International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 14, Issue 1 [January. 2025] PP: 14-19

Performance Analysis Of The Clean Water Distribution System By Pdam Way Sekampung In Pringsewu Regency (case study in Bumi Arum village, Pringsewu district)

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ABSTRACT : *PDAM is a government company responsible for managing clean water supply and is expected to meet clean water needs in terms of quantity, quality, and continuity. However, currently, PDAM Way Sekampung has not been able to meet water demand, as indicated by a service coverage rate of only 13.40%, water losses of 34.01%, and numerous customer complaints regarding the poor performance of its distribution system. The aim of this study is to assess the performance of PDAM Way Sekampung's distribution system by analyzing the network's capability to meet water demand based on performance factors, quality, quantity, and continuity, as well as to evaluate customer satisfaction with PDAM's performance. Therefore, this study is expected to help PDAM Way Sekampung meet clean water standards in terms of quantity, quality, and continuity for the service area of Kelurahan Bumi Arum.*

KEYWORDS *: Clean Water, Distribution System, Performance, Epanet 2.2, Pressure, Flow Rate, Distance*

Date of Submission: 29-12-2024 Date of acceptance: 09-01-2025

I. INTRODUCTION

Water is one of the most important natural resources for living beings, especially humans. With approximately 70% of the human body composed of water, it is considered a basic necessity that must be fulfilled. The availability of clean water is crucial for various human activities; therefore, ensuring clean water availability depends on quality, quantity, continuity, and the clean water distribution system. The demand for clean water in a region is directly proportional to the population size. Population growth will impact the increased demand for clean water to meet daily needs. In this context, the clean water needs of the community in Pringsewu Regency are met through groundwater (wells) managed by the community and surface water (rivers, reservoirs) managed by the Regional Water Supply Company (PDAM).

The Regional Water Supply Company (PDAM) Way Sekampung Pringsewu is a government-owned company of Pringsewu Regency responsible for managing the clean water supply for several areas. The performance of the clean water supply system at PDAM Way Sekampung Pringsewu Regency is influenced by various factors, both technical and non-technical. For piped water supply systems, service quality depends on the condition of the distribution pipe network and service performance, while non-piped systems depend on the surrounding natural environment.

Based on the performance assessment by the Ministry of Public Works and Housing (PUPR) in 2021, the performance of PDAM Way Sekampung in 2022 was rated as "unhealthy." One of the indicators of this performance evaluation is the high rate of water loss, reaching 34.01%, which exceeds the maximum allowable limit of 20% [8]. The second indicator is the low level of service, with technical reports from September 2023 showing that only about 13.40% (4,326 customers or 17,304 residents served) of the total population of Pringsewu Regency, which is 408,415 people [2], has access to clean water. Furthermore, according to Ulfa [12], her research concluded that access to clean water managed by PDAM Way Sekampung in Pringsewu Regency has not yet reached all the sub-districts in the regency. The lack of equitable access is caused by several factors, including the large volume of water consumed by the community, while PDAM Way Sekampung has limited raw water sources, varying access to clean water, the time required to obtain clean water, suboptimal quality and price of clean water, and policies regarding clean water supply in Pringsewu Regency, which have generally been less than optimal.

Given these conditions, comprehensive improvements to the clean water system at PDAM Way Sekampung are necessary to enhance service capacity and meet the clean water needs of the community.

II. RESEARCH METHODS

2.1. Research Location

Research on the performance analysis of the clean water distribution system in Bumi Arum Village, within the service area of PDAM Way Sekampung, is a survey-based study aimed at assessing the performance of the clean water distribution system in terms of quality, quantity (flow rate), continuity, and pressure. The research approach employs a mixed-methods approach, combining quantitative and qualitative methods, involving measurements and observations for data collection. This research was conducted in Bumi Arum Subdistrict, Pringsewu District, Pringsewu Regency, within the service area of PDAM Way Sekampung. The research location is illustrated in Figure 1.

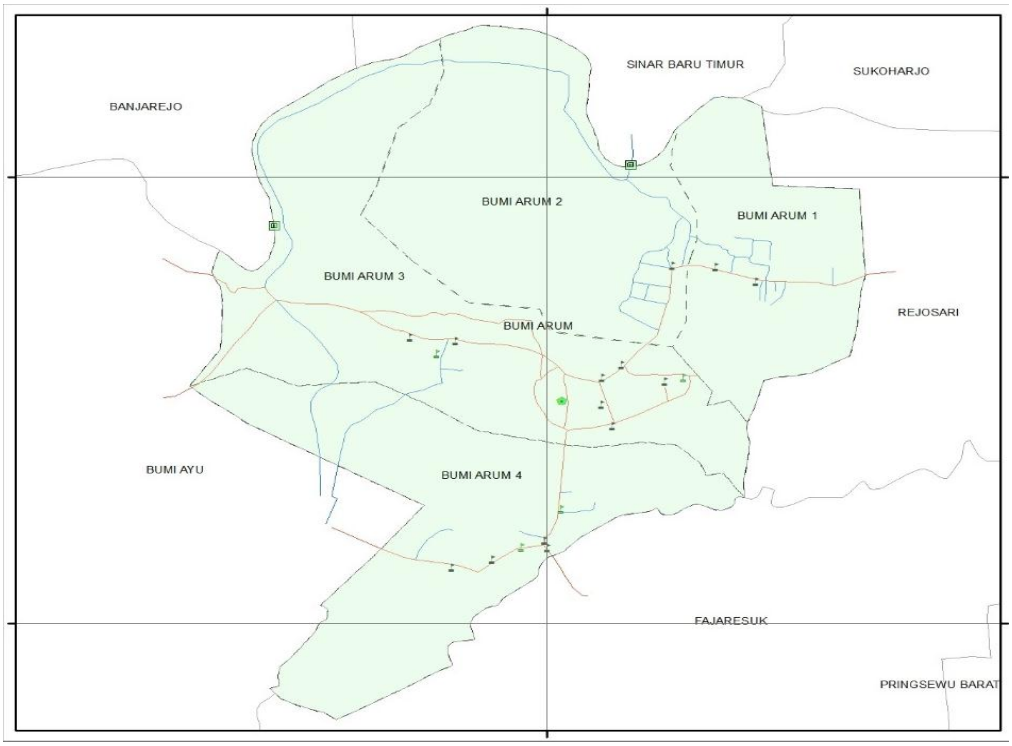

Fig. 1 Research Location

The data used includes secondary data obtained from the Pringsewu Regency Statistics Agency (BPS) in the 2023 Report and PDAM Way Sekampung. This data comprises demographic data, public facilities data, and planned clean water service needs in Bumi Arum Subdistrict. The primary data used consists of direct interviews conducted at residents' homes, focusing on the availability of clean water through a piped system for the subdistrict's water needs.

2.2. Data Analysis Techniques

This research utilizes SPSS 24 (Statistical Package for Social Sciences) and EPANET 2.2 software to assist in the optimal and precise data analysis process. The use of the Statistical Package for Social Sciences involves statistical tests such as validity tests, reliability tests, normality tests, and simple linear regression analysis.

2.3. Sampling Technique

The sampling technique used in this research is proportionate stratified random sampling, where samples are proportionally selected from each level/stratum. This sampling method is applied because the population consists of several residential areas of varying sizes, and each location has a different population size.

2.4. The Number Of Samples

Based on the field conditions in the four research zones, and assuming that the population in these zones follows a normal distribution with a total customer population of 378 households, the sample size can be calculated using Slovin's formula. The result of the calculation is 180 households.

III. RESULTS AND DISCUSSION

3.1. Performance Analysis of Distribution System

From the system analysis overview, a comparison between direct analysis and EPANET analysis of pressure and flow rate can be observed. The pressure in Bumi Arum 2, 3, and 4 has already met the minimum pressure requirement of 10 meters, whereas Bumi Arum 1 has not yet met this requirement. The flow rate in Bumi Arum 1, 2, 3, and 4 has already fulfilled the daily water needs per household, which is 0.0046 liters/second, based on the assumption of water demand according to the urban category of 100 liters/person/day.

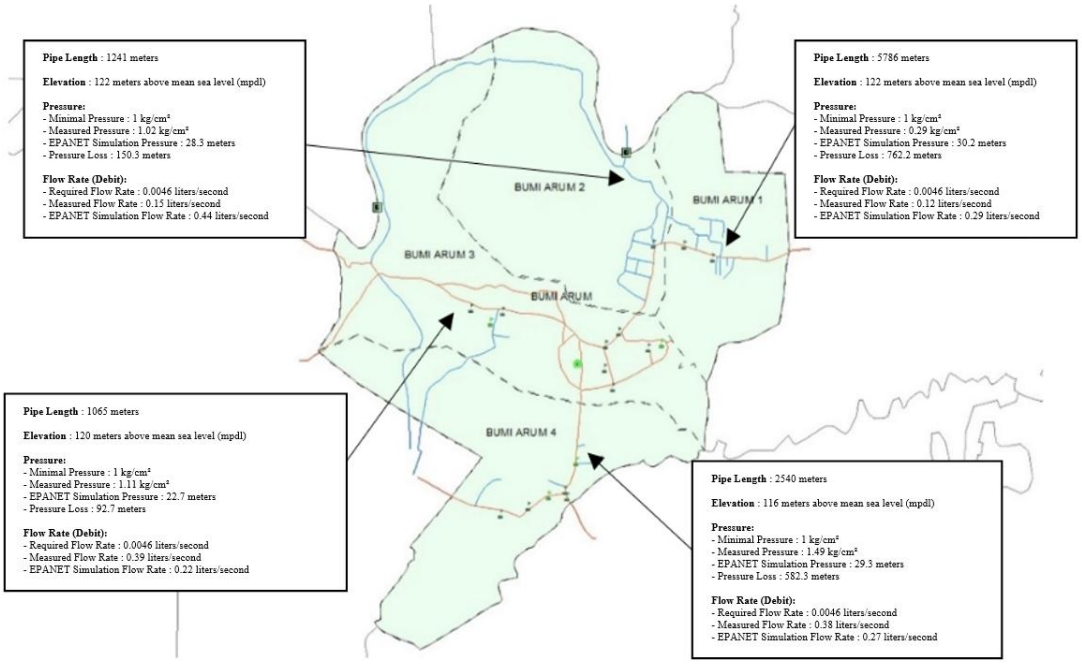

Fig. 2 System Analysis Overview

The analysis of the performance of the distribution system indicates that the water pressure in Bumi Arum Subdistrict has already met the water pressure standards required for the development of the distribution network in the area. However, when examined regionally within Bumi Arum, the Bumi Arum 1 area has not yet reached the required pressure standard for development. Meanwhile, Bumi Arum 2, Bumi Arum 3, and Bumi Arum 4 have achieved the pressure standards necessary for the development of the distribution network, with the standard pressure for development being 0.7 bar or 0.7 kg/cm².

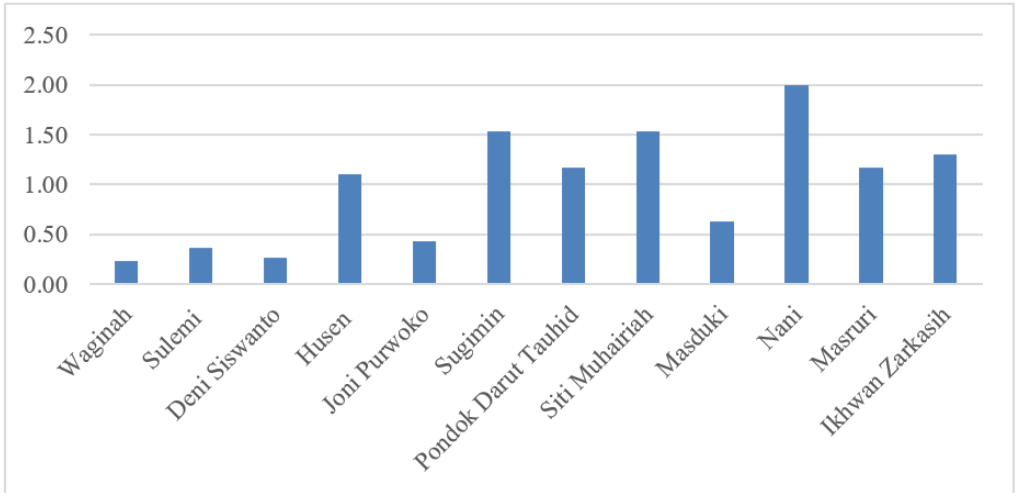

Fig. 3 Water Pressure at 12 Points

The manometer readings during water flow indicate that the lowest pressure is 0.23 kg/cm² at Bumi Arum 1, Waginah's residence, and the highest pressure is 2.00 kg/cm² at Bumi Arum 4, Nani's residence. Meanwhile, other houses have pressure readings ranging from 0.27 to 1.54 kg/cm². The average pressure measurement obtained is 0.98 kg/cm².

The calculation results show that the lowest water flow rate, 0.11 liters/second, is at Bumi Arum 1, Sulemi's residence, while the highest water flow rate, 0.56 liters/second, is at Bumi Arum 4, Ikhwan Zarkasih's residence. Regionally, Bumi Arum 1 has an average water flow rate of 0.12 liters/second, while Bumi Arum 4 has an average flow rate of 0.38 liters/second.

The analysis results from EPANET 2.2 indicate that the simulated pressure is higher than the pressure measured directly at household connections. However, in terms of water flow rates, the simulation shows lower flow rates in the pipes compared to the direct measurements at household connections. The results from EPANET 2.2 are illustrated in the following figure:

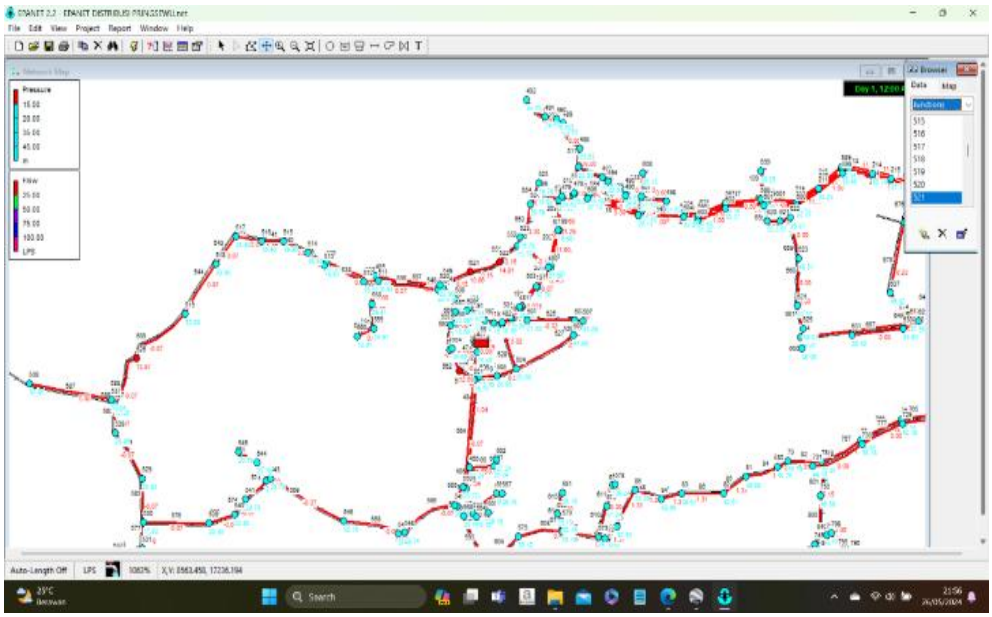

Fig. 4 Analysis Results of Pressure and Flow Rate Based on EPANET 2.2

Based on the simulation results from EPANET 2.2, the comparison of pressure analysis between EPANET 2.2 and the measured and calculated results shows a significant disparity. However, for the analysis of water flow rates, the comparison between EPANET 2.2 and the measured results shows only a minor difference.

3.2. Customer Satisfaction Level Analysis

Based on the customer satisfaction level results related to the performance of the PDAM distribution system (independent variable), the customer satisfaction levels are as follows, which can be seen in the following figure :

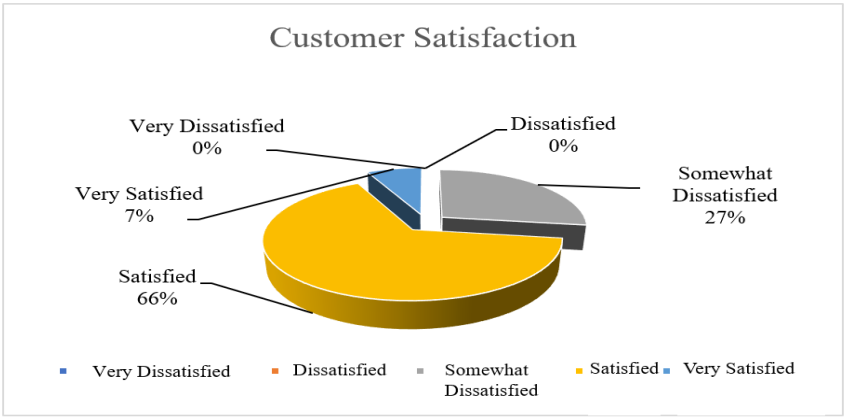

Fig. 5 Customer Satisfaction

The customer satisfaction level (dependent variable) shows that 0% of customers stated they were very dissatisfied, 0% were dissatisfied, 27.2% were somewhat dissatisfied, 65.6% were satisfied, and 7.2% were very satisfied. Therefore, it can be concluded that the respondents expressed satisfaction or a positive opinion regarding the performance of the PDAM Way Sekampung distribution system.

The quality aspect is a key factor influencing customer satisfaction, as it plays a crucial role in the treatment of raw water into clean water. According to the survey results, 61% of respondents agreed that the PDAM water is odorless, tasteless, and clear. This is further supported by laboratory results, which show that the distributed water has no odor, taste, or turbidity.

Next, the aspect that influences customer satisfaction is reliability performance, which is based on the distribution system's ability to meet customer needs. This can be seen from the survey results, where 74% of respondents expressed satisfaction with the performance of the PDAM Way Sekampung distribution system. The quantity or availability of water meets daily needs, and the continuity or availability of water is consistently provided, flowing 24 hours a day. Therefore, it can be concluded that the quantity and continuity needs of customers in Bumi Arum Subdistrict are being met.

3.3. Statistical Test of Customer Satisfaction

From the results of the statistical test on the performance of the PDAM Way Sekampung distribution system concerning customer satisfaction, the findings can be observed in the following table :

Simple Linear Regression Test With Anova Model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	788,688	1	788,688	8712,970	0,000[b]
Residual	16,112	178	0,091		
Total	804,800	179			

The output of the simple linear regression test using SPSS 24 shows that the F-calculated value is 8712.970, with a significance value of 0.000. Since this value is smaller than 0.05, the regression model can be used to predict the participation variable, or in other words, there is an influence of the Distribution System Performance variable (X) on the Customer Satisfaction variable (Y) [9].

Simple Linear Regression Test Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,990[a]	0,980	0,980	0,30086

The analysis results from the SPSS 24 Model Summary table for the simple linear regression test indicate a correlation value (R) of 0.990. From this output, the coefficient of determination (R Square) is 0.980, which implies that the influence of the independent variable (distribution system performance) on the dependent variable (customer satisfaction) is 98.0%.

It can be concluded from the results of the linear regression test and the questionnaire on customer satisfaction levels that H0 is rejected and Ha is accepted. This means there is an influence between the independent variable and the dependent variable, and the performance of the PDAM Way Sekampung clean water distribution system meets customer satisfaction.

IV. CONCLUSION

The performance of PDAM Way Sekampung in the service area of Bumi Arum Village is considered quite good in both technical aspects (pressure and flow analysis) and public service. This is supported by the results from the questionnaire, as well as the pressure and flow measurements and EPANET simulations. Therefore, it can be concluded that the performance of the PDAM Way Sekampung distribution system has met the standards for clean water needs in terms of quantity and continuity for the Bumi Arum Village service area.

The water quality aspects (odor, taste, turbidity) based on customer responses have met the clean water quality standards. In terms of quantity and continuity, the questionnaire results indicate positive outcomes, supported by pressure measurement results. These measurements show that three service areas have met the minimum pressure standard, while one area has not, with a pressure of 1.02 kg/cm² in Bumi Arum 2, 1.11 kg/cm² in Bumi Arum 3, 1.49 kg/cm² in Bumi Arum 4, and 0.29 kg/cm² in Bumi Arum 1, where the minimum pressure is 10 mka or 10 meters or 1 atm. Meanwhile, the flow measurement results indicate that all four service areas have exceeded the minimum flow standard of 0.12 liters/second for Bumi Arum 1, 0.15 liters/second for Bumi Arum 2, 0.39 liters/second for Bumi Arum 3, and 0.38 liters/second for Bumi Arum 4, where the minimum flow standard for a household connection in Bumi Arum Village is 0.0046 liters/second.

Customer satisfaction with the performance of the PDAM Way Sekampung distribution system reached 65.6% with a "satisfied/good" rating, 7.2% with a "very satisfied/very good" rating, and 27.2% with a "dissatisfied/average" rating. This indicates that the performance and service of the PDAM Way Sekampung distribution system are optimal in Bumi Arum Village.

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