Feasibility evaluation of water supply infrastructure in Luwuk district

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Abstract. Water is an essential factor in determining human needs. Society has increased or not in a city or region can be seen from the availability of clean water that available whenever we need it. Provision and development of clean water is an activity directly related to one of the basic needs of the community. The availability of clean water is a necessity, which, if neglected, will have a significant effect on the sustainability of human life. Clean water infrastructure functions to empower water resources for the community. The availability of adequate and enough clean water infrastructure has a significant influence on clean water services. Luwuk District receives a clean water supply from the PDAM sourced from the water treatment plants (WTP) of Keles and WTP of Mangkio. This study aims to (1) Analyze the existing conditions of the clean water infrastructure of Luwuk District, (2) Evaluate the performance of the clean water infrastructure of Luwuk District. The object of research is the PDAM clean water infrastructure. The results showed that the physical condition and performance of the WTP Keles clean water infrastructure was not good while in Mangkio was quite good. It is necessary to have regular and periodic maintenance of the clean water infrastructure in the two water treatment plants to maintain the continuity of the existing infrastructure and maximize the economic life of the support in supply the freshwater needs of the community.The first section in your paper

1. Introduction

A water supply system must be planned and built in such a way as to be able to meet the availability of sufficient quantities of water with quality that meets drinking water requirements. Also, the purpose of developing a clean water supply system is the availability of water at all times or in a sustainable manner and the availability of water at a price that can be affordable by the community for survival [1]. Luwuk Sub-district is one of the sub-districts as well as the center of government in Banggai Regency . with an area of 72.82 km2 and a population of 37,719 people [2]. The clean water supply system in this region has not run smoothly. Service issues include the quality of clean water, which in certain seasons there is still turbidity of water received by the customer, the continuity of the flow of water has not been entirely able to serve 24 hours in specific service areas [3]. Therefore, it is necessary to evaluate the condition of clean water infrastructure so that we can determine alternative solutions [4,5,6].

2. Research Method

This type of research is a quantitative descriptive study with an evaluative approach explaining the condition of clean water infrastructure in Luwuk District, which is managed by the PDAM. Data collection techniques consist of primary data and secondary data. Primary Data, through observation, interviews, questionnaires, documentation. Secondary data, using literature studies, data on population, condition of the research area, and data from PDAM related to this research.

The location of this research was the PDAM water supply infrastructure in water treatment plants of Keles and Mangkio. Water supply infrastructure, according to the NSPM Kimpraswil 2002 concerning Urban Drinking Water [7], includes:

- Building Intake.
- Water Treatment Plant (WTP)
- Transmission pipe
- Reservoir
- Distribution Network

Analysis of water supply infrastructure in Luwuk District based on NSPM Kimraswil 2002 and Permen PUPR No.12 / PRT / M / 2015 [8] can be seen in table 1 and 2.

Table 1. Infrastructure Performance Index.

Assessment	Weight
Excellent performance	80 – 100
Good performance	70 – 79
Performance is lacking and needs attention	55 – 69
Poor performance and need attention	<55

Table.2. Evaluation of Water Supply Infrastructure Performance.

Parameter	Indicator	Weight
Water Source	Debit - Quantity - Quality	40%
Transmission Pipe	Pipe Accessories pipe	15%
Water Treatment Plant	Processing Unit Processed Products	15%
Reservoir	Inlet Outlet Drainer By.pass Manhole	5%
Distribution Pipe	Pipe Accessories pipe Service	15%
Maintenance	Routine Periodic	10%
Total		100%

3. Result and Discussion

3.1. Existing Condition Analysis of PDAM Water Supply Infrastructure

3.1.1. Raw Water Source

The PDAM supplies clean water to the area provided by Luwuk District from two Water Treatment Plants (WTP) [9], namely:

- WTP of Keles, the source of raw water comes from the Keles water spring
- WTP of Mangkio, the source of natural water comes from the Mangkio water spring

Figure 1. Keles water spring building.

Figure 2. Mangkio water spring building.

Data on the raw water capacity of each installed WTP can be seen in table 3.

Table 3. The installed capacity of raw water sources [8]

No	Location	Year	Capacity (l/s)
1.	Water Treatment Plants (WTP) of Keles	1945	100
2.	Water Treatment Plants (WTP) of Mangkio	1986	300

Based on the PDAM technical report in 2017, the raw water used from the two springs is 133.5 liters/ second or about 32% of the existing raw water capacity, as in table 4.

Table 4. The capacity of raw water utilized [8]

No	Location	Capacity (l/s)
1.	Water Treatment Plants (WTP) of Keles	53
2.	Water Treatment Plants (WTP) of Mangkio	80,5

This condition indicates that the capacity of raw water sources in both springs is still very possible to be used for future purposes in improving services. The availability of raw water can serve WTP of Keles and Mangkio, but during the dry season, the Keles's WTP loses 50% of raw water. In terms of quality, the source of raw water from the springs is entirely guaranteed because the location is far from the settlement, although physically there is still turbidity if there is continuous rain.

Conditions in the entire building of existing springs can be said to be normal. The infrastructure is still under the planning standards, including safe for pollution, placed in a location that is safe against the carrying capacity of the natural environment. Always, the physical condition of the catchment springs looks not maintained. The results of the assessment of the situation of the water source building are functional categories with more attention to the periodic maintenance of the condition of the building.

3.1.2. Transmission network

The transmission network is a closed channel form that serves to bring raw water to the water treatment plants to be processed into clean water. Drainage uses a gravity system for Keles springs and Mangkio springs using pumping and gravity systems.

The installation of the transmission pipe is proper because it is equipped with a pipe buffer that functions as a pipe binder and accessories, namely the air release valve before being flowed to the treatment unit

The transmission pipeline network has been installed for quite a long time, and there has never been a replacement so that there are parts of the pipe that are corroded and mossy. The tube is also not painted with anti-rust material. It will affect the quality of treated water because of the risk of contamination of treated water with rust in the pipes. Maintenance of pipelines is not carried out routinely.

The condition assessment results of the Water Treatment Plants (WTP) of the Keles transmission network are not good because the network conditions are only partially according to the planning standards or poorly maintained physical conditions.

For the WTP of Mangkio, raw water is pumped directly from the spring to the reservoir, there are no problems with the transmission network, but operational costs tend to be higher in the event of a power outage. From the results of observations in the field, the WTP of Mangkio is in quite good condition, although sometimes it requires high operational costs.

3.1.3. Water Treatment Plant (WTP)

Water Treatment Plants (WTP) Package process raw water through certain physical, chemical, and or biological processes to produce drinking water quality that meets drinking water quality standards in force. Water Treatment Plants (WTP) Package is designed and made in a place that can then be assembled at the planned location. A protective roof is built/equipped to support perfect processing. In WTP of Keles, a water process plant was built with shoddy construction. The awakened WTP appears to have undergone corrosion, and painting does not use anti-rust material. This installation also does not have a protective roof, so it is vulnerable to contamination from materials and exposure to direct sunlight, which can affect the processing process.

Besides, although the WTP of Keles has a complete water process system since 2017, several units have no longer functioned. Water entering the WTP only undergoes a sedimentation process without adding any chemicals to the coagulation unit due to limited operational costs. From the aspect of quality, water clarity is only seen physically with the consideration that raw water is sourced from

springs. The operation of a water treatment plant is usually guided by standard operating procedures (Standard Operating Procedure / SOP) to ensure that the service is following technical requirements and makes it easier for replacement/addition of operator personnel.

Based on observations at the location of the water process plant, there is no SOP as a guide for the implementation of work and the limited equipment to support operational activities in the field. The results of the condition assessment result of the Keles Water Process Plant are unfavorable because only part of the construction is by planning standards and is less able to reduce the turbidity of raw water in the rainy season.

Based on PDAM technical reports, water treatment system data can be seen in table 5.

Table 5. Water treatment systems [8]

No.	Location	Water Treatment System	Capacity Installed (l/s)
1.	Water Treatment Plants (WTP) of Keles	Complete	60
2.	Water Treatment Plants (WTP) of Mangkio	Simple	90

Figure 3. Water Treatment Plants (WTP) of Keles

3.1.4. Reservoir

An ideal water supply system has a reservoir that functions to hold clean water that has been treated in a water process plant. Reservoir capacity can be seen in table 6.

Table 6. Reservoir capacity.

No.	Location	Capacity (m^3)	Construction
1.	Water Treatment Plants (WTP) of Keles	500	Concrete
2.	Water Treatment Plants (WTP) of Mangkio	600	Concrete

Figure 4. Reservoir Keles.

Figure 5. Reservoir Mangkio.

The dimensions of the two installations are 1100 m3. From the analysis, results for reservoir dimensions are categorized as useful. The condition assessment result of the reservoir is good because of the construction according to the planning standards and clean physical conditions.

3.1.5. Distribution Pipe Network

The drainage system in the distribution network for WTP of Keles and WTP of Mangkio uses a gravity system. In the current distribution network, there are still leakages in some service areas due to the age of the long-installed distribution pipeline network that has not been carried out in stages and continuous maintenance and replacement. The PDAM obtains complaints regarding leaks through community reports and forwarded them to the responsible section. The condition assessment result of the distribution network is not good because the network conditions are only partially under the standard.

3.2, Evaluation of Water Supply Infrastructure Performance

Based on the analysis of the existing conditions of water supply infrastructure and respondent characteristics, the assessment of the performance of the water supply infrastructure of Luwuk district for the WTP of Keles and Mangkio can be seen in table 7 up to table 8 below:

In table 7, the performance of the Water Treatment Plants (WTP) of Keles is not excellent and needs attention. It is due to the condition of the infrastructure that has been long and requires regular replacement and maintenance.

In table 8, the performance of Water Treatment Plants (WTP) of the Mangkio water supply infrastructure is quite good and needs attention. Problems with the conditions of transmission networks and water treatment plants that are still simple.

Table.7. The condition of the water treatment plants (WTP) of Keles water supply infrastructure.

Parameter	Indicator	Infrastructure Condition	Evaluation Value	Weight
Water Source	Debit			40%
	-Quantity	Meets with the volume of raw water 100 l/d	20%	
	-Quality	Sometimes cloudy if there is continuous rain	10%	
Transmission Pipe	Pipe	Meets adequacy of diameter but there are still leaks because of the installed pipe age	5%	15%
	Accessories	Complete	5%	
Water Treatment Plant	Processed Unit	Complete Processing Unit Water Treatment Plant, but some units no longer function due to limited operating costs	5%	15%
	Processed Products	Not able to reduce turbidity	2%	
Reservoir	Inlet Outlet Drainer By.pass Maintenance hole	Good	5%	5%
Distribution Pipe	Pipa	There are still leaks due to long installed pipe	5%	15%
	Accessories pipes	Complete	5%	
	Service	Good enough	2%	
Maintenance	Routine		-	10%
	Periodic		5%	
Total			69%	100%

Table 8. The condition of the water treatment plants (WTP) Mangkio water supply infrastructure.

Parameter	Indicator	Infrastructure Condition	Evaluation Value	Weight
Water Source	Debit			40%
	-Quantity	Meets with raw water volume 300l/sec	25%	
	-Quality	Good physically	10%	
Transmission Pipe	Pipe	Not Good	5%	15%
	Accessories pipe	Complete	5%	
Water Treatment Plant	Processing Unit	Simple, there is only a chlorine affixing place that is not functioning again	5%	15%
Reservoir	Inlet Outlet Drainer Maintenance hole	Good	5%	5%

Parameter	Indicator	Infrastructure Condition	Evaluation Value	Weight
Distribution Pipe	Pipe	Good enough, there is rarely a leak	5%	15%
	Accessories	Complete	5%	
	Pelayanan	Good enough	3%	
Maintenance	Routine	-		10%
	Periodic	5%		
Total			73%	100%

4. Conclusion

- The condition of water supply infrastructure is currently still feasible for raw water units and reservoirs. Problems occur in the state of the transmission network and water process plants.
- Based on the PUPR Regulation No.12 / PRT / M / 2015, the performance of the WTP Keles infrastructure is not excellent. It needs attention or 69% due to the condition of the old infrastructure so that it requires regular replacement and maintenance while the Water Treatment Plants (WTP) Mangkio is quite good and needs attention with a weight of 73%.

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