared to the availability of clean water provided, which is then multiplied by 100%. Based on the results of the calculation of the clean water service ratio of settlements in the research area in the table above, it can be seen that the average clean water service in the research area has not been able to achieve the clean water service target of 100%. The highest service ratio in East Supiori Sub-district is Waryesi Village, while the lowest service ratio is Sorendiweri Village. The service ratio of East Supiori Sub-district is the highest

Analyzing Clean Water Services Based on Community Perceptions

The analysis used at this stage is a descriptive analysis of the results of field conditions by conducting interviews by purposive random sampling to the community in East Supiori and South Supiori Sub-districts. This analysis is used to determine how clean water services are based on community perceptions, especially using protected pipes.

The sampling technique used is proportional cluster random sampling. This calculation is first calculated using the random sampling formula. With a population of Supiori Regency of 2,935 families and a degree of accuracy of 10%, the sample that will be used is 97 families. After that, the number of samples is proportional based on the number of families in each village.

Table 5 Number of samples

No.	Village	Number of households	Sample/neighborhood
1	Yawerma	145	5
2	Wambonda	123	4
3	Marsram	215	7
4	Duber	192	6
5	Sauyas	186	6
6	Wafor	251	8
7	Sorendoweri	431	14
8	Waryesi	350	12
9	Dauwbo	95	3
10	Syurdori	91	3
Total Supiori Timur		**2.079**	**68**
1	Biniki	147	5
2	Maryadori	130	4
3	Warbefondi	86	3
4	Fanindi	115	4
5	Awaki	139	5
6	Odori	119	4
7	Didiabolo	120	4
Total Supiori Selatan		**856**	**29**
Grand total		**2.935**	**97**

Source: Analysis, 2024

This stage is an analysis after the calculation of water availability in the study area. This analysis of clean water services uses 97 households consisting of 68 respondents from the East Supiori Sub-district and 27 respondents from the South Supiori Sub-district. Most of the results from East Supiori Sub-district have not used water in the SPAM network (93%), and the quality of clean water used is mostly cloudy and does not flow every day. This condition causes the community to continue to use other sources of clean water to meet their needs, such as gallon water and boreholes. As for Supiori Selatan Sub-district, which does not yet use the SPAM network (75%), the quality of clean water used

is mostly clean and does not flow every day. This condition causes the community to continue to use other sources of clean water to meet their needs, such as gallon water and bore wells. The following is a description of the factual conditions of how clean water needs are met in East Supiori and South Supiori Sub-districts.
The current condition of the Transmission Pipe is that lacks support, is open, prone to falling trees and without trust blocks.

Figure 2. Clean water sources used by the people of Waryesi Village
Source: Primary Survey, 2024

Based on the results of field observations, the community of East Supiori Sub-district uses water sourced from the SPAM network, buys traveling water and self-helps by building water reservoirs. Table 1 shows the sources of water used by the community in the East Supiori Sub-district area. Figure 3 From Source to Distribution

Figure 3. Illicit tapping on a transmission pipeline
Source: Primary Survey, 2024

Based on the results of field observations, the community of East Supiori Sub-district uses water sourced from the SPAM network and wells used by individuals.

Analyzing Factors Affecting Clean Water Services in Supiori District.

Multiple linear regression analysis was used to determine the variables that can be used as factors that influence clean water services in Supiori Regency. This multiple linear regression analysis was conducted to determine how much influence these variables have on the dependent variable. There are 3 dependent variables used in measuring the level of clean water service per household in the research area, namely quality, quantity and continuity.

- Y= Clean water service
- Y_1 = Quality $(Y)_1$
- Y_2 = Quantity $(Y)_2$
- Y_3 = Continuity $(Y)_3$

In the regression analysis, the independent variables used to determine the factors affecting clean water services in Supiori District are piping distance, indiscriminate tapping of pipes and the number of people in the household.

X_1 = Piping Distance
X_2 = Participation
X_3 = Management and Maintenance
X_4 = Number of people in the household

All of these variables have different values and units, so from the results of the existing questionnaire survey, equalization is carried out in the form of a scale using the Likert method. The division of the variable scale is done by quartile division. Quartile division is a measurement made to determine the limit value if the frequency distribution is divided into 4 parts. The following is a variable scale table of clean water service factors in Supiori Regency.

Table 6. Variable Scale of Clean Water Service Factors of Supiori District

Scale	1	2	3	4
Y_1 Quality	Odor and color (cloudy)	Color (cloudy) and Taste (salty)	Colorless and Tasteless (salty)	Odorless, colorless, tasteless.
Y_2 Quantity	Drip	Flows smoothly with the help of a pump	Flow not smooth (stagnant) without Pump	Flows smoothly without a pump
Y_3 Continuity (time to get water)	0-5 hours	6-11 hours	12-17 hours	18-24 hours
X_1 Participation	Below average	Average	Medium	High
X_2 Number of people in the household	2 -3	4 - 5	6 - 7	8 - 9
X_3 Management and Maintenance	Below average	Average	Medium	High
X_4 Piping Distance	Well	Well	SPAM Nyalur	Direct SPAM

Source: Analysis Results, 2024

The following will explain each regression analysis result for each sub-district in Supiori Regency.

Multiple Linear Regression Analysis in South Supiori District

1. Clean Water Quality

The purpose of this multiple linear regression analysis is to see how the influence of the independent variables of Piping Distance (X_1), Participation (X_2), Management and Maintenance (X_3), Number of people in KK (X_4), on the dependent variable, namely Clean Water Quality (Y_1). The results of the clean water service model in South Supiori District in terms of quality are as follows:

Description:

$$\mathbf{Y_1 = 2.998 + 0.431X_1 - 0.171X_2 + 0.066X_4}$$

Y_1 = Quality
X_1 = Piping Distance
X_2 = Participation
X_4 = Number of people in the household

From the regression equation model above, it is known that the quality of clean water services in Supiori Selatan Sub-district is influenced by piping distance, participation and the number of people in the household.

Then to find out how the magnitude of the influence of each predictor variable is simulated by assuming that there is a one-unit increase in each one variable while the others are not. From this assumption, it means that it will give rise to 3 memorization conditions with the three objects of predictor variables that experience different increases. For more details, here are the results of the simulation.

- The regression coefficient X_1 of 0.431 states that each additional distance of 1 unit will affect the quality of clean water by 0.431 units. The coefficient is positive, meaning that there is a positive relationship between piping distance and clean water quality.
- The regression coefficient X_2 of 0.171 states that every additional participation of 1 unit will affect the quality of clean water by 0.171 units. The coefficient is negative, meaning that there is an inverse relationship between participation and clean water quality.
- The regression coefficient X_4 of 0.066 states that each additional person in a household of 1 unit will affect the quality of clean water by 0.066 units. The coefficient is positive, meaning that there is a positive or unidirectional relationship between the addition of the number of people in the household and the quality of clean water.

2. Clean Water Quantity

Multiple linear regression analysis at this stage aims to see how the influence of the independent variables Piping distance (X_1), Participation (X_2), Management and

Maintenance (X_3), number of people in the household (X_4), on the dependent variable, namely Clean Water Quantity (Y_2).

Based on the results of multiple linear regression analysis (Appendix B), the significance value of the resulting model is 0.001, while the model is said to be significant if the significance value is smaller than 0.05. So it can be concluded that clean water services in South Supiori District cannot be measured based on clean water quality.

3. Continuity

Multiple linear regression analysis at this stage aims to see how the independent variables influence Piping distance (X_1), household income (X_2), management and maintenance (X_3), number of people in the household (X_4), on the dependent variable, namely Continuity (Y_3). The results of the clean water service model in South Supiori District in terms of Continuity are as follows:

$$Y_3 = 1.250 + 0.398X_1$$

Description:
Y_3 = Continuity
X_1 = Piping Distance

From the regression equation model above, it is known that clean water services in South Supiori Sub-district are influenced by piping distance in terms of continuity.

Then, we will find out how the influence of the predictor variables is simulated by assuming that there is a one-unit increase in each variable while the others are not. From this assumption, it means that it will bring up 1 memorization condition with one predictor variable object that has increased differently. For more details, here are the results of the simulation.

- The regression coefficient X_1 of 0.398 states that each additional piping distance of 1 unit will affect continuity by 0.398 units. The coefficient is positive, meaning that there is a positive relationship between piping distance and clean water continuity.

Multiple Linear Regression Analysis in East Supiori District

1. Clean Water Quality

The purpose of this multiple linear regression analysis is to see how the independent variables of piping distance (X_1), participation (X_2), management and maintenance (X_3), and number of people in the household (X4) affect the dependent variable, namely Clean Water Quality (Y_1). The results of the clean water service model in East Supiori District in terms of quality are as follows:

$$Y_1 = 3.363 + 0.759 X_1$$

Description:
Y_1 = Quality
X_1 = Piping Distance

From the regression equation model above, it is known that quality of clean water services in East Supiori Sub-district are influenced by piping distance. To find out how the magnitude of the influence of the predictor variables is simulated by assuming that there is a one-unit increase in each variable while the others are not. From this assumption, it means that it will give rise to 1 modeling condition with one object of predictor variables that experience different increases. For more details, here are the results of the simulation.

- The regression coefficient X_1 of 0.759 states that every additional piping distance of 1 unit will affect the quality of clean water by 0.759 units. The coefficient is positive, meaning that there is a positive relationship between piping distance and clean water quality.

2. Clean Water Quantity

Multiple linear regression analysis at this stage aims to see how the influence of the independent variables of piping distance (X_1), participation (X_2), management and maintenance (X_3), and number of people in the household (X4) on the dependent variable, namely Clean Water Quantity (Y_2). The results of the clean water service model in East Supiori District in terms of quantity are as follows:

$$\mathbf{Y_2 = 0.023 - 0.126X_3}$$

Description:
Y_2 = Quantity
X_3 = Management and Maintenance

From the regression equation model above, it is known that the quantity of clean water services in East Supiori Sub-district is influenced by management and maintenance.

To find out how the magnitude of the influence of the predictor variables is simulated by assuming that there is a one-unit increase in each variable while the others are not. From this assumption, it means that it will bring up 1 memorization condition with one object of predictor variables that experience different increases. For more details, here are the results of the simulation.

- The regression coefficient X_3 of 0.126 states that every additional management and maintenance of 1 unit will affect the quantity of clean water by 0.126 units. The coefficient is negative, meaning that there is an inverse relationship between management and maintenance and the quantity of clean water.

3. Continuity

Multiple linear regression analysis at this stage aims to see how the influence of the independent variables of piping distance (X_1), participation (X_2), management and maintenance (X_3), and number of people in the household (X4) on the dependent

$$\mathbf{Y_3 = 1.809 - 0.296X_1}$$

variable, namely Continuity (Y_3). The results of the clean water service model in East Supiori District in terms of continuity are as follows:
Description:
Y_3 = Continuity
X_1 = Piping distance

From the regression equation model above, it is known that piping distance influences clean water services in the East Supiori Sub-district in terms of infrastructure.

Then, we will find out how the influence of the predictor variables is simulated by assuming that there is a one-unit increase in each variable while the others are not. From this assumption, it means that it will bring up 1 memorization condition with one predictor variable object that has increased differently. For more details, here are the results of the simulation.

- The regression coefficient X_1 of 0.296 states that each additional piping distance of 1 unit will affect the continuity of clean water by 0.296 units. The coefficient is negative, meaning that there is an inverse relationship between piping distance and clean water continuity.

Practical Implications for Local Governments in Improving Clean Water Services in Supiori

The findings in this study provide several important implications for local governments in their efforts to improve clean water services in Supiori District. To achieve the expected goals, efforts to optimize clean water services in Supiori can be structured systematically by separating solutions that focus on three main aspects: infrastructure, water quality, and community involvement. This separation helps the government to identify and address different issues in a more targeted and effective manner.

Optimization efforts for East Supiori District:

1. Infrastructure

   In East Supiori District, the first step that needs to be taken is the provision of piped connections in areas with the lowest service ratio, especially in Kelurahan Sorendoweri. By expanding the piping network, the community's access to clean water will increase, thus helping to fulfill their basic needs. In addition, the construction of shallow boreholes as a backup solution when water does not flow needs to be implemented. This drilling process should be done communally to ensure efficiency and good coordination, and should comply with applicable standards and regulations.
2. Water Quality

   It is important to ensure that the shallow boreholes constructed are able to provide water that meets clean water quality standards. This is important so that the water used by the community is safe and does not pose health risks. Local governments need to monitor and conduct regular water quality tests to ensure that water drawn from local sources is fit for consumption.
3. Community Involvement

Community involvement is very important in water resources management. In East Supiori District, it is necessary to develop a community empowerment program to utilize existing local water sources. By maximizing the sustainable use of potential nearby water sources, communities can meet their own clean water needs and reduce dependence on hard-to-reach infrastructure.

Optimization Efforts for Supiori South District:

1. Infrastructure
   Similar to East Supiori District, the provision of piped connections should also be increased in areas with the lowest service ratio, such as Didiabolo Village. This will improve access to clean water for communities that have been underserved. In addition, the construction of small communal boreholes is also necessary as an anticipatory measure if water does not flow through the main pipeline network. This drilling process should be well coordinated to ensure that all actions comply with regulations and run efficiently.
2. Water Quality
   In terms of water quality, it is critical for local governments to maintain the maintenance and management of the clean water network so that the water distributed remains safe for consumption. This requires regular monitoring of existing infrastructure, including routine maintenance of pipes, boreholes and other distribution systems.
3. Community Involvement
   In Supiori Selatan District, community participation is also crucial. One important step is the addition of community-based clean water networks in areas not yet covered by clean water services. Actively involving the community in the management of this network will increase the sense of responsibility and sustainability of the program. In addition, protection of springs in Odori Village is also necessary. This spring can serve as a very important clean water backup and alternative source for the local community, especially in the event of a disruption to the main service.

By implementing these recommendations, the local government can increase the coverage of clean water services in Supiori more effectively and sustainably, and minimize the gap in access to clean water between regions in Supiori District.

Conclusion

This study examines clean water services in 17 villages across East and South Supiori districts, focusing on demand versus supply and the factors affecting service optimization. Findings reveal that clean water coverage has not reached the target of 100%. In East Supiori, Yawerma Village has the highest service ratio, while Sorendoweri Village has the lowest. In South Supiori, Awaki Village leads, and Didiabolo Village lags behind. A significant portion of the population (93% in East Supiori and 75% in South Supiori) lacks access to the SPAM network, relying on shallow wells or boreholes instead. In East Supiori, service quality and continuity are affected by factors like piping distance, income, and household size. Meanwhile, in South Supiori, service quality, quantity, and continuity are influenced by water expenditure and household characteristics.

To optimize services, recommendations align with SDG targets and local development goals, emphasizing infrastructure, water quality, and community engagement. Infrastructure efforts in East Supiori include expanding piping connections, particularly in low-coverage areas like Sorendoweri, and drilling shallow boreholes as backups. Boreholes must meet water safety standards, and regulations must guide drilling processes. Community involvement should be promoted through empowerment programs that encourage the sustainable use of local water sources. Similarly, South Supiori requires enhanced infrastructure, especially in Didiabolo Village, where communal boreholes and expanded piping connections are essential. Maintaining high water quality and actively managing networks will ensure safe access. Community participation is also vital here, with proposed initiatives for community-based water networks and the protection of natural water sources, such as Odori Village's springs, for long-term clean water sustainability.

Bibliography

Alfikri, M. (2016). Tanggung Jawab Negara Terhadap Pemenuhan Hak Atas Air Bersih Di Kabupaten Gunungkidul Dalam Perspektif Hak Asasi Manusia.

Ardiminsyah, A., Fauzi, M., & Sandhyavitri, A. (2019). Optimasi Teknis Penyediaan Air Bersih (Pab)(Studi Kasus Kota Pasir Pengaraian). Aptek, 15-24.

Farhan, Rahmatul, & Rahman, Herawati Zeta. (2024). Analisis Tingkat Kepuasan Pelanggan Untuk Pengembangan Sistem Penyediaan Air Minum. Jurnal ARTESIS, 4(1), 1–8.

Husein, Acmad. (2016). Identifikasi Wilayah Krisis Air Bersih Berdasarkan Analisa Kebutuhan Dan Ketersediaan Air Di Kabupaten Banyuwangi. CAKRAWALA, 10(1), 1–12.

Mansyur, Zulkifli. (2022). Peran Komando Kewilayahan Dalam Membantu Pemerintah Daerah Dan Implikasinya Terhadap Ketahanan Pangan (Studi Kampung Moibaken Dan Kampung Suneri Di Kabupaten Biak Numfor). Jurnal Ketahanan Nasional, 28(2), 257–276.

Machmud, Senen. (2015). Kajian Pemanfaatan Dana Corporate Social Responsibility Sebagai Alternatif Sumber Pembiayaan Pembangunan Daerah. None.

Mappasere, Stambol A., & Suyuti, Naila. (2019). Pengertian Penelitian Pendekatan Kualitatif. Metode Penelitian Sosial, 33.

Marta, Adi, Yusman, Ana Susanti, & Harahap, Rumilla. (2021). kebutuhan air minum nagari Malampah kecamatan Tigo Nagari kabupaten Pasaman. Akselerasi: Jurnal Ilmiah Teknik Sipil, 2(2).

Pamuji, K. E. (2021). Identifikasi Kawasan Nilai Konservasi Tinggi 4 (NKT4) di Daerah Aliran Sungai Wafor, Kabupaten Supiori, Provinsi Papua. Jurnal Natural, 17(1), 26–36. https://doi.org/10.30862/jn.v17i1.143

Pamudjianto, Agung, & Sutiono, Wilis. (2018). Pemanfaatan air danau sebagai sumber air untuk irigasi.

Pratikno, F. A., Endrawati, B. F., Renaldy, M., Rozan, M. I., Nurfa'izah, R., Fazri, A. T. I., & Hayati, K. (2024). Optimalisasi akses dan peningkatan kualitas air bersih di panti asuhan melalui teknologi filtrasi. Jurnal Inovasi Hasil Pengabdian Masyarakat (JIPEMAS), 7(3), 669-679.

Setioningrum, R. N. K., Sulistyorini, L., & Rahayu, W. I. (2020). Gambaran Kualitas Air Bersih Kawasan Domestik di Jawa Timur pada Tahun 2019. Jurnal Ilmu Kesehatan Masyarakat, 16(2), 87-94.

Shomad, M. A., Nurisna, Z. N., & Soelidarmi, S. (2019). Menjernihkan Air Di Lingkungan PRM 3 Banguntapan. In Prosiding Seminar Nasional Program Pengabdian Masyarakat.

Sinaga, J. A., Siahaan, S. H., & Sianturi, E. H. (2023). optimasi infrastruktur saluran air pada bakpenampungan air masyarakat desa mbinanga dengan pendekatan kegiatan pengabdian pada masyarakat. Indonesian Journal of Community Service, 3(2), 13-18.

Widiastutie, R. (2024). Dampak Krisis Air Bersih Terhadap Kesehatan Dan Strategi Dalam Mengatasi Permasalahan Di Perkampungan Ciwantani RW 17. Jurnal Ilmiah Ekonomi Dan Manajemen, 2(2), 114-120.