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Evaluation of Clean Water Management at Tebuireng Islamic Boarding School I

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ABSTRACT: This study evaluates the clean water management at Tebuireng Islamic Boarding School I, one of the largest boarding schools in East Java, Indonesia. The boarding school plays a significant social role and contributes to environmental improvements, despite facing issues such as clean water shortages that can hinder activities. The research methods involved field observations, laboratory tests of clean water quality, and interviews with staff and students of the boarding school using questionnaires. These questionnaires aimed to gather data on environmental awareness related to clean water management. The evaluation of clean water facilities and infrastructure was based on three aspects: technical, financial, and community participation. The study results showed that the clean water infrastructure in some parts of the boarding school did not fulfilled the standards set by the Ministry of Public Works Regulation (PERMEN PU) Number 60 of 1992, particularly concerning water storage for a minimum of 6 hours. On the other hand, the clean water quality test results showed that some parameters, such as TDS and Total Coliform, exceeded the quality standards set by the Ministry of Health Regulation (PERMENKES) Number 2 of 2023. The TDS and Total Coliform parameter values exceeding the quality standards were 477 mg/L and 12 MPN/100 mL, respectively. The cost incurred by the foundation for maintaining clean water facilities and infrastructure for one year reached IDR 126.183.900. The boarding school community's attitude towards environmental awareness in clean water management was rated well, with a score of 87, 86, indicating a high level of awareness.

KEYWORDS: boarding school, clean water management, environmental, evaluation, facilities, infrastructure

I. INTRODUCTION

Islamic boarding schools, or pesantren, are the oldest traditional Islamic educational institutions in Indonesia (Madjid, 1997; Purnomo, 2017) . Pesantren play an important social role in the community, not only as religious educational institutions but also as centers for spiritual and physical improvement in their surroundings (Nisa, 2019). Clean water and sanitation management are crucial in boarding school environments to keep the environment clean and ensure all residents stay healthy (Murtako & Khomsatun, 2017).

Water is essential for human life and for both current and future development. The availability of clean water for the community is crucial for meeting basic needs. With the increasing population, settlements are also rapidly expanding (Afriyanda et al., 2018; Dwi Cahyaningtyas & Rahardjo, 2017; Wahyuni & Junianto, 2017). Islamic boarding schools generally utilize well water for daily needs. Its management includes storage and distribution, with water from bore wells stored in tanks or reservoirs located inside or on top of buildings. The water supply system adheres to Ministry of Public Works Regulation (PERMEN PU) Number 60 of 1992 concerning Technical Requirements for the Construction of Flats. Clean water is defined as water that is safe and healthy for consumption after being boiled, is colorless, odorless, and has a fresh taste. This includes water for drinking and household needs such as washing, bathing, and cooking (Kodoatie, 2003; Suripin, 2002; Suryani, 2020). Water for personal hygiene and sanitation is used for hygiene and household purposes. The quality standards of clean water for hygiene and sanitation purposes are regulated by the Ministry of Health Regulation (PERMENKES) Number 2 of 2023 (Indonesia, 2023).

Tebuireng Islamic Boarding School I is one of the largest boarding schools in East Java, Indonesia. At Tebuireng Islamic Boarding School I, borehole water is used not only for bathing and washing needs but also as raw water for drinking. The foundation has provided a drinking water treatment plant to fulfilled the daily drinking water needs of the boarding school

community for free. However, there are still some issues, such as complaints from the students about the lack of clean water for bathing and washing needs, which has led the foundation to supply water from external sources. Therefore, this study evaluates the clean water facilities and infrastructure at Tebuireng Islamic Boarding School I.

II. RESEARCH METHOD

The research was conducted at Tebuireng Islamic Boarding School I, located in Dusun Tebuireng, Cukir Village, Jombang Regency, East Java Province, Indonesia. The research lasted for four months. This study is a case study using the observation method. The research data needs include the quantity and quality of borehole water, the physical condition of water storage/building tanks, information related to clean water service conditions, information related to the environmental awareness of boarding school residents, and documentation of clean water facilities. Data collection was carried out through direct interviews and questionnaires. The sampling technique used in this research is proportionate stratified random sampling. The number of respondents was 267 people, consisting of students, staff, and visitors to cemetery.

The study aspects used are technical aspects, financial aspects, and community participation aspects. The technical aspect focuses on the completeness of clean water facilities and infrastructure and the management system used. The analysis of the technical aspect uses qualitative-comparative methods referring to applicable standards or regulations. The analysis of environmental awareness attitudes is conducted by calculating scores using the Campbell formula (Istiqomah, 2019; Yansyah et al., 2021). Attitude scores are categorized into four types with different score ranges.

$$\text{Attitude Score} = \frac{\text{Total score of response}}{\text{Maximum score}} \text{x} 100$$

Table 1. Score Range for Environmental Awareness Attitude Categories

Attitude Category	Score Range
Very good	> 94
Good	64 - 94
Low	31 - 64
Apathetic	< 31

III. RESULTS AND DISCUSSION

A. Technical Aspect

The source of clean water used for daily activities at Tebuireng Islamic Boarding School I comes from borehole water (ground water). The water is pumped from underground and stored in storage tanks. Tebuireng Islamic Boarding School I has one type of storage tank, namely a Polyethylene (PE) water tank placed on top of each building. Clean water is pumped up to the water tanks, and then distributed to each bathroom, washing area, and ablution area by gravity. Some buildings do not use storage tanks, so the water is pumped and used directly. The male boarding school area has 12 dormitory buildings, an administration office building, a cooperative, a central kitchen, and a cemetery area. The female boarding school area has 5 dormitory buildings, 3 canteen units, and 1 dining room unit. The availability of clean water facilities at Tebuireng Islamic Boarding School I is shown in Table 2.

The total daily clean water requirement is calculated based on the capacity of the occupancy. The calculation of water requirements is based on the planning criteria explained in Table 2. The clean water needs at Tebuireng Islamic Boarding School I are explained in Table 3, where the clean water needs are assumed to match the daily use per person.

Table 2: Avalability of clean water infrastructure

Building	Number of Water Tanks	Tank Capacity (L)	Number of Pumps
Male Islamic Boarding School Area			
KH. Abdurrahman Wahid Dormitory	3	1.100	1
KH. Syaifudin Zuhri Dormitory	6	1.100	1
Nyai Hj. Sholihah Dormitory	2	1.100	1
K-Al-Hidayah Dormitory	3	1.100	1
Y Dormitory	3	1.100	1
KH.M. Ilyas Dormitory	4	1.100	2

Evaluation of Clean Water Management at Tebuireng Islamic Boarding School I

Building	Number of Water Tanks	Tank Capacity (L)	Number of Pumps
KH. Kalla Dormitory	2	1.100	1
KH. Ahmad Baidlowi Dormitory	Bathroom: 31 units @capacity tank: 60 L.	1.860	1
KH.A. Karim Hasyim Dormitory	• Directly into large bathtub: 8.815,5 L • Wudhu: 650 L		2
LH Shalaf Dormitory			
Suryo Kusumo Dormitory	4	1.100	2
Central kitchen	Used directly		1
KH.M. Yusuf Hasyim Building	2	500	1
Roudloh Dormitory	3	1.100	1
Kasepuhan residence	2	3.300	1
Ndalem kasepuhan	1	650	1
Drinking water tank	1	3.300	1
Female's Islamic Boarding School Area			
Nyai Hj. Naviqoh Dormitory	4	1.100	3
Nyai Aisyah Dormitory	5	1.100	3
Nyai Azah Dormitory	4	3.300	2
Nyai Masruroh Dormitory	6	1.100	2
Nyai Khoiriyah Dormitory	2	1.100	1
Drinking water tank	1	1.100	1

Table 3: Clean water requirements

Usage purpose	Criteria	Water Requirements (L/person/day)
Boarding school's students[1]	Type B Islamic Boarding School	75
Students who do not stay in building school[1]	Educational facilities	10
The employees of the cottage management[2]	Employee	50
Canteen[2]	Employee	50
Kasepuhan Residents[2]	Residents of the house	120
Tomb visitors[2]	Visitors	3
Raw water for drinking water[3]	Drinking water consumption	2

Notes: *[1] Technical Guidelines for Planning Clean Water Facilities and PLP in Islamic Boarding Schools*

[2]SNI 03-7065-2005: Procedures for Planning Plumbing Systems

[3]Recommendations of the Ministry of Health regarding the need for drinking water consumption

Table 4: Avalability of clean water infrastructure

Source	Number of People	Water Requirement (L/p/day)	Quantity (L/day)
Boarding school's students	6.412	75	480.900
Students who do not stay in building school	97	50	4.850
The employees of the cottage management	11.000	3	33.000
Canteen	5	50	250
Kasepuhan Residents	10	10	100
Tomb visitors	4	120	480
Raw water for drinking water	6.412	2	12.824
Total			**532.404**

According to the Minister of Public Works Regulation No. 60 of 1992 concerning the Technical Requirements for Apartment Building Construction, a compliant water supply system should fulfilled the following standards (Umum, 1992):

- An underground, surface, or partially underground water tank must have the capacity to supply water for a minimum of 3 days.
- The storage tank must also have a reserve for fire protection purposes.
- To maintain the cleanliness of the storage tank and prevent algae and sediment buildup on the walls, it is recommended to flush the tank every 3-6 months.
- Additionally, these tanks are prone to damage such as leaks, cracks, breaks, or flooding.
- Meanwhile, above-ground tanks must be able to supply water for at least 6 hours.
- To maintain the cleanliness of these tanks and prevent algae and sediment buildup, it is also recommended to flush them every 3-6 months.

Based on the results of surveys and interviews with the environmental cleanliness staff of the boarding school, the borehole water at Tebuireng Islamic Boarding School I is consistently available, the storage tanks in each building are placed on top of the buildings, and there is no damage such as cracks or leaks in the water tanks. The tanks are cleaned every 3 months, and the fire protection system used is hydrants, which are only installed in the male boarding school area.

The analysis of meeting the clean water needs for 6 hours at Tebuireng Islamic Boarding School I is explained in Table 5. This evaluation was carried out by examining the borehole water discharge (groundwater) based on the type of aquifer and pump capacity and comparing it with the theoretical water needs over a 6-hour period. Referring to the hydrogeological map, Dusun Tebuireng is located within an aquifer system that flows through intergranular spaces (a productive aquifer with extensive distribution), with a discharge ranging from 5 to 10 L/second. The pumps used are centrifugal pumps, with two brands available, each with a design capacity of 3000 L/hour and 600 L/hour.

According to Table 5, most buildings have fulfilled the clean water needs for 6 hours based on the standards of Minister of Public Works Regulation (PERMEN PU) Number 60 of 1992. However, there is one building that has not fulfiled this requirement, namely Nyai Khoiriyah Dormitory in the female's boarding school area. An alternative solution to fulfilled the clean water needs and support activities at Nyai Khoiriyah Dormitory is to increase the pump capacity. The problem of water shortages requiring the boarding school to supply clean water from outside can occur if the distribution system, particularly the pump, suddenly fails. This can happen due to a lack of maintenance. Regular maintenance of the water pump can improve the water pumping discharge by ensuring the pump operates efficiently and optimally. It is recommended to perform preventive maintenance, which is a routine action carried out according to a predetermined schedule with the aim of increasing reliability and extending the pump's lifetime (Alfalah et al., 2018).

Table 5. Fulfillment of clean water needs for 6 hours

Building	6 Hours Requirement (L)	Well Discharge (L/6 hours)	Pump Design Capacity (L/6 hours)	Information
Male's Islamic boarding school area				
Wisma KH. Abdurrahman Wahid	6.525	108.000	18.000	Fullfiled
Wisma KH. Syaifudin Zuhri	9.788	108.000	18.000	Fullfiled
Wisma Nyai Hj. Sholihah	9.788	108.000	18.000	Fullfiled
Wisma K-Al-Hidayah	9.788	108.000	18.000	Fullfiled
Wisma Y	9.788	108.000	18.000	Fullfiled
Wisma KH.M. Ilyas	9.788	108.000	18.000	Fullfiled
Wisma KH. Kalla	9.788	108.000	18.000	Fullfiled
Wisma KH. Ahmad Baidlowi	4.350	108.000	18.000	Fullfiled
Wisma KH.A. Karim Hasyim	13.050	108.000	18.000	Fullfiled
Wisma LH Shalaf		108.000	3.600	Fullfiled
Wisma Suryo Kusumo	15.660	108.000	18.000	Fullfiled
Central kitchen	No storage tank, direct discharging via faucet			
KH.M. Yusuf Hasyim Building	1.500	108.000	3.600	Fullfiled
Roudloh Guesthouse	15.660	108.000	18.000	Fullfiled
Central mosque	375	108.000	18.000	Fullfiled
Ndalem kasepuhan	120	108.000	3.600	Fullfiled

Building	6 Hours Requirement (L)	Well Discharge (L/6 hours)	Pump Design Capacity (L/6 hours)	Information
Drinking water	2.726	108.000	18.000	Fullfiled
Female's Islamic Boarding School Area				
Wisma Nyai Hj Naviqoh	5.760	108.000	18.000	Fullfiled
Wisma Nyai Aisyah	5.760	108.000	18.000	Fullfiled
Wisma Nyai Azah	5.760	108.000	18.000	Fullfiled
Wisma Nyai Masruroh	5.760	108.000	18.000	Fullfiled
Wisma Nyai Khoiriyah	5.760	108.000	3.600	Not fullfiled
Drinking water	480	108.000	3.600	Fullfiled

Based on Minister of Public Works Decree (KEPMEN PU) Number 10 of 2002, every building must organize and comply with safety regulations against fire hazards, rescue facilities, active protection systems, and passive protection systems. A fire fighting system is typically provided in buildings as a preventive measure against fires. This system consists of sprinkler systems, hydrant systems, and fire extinguishers. Therefore, the installation of a fire fighting system is necessary to prevent and address potential building fires. With a fire fighting system, the availability of water must always be ensured and ready whenever needed (Umum, 2000).

Calculating the clean water needs for the ground floor main building sprinkler. According to SNI-03-3989-2000, a sprinkler with an open system requires a water discharge (Q) of 84.62 L/min and should be able to flow water for 30 minutes for light fire categories (Nasional, 2000). Therefore, the water needed for fire fighting purposes in the women's boarding school dormitory is as follows:

$$Q = V \text{ x } t$$
$$Q = 84{,}62 \frac{L}{minute}$$
$$T = 30 \text{ minute}$$
$$V = \frac{84{,}62}{30} L$$
$$V = 2{,}82 L$$

The total number of sprinklers in the women's boarding school dormitory building is around 60 units. Therefore, the total volume for 60 sprinkler points is calculated as follows:

$$V = 60 \text{ x } 2,82 L$$
$$V = 169{,}2 L$$

According to Minister of Public Works Regulation (PERMEN PU) Number 20 of 2009, the water supply for firefighting purposes can be obtained from natural sources such as ponds, lakes, rivers, streams, deep wells, and irrigation channels, as well as artificial sources such as water tanks, gravity tanks, swimming pools, fountains, reservoirs, water tank trucks, and hydrants. The women's boarding school does not yet have a fire protection system installed. After calculating the required water supply for firefighting, it was found that 169.2 liters are needed. From this data, it can be said that the water needs for fire protection in the women's boarding school dormitory have not yet been fulfilled.

The clean water quality used at Tebuireng Islamic Boarding School I refers to the Ministry of Health Regulation (PERMENKES) Number 2 of 2023 concerning Water Quality Standards for Hygiene and Sanitation Purposes. A sample of borehole water was tested in an environmental laboratory, and Table 6 shows the results of the borehole water quality testing at Tebuireng Islamic Boarding School I.

Table 6. Borehole Water Quality at Tebuireng Islamic Boarding School I

Parameter	Unit	Test Results	Quality Standards*
Turbidity	NTU	0,81	< 3
TDS	mg/L	477	< 300
Fe	mg/L	0,06	0,2

Parameter	Unit	Test Results	Quality Standards*
Mn	mg/L	0,04	0,1
Total coliform	MPN/ 100 mL	12	0

Note: *Ministry of Health Regulation (PERMENKES) Number 2 of 2023

Source: Laboratory Test Results, 2024

The laboratory test results of borehole water quality used for sanitation purposes in Table 5 indicate that it does not fulfilled the quality standards of Ministry of Health Regulation (PERMENKES) Number 2 of 2023. The TDS and Total Coliform parameters have results higher than the reference standards. High TDS values can be influenced by the presence of many dissolved organic substances and gases in clean water. Additionally, high TDS can cause scaling on kitchen equipment. Total coliform values exceeding the threshold can be caused by groundwater contamination by E. coli bacteria. If consumed, this water can cause stomachaches and diarrhea. It is recommended to add filtration units to reduce TDS levels and disinfection units to reduce coliform levels.

Tebuireng Islamic Boarding School I uses borehole water as raw drinking water, which is then consumed by the boarding school community. The foundation has provided drinking water treatment facilities in both the male and female boarding schools, so there is no need to purchase drinking water from outside. The maximum daily clean water usage and peak hour usage at Tebuireng Islamic Boarding School I are calculated using equations below:

$$Q_{hm} = Q_d \times f_{hm}$$

Where:

Q_{hm} = maximum daily discharge (L/day)

Q_d = calculated water discharge (L/day)

F_{hm} = Maximum Daily Factor Number = 1,1

$$Q_{jm} = Q_h \times f_{jm}$$

Where:

Qjm = peak hour discharge (L/day)

Qhm = maximum daily discharge (L/day)

Fjm = Peak Hour Factor Number = 2

Table 7. Maximum Water Usage

Area	Qd	Qhm (L/day)	Qjm (L/day)
Males's Islamic Boarding School	458.334	504.167	1.008.335
Female's Islamic Boarding School	74.070	81.477	162.954
Total	532.404	585.644	1.171.289

The maximum daily discharge value (Table 7) serves as a reference for meeting daily clean water needs, with a calculated result of 504,167 liters for the male boarding school and 81.477 L/day. Meanwhile, the peak hour discharge represents the time when everyone uses water simultaneously or during high usage periods.

Supporting equipment for the clean water distribution system, such as water pumps and pump houses, must fulfilled certain requirements according to Minister of Public Works Regulation No. 60 of 1992. While the pump house must be placed in an appropriate location to protect it and reduce noise levels, the water pump must have the capability to pump water to the rooftop tank. The supporting equipment for the clean water distribution system at Tebuireng Islamic Boarding School I currently includes centrifugal pumps in each building. These pumps can still pump water to the storage tanks. However, the special protection for the pumps only consists of a zinc box that protects the pumps from rain and heat.

B. Financial aspect

The maintenance procedure for clean water facilities is conducted to ensure that these facilities continue to function properly and do not experience performance degradation. At Tebuireng Islamic Boarding School I, the clean water system is maintained sporadically. This means that maintenance is only carried out when necessary or when the system is not functioning regularly. Tebuireng Islamic Boarding School I has never performed regular maintenance on its clean water system, leading to several unusual conditions such as broken faucet handles, malfunctioning pumps, broken or leaking water tanks, and pipe leaks.

Evaluation of Clean Water Management at Tebuireng Islamic Boarding School I

The clean water facilities at Tebuireng Islamic Boarding School I have never received major maintenance, except for faucet replacements, pump repairs, and pipe repairs. Major maintenance is usually performed only when there is a fatal breakdown.

Table 8. Maintenance of clean water facilities at Tebuireng Islamic Boarding School I

	Male's Islamic Boarding School	Female's Islamic boarding school
Routine maintenance	None	None
Periodic maintenance	Water tank flushing	Water tank flushing
Incidental maintenance	• Faucet replacement • Water tank replacement • Pump repair • Pipe repair	• Faucet replacement • Pump repair • Pipe repair

To calculate the operational and maintenance costs of the clean water system at Tebuireng Islamic Boarding School I, a financial analysis was used. This outlines the expenses incurred by the foundation. Table 9 shows the budget plan for the operational and maintenance costs of the clean water facilities.

Table 9. Budget details for maintenance of clean water facilities

Description	Vol.	Unit	Price (IDR)	Amount (IDR)
Purchase of 1/2" water faucet	1470	Pieces	35.000	51.450.000
Purchase of pump lubricants	1	Bottle	163.900	163.900
Purchase of 60 L Water Tanks	730	Pieces	71.500	52.195.000
Pump repair costs	31	Service	425.000	13.175.000
Pipe repair costs	46	Service	200.000	9.200.000
Total				**126.183.900**

C. Community participation aspect

In everyday life, environmental awareness means an individual's reaction to their environment by not damaging the natural environment. Thus, a clean and green environment will be created (Tamara, 2016). From an early age, it is important to instill a character that is concerned with environmental preservation and water resource conservation. Therefore, it is crucial to understand that caring for nature affects the quality and quantity of water, which is a source of life. The achievements per category of statements in the attitude indicator toward clean water management are shown in Table 10.

Table 10. Score of attitude indicator in clean water management

Respondent Statement Indicator	Average Score of Respondent Answers
Saving water for toilet use	4,36
Turn off the tap after washing hands.	4,55
Supporting water resource conservation activities.	4,27
Total	4,39

Based on Table 10, the achievement of the respondent statement indicators received a score > 4. This indicates that respondents predominantly agree on water-saving behaviors for toilet use, turning off taps after use, and supporting water conservation activities. Water-saving behavior refers to using water as efficiently as possible and reducing water wastage. One of the water conservation efforts is water-saving behavior, which not only preserves the quantity of water resources but also minimizes the generation of domestic wastewater (Larayana et al., 2017). The calculated value of environmental awareness in the category of clean water management is 87.86, which falls into the good category.

$$\text{Attitude score} = \frac{4{,}39}{5} \text{ x } 100 = 87{,}86$$

IV. CONCLUSION

The clean water management at Tebuireng Islamic Boarding School I is not yet fully optimal. The clean water storage infrastructure for 6 hours has not fulfilled the standards of the Minister of Public Works Regulation (PERMEN PU) Number 60 of

1992 for Nyai Khoiriyah Dormitory, and the need for water for the fire protection system in the female boarding school is not fulfilled. The quality of clean water used does not fulfilled the quality standards for hygiene and sanitation requirements according to the Ministry of Health Regulation (PERMENKES) Number 02 of 2023. The maintenance costs for clean water facilities and infrastructure required for 1 year amount to IDR 126.183.900. The results of the community's attitude questionnaire towards clean water management fall into the good category. It is recommended to increase the capacity of clean water pumps to fulfilled the 6-hour storage standard and to add treatment units such as chlorination tanks and filtration tanks to reduce the coliform and TDS levels in the well water.

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