

# Reliability Study of Clean Water Supply System in Slums Area of Palembang City

## (Case Study in Palembang 5 Ulu Village)

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**Abstract**— Palembang which is crossed by the Musi River is divided into two major parts, Seberang Ulu and Seberang Ilir. Seberang Ulu is a densely populated area with not well organized spatial, such as 5 Ulu region which is classified as a high slum area, this condition will certainly be faced with many problems one of them is clean water to meet the daily needs, such as bathing, washing, cooking and drinking. Therefore, this study aims to measure the water needs of 5 Ulu residents and to analyze how much the clean water accessibility level for the 5 Ulu residents. The variables used to see the reliability level include the amount, distance, time, cost, and quality based on field observations, interviews, and questionnaires from 100 respondents as well as secondary data from relevant institutes. Based on calculations, it is known that the size of the public clean water needs in 5 Ulu Palembang ranges from 140 - 160 liter/person/day. Whereas their accessibility to clean water from the analysis result is the amount of clean water fulfilled only by 22 liters/person/day, the distance taken to get clean water is <100m with an average travel time of 5 minutes, 5 Ulu residents who are not Water Supply Company subscription, indirectly costs more because refill drinking water costs are far greater than the basic Water Supply Company tariff, some 5 Ulu residents use non- Water Supply Company to meet their needs where its quality does not meet clean water standards according to the Ministry of Health.

**Index Terms**— Clean Water, Reliability, Slum Area

## 1 INTRODUCTION

Seberang Ulu area is generally a densely populated area and not well-organized spatial structure, one of its Region is 5 Ulu which is classified as a high slum area [1]. Most of 5 Ulu's land is dominated by settlements where the distance between the houses is close together so that visually the condition of this area is dense and tight. This condition is very vulnerable to social problems such as the need of clean water. Based on Central Bureau of Statistic population data for 2014, 5 Ulu has 342 Ha area and 6,049 families in total. Population conditions and the poverty level in Seberang Ulu 1 and 5 Ulu area can be seen in the following table 1.

**Table 1. Palembang City Slums Level in 2014**

Districts	Number of Villages	Number of Slum Villages	Slum Level		
			Low Slum	Middle Slum	High Slum
Seberang Ulu I	10	10	-	6	4
Seberang Ulu II	7	7	3	4	-
Kemuning	6	2	2	-	-
Gandus	5	2	2	-	-
Ilir Barat I	6	1	1	-	-
Ilir Barat II	7	7	7	-	-
Ilir Timur I	11	5	5	-	-
Bukit Kecil	6	2	2	-	-
Ilir Timur II	12	6	6	-	-
Kertapati	6	4	1	3	-
Sukarami	7	1	1	-	-

The clean water availability that is difficult to reach could

lead to decreased community productivity levels. This resulted in public socioeconomic conditions and low public health resistance [2]. In general, 5 Ulu is a city center area, but the community still have difficulty in getting clean water.

Therefore, as an effort to achieve the National Medium-Term Development Plan target 100 - 0 -100 (100% drinking water services, 0% urban slums and 100% urban sanitation) for the Indonesian population. Evaluation for clean water supply systems reliability in slums is an important issue considering the low level of clean water services due to the unoptimal service delivery system.

Controlling the clean water supply reliability that is evenly distributed to the whole community is principally prioritized for people who do not yet have access to clean water, especially in water-prone areas, slums, fishermen, and underdeveloped regions [3]. There are several criterias used to measure the clean water services performance/reliability based on WHO including (1) safe and acceptable; (2) sufficient ; (3) accessible; and (4) affordable. So that in this study the reliability criterias are taken based on the amount, distance, time, cost, and quality

Based on the social problems faced by slums in Palembang City, this study aims to measure the water needs of 5 Ulu slum area and analyze how much the accessibility levels of clean water for the people in 5 Ulu.

## 2 METHODS

This research contains a field study in 5 Ulu with several approaches, such as literature study, primary data collection in the form of (1) field survey by observing and recording community activities in meeting their daily clean water needs,

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water sources used, and the physical condition of the water used in plain view. (2) questionnaire interviews to find out more in-depth information directly from the community. (3) secondary data collection from relevant institutes.

The number of families in 5 Ulu is as many as 6049 families which are divided into 5 Ulu Darat and 5 Ulu Laut areas. In determining the decision of these respondents determined using the Taro Yamane formula [4] :

$$n = \frac{N}{N \cdot d^2 + 1}$$

Where :

- n = Total Sample Size
- N = Total Population
- d = Precision Established

$$n = \frac{4635}{(4635 \cdot 0.1^2 + 1)} = 97.88 \sim 100 \text{ respondent}$$

From the calculation results obtained 100 respondents sample using the random sampling method. Community water needs in 5 Ulu in general further information on secondary data obtained from relevant parties, in this case, the Water Supply Company. The data is 5 Ulu residents' monthly cubication for one year which is then recruited through usage classes. The trend of clean water use can be seen in liters /person/day each month. Meanwhile, to analyze the clean water performance in 5 Ulu, it is done by comparing the characteristics of needs, availability, and the range level of the community based on quality, quantity, and continuity. Refers to service performance based on the Department of Regional Infrastructure [5] in terms of:

- a. Quantity: consumption 150-160 liter / person / day.
- b. Quality: drinking / clean water standard.
- c. Continuity: 24 hours per day / can be obtained at any time.

Optimal clean water service means that the access level is said to be high if the water used by the community is flowed directly into the house. Because the further the community accesses clean water means the worse the access to clean water for the community [6].

As well as the community accessibility level to clean water sources, the correlation between one place to another which includes distance, time, and cost [7].

From this description, several variables were examined, among others

1. The volume of water consumed by the community
2. Reach to get clean water.
3. Time to get clean water.
4. The quality of clean water used.
5. Cost for getting clean water.

The variables analyzed in this study will become the

basic variables in determining the reliability level of clean water services for the community in 5 Ulu.

### 3 RESULTS AND DISCUSSION

#### 3.1 CLEAN WATER NEEDS MEASUREMENT IN EXISTING CONDITIONS IN 5 ULU SLUM AREA

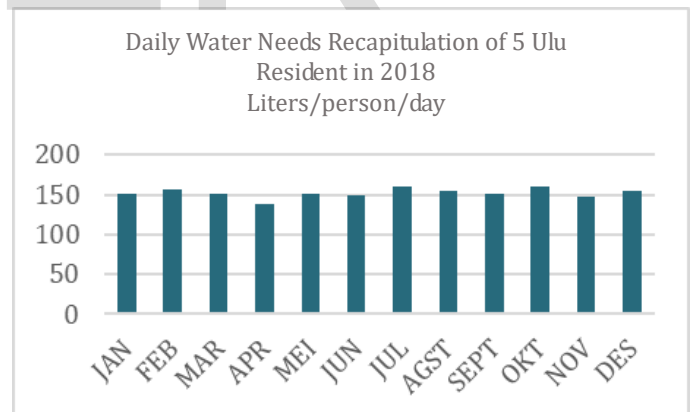
The use of clean water in 5 Ulu slum area is mostly classified as domestic use, this is because almost all users of clean water in 5 Ulu are households. Because the composition of non-domestic use is small in number, non-domestic use is considered to be the same as domestic use..

The daily clean water needs amount for people in 5 Ulu is calculated based on meeting the needs of clean water for drinking, cooking, bathing, washing, latrines, and others. From the questionnaire results and data calculation on the use of clean water cubication in 5 Ulu, the recapitulation of clean water needs amount in 5 Ulu region can be seen as shown in Table 2 and Figure 1.

**Table 1.** Amount of Clean Water Needs in 5 Ulu

Total Clean Water Needs	Total
< 35 liters/people/day	0
35 liters/people/day	0
36 - 140 liters/people/day	39
> 140 liters/people/day	61
<b>Total</b>	<b>100</b>

**Fig. 1.** Community Clean Water Needs Level in 5 Ulu



#### 3.2 CLEAN WATER ACCESS BASED ON DISTANCE AND TRAVEL TIME OF CLEAN WATER NEEDS

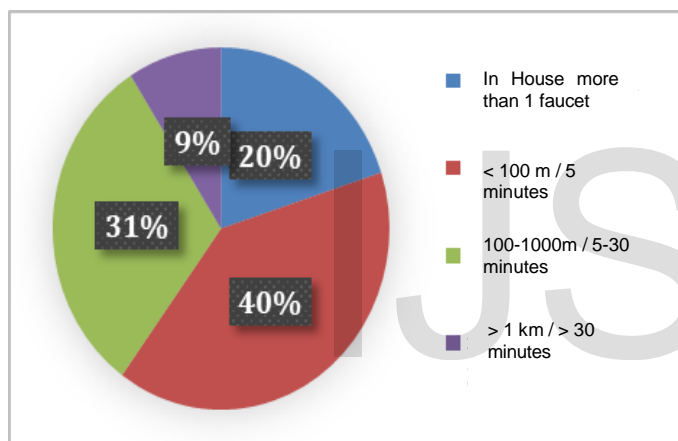
The distance traveled in getting clean water will be directly proportional to the travel time, where the closer the distance traveled, the shorter the time required, and vice versa. Distance and travel time are the basic variables in determining the access level, where the access level to clean water is said to be bad if the longer the distance traveled and the longer travel time [6]. Diverse results were obtained from questionnaire distributed, where the distance and travel time

used to get clean water from the 5 Ulu residents and the percentage for distance and travel time are attached in Table 4 and Figure 2 below.

**Tabel 2.** Distance and Travel Time Based on Clean Water Source

Clean Water Sources	Distance and Time Travel			
	In House more than 1 faucet	< 100 m / 5 minutes	100-1000m / 5-30 minutes	> 1 km / > 30 minutes
Water Supply	20	0	0	0
Drinking	0	10	25	9
River Water	0	30	6	0

**Fig. 1.** Distance and Travel Time Percentage From Clean Water Source



### 3.3 RELIABLE WATER SUPPLY CALCULATION

In analyzing the reliability level of clean water supply in 5 Ulu is divided into several factors, i.e.

#### 1. Cost Analysis To Get Clean Water Based on Clean Water Price Per m<sup>3</sup>

The price category of clean water per m<sup>3</sup> is seen from clean water source used by the 5 Ulu residents. Where clean water can be said to be more expensive if the water is obtained by buying from water peddler. On the contrary, clean water price per m<sup>3</sup> can be cheaper if it is obtained from Water Supply Company or from free water sources so that the residents do not need to pay a large fee to get clean water to meet their daily water needs. From the questionnaire results, most of them spent a huge amount of fee to get clean water. The cost of clean water from non- Water Supply spent by the 5 Ulu residents is listed in the following Table 3.

**Table 3.** 5 Ulu Residents' Cost for Clean Water Per m<sup>3</sup>

Clean Water Cost /m <sup>3</sup> (Rp)	Percentage
> 100.001,-	88
66.001,- s.d. 100.000,-	6
33.001,- s.d. 66.000,-	0
0 s.d. 33.000,-	6

#### 2. Costs Analysis to Get Clean Water Based on Ability to Pay Per m<sup>3</sup>

Drinking water is said to be expensive if the community spends more than 3% of their average income for buying clean water [8]. Therefore the cost analysis will be conducted to determine the amount of costs incurred by the 5 Ulu residents in obtaining clean water by calculating how much their ability to pay for clean water per m<sup>3</sup>.

With the people's amount of use per day based on previous data is taken 140 liters/person/day and the number of people in 1 household is 6 people, calculated 3% of their income. Then the ability to pay for clean water per m<sup>3</sup> can be seen in the following Table 4.

**Tabel 4.** The Estimation of Ability to Pay for Clean Water Per m<sup>3</sup>

Income (Rp.)	Ability to Pay Estimation / Month (Rp.)	The Clean Water Use (m <sup>3</sup> month)	Ability to Pay Estimation /m <sup>3</sup> (Rp.)
850.000,-	24.000	25,2	1.012
1.500.000,-	45.000	25,2	1.768
2.500.000,-	75.000	25,2	2.976
3.500.000,-	105.000	25,2	4.167
4.500.000,-	135.000	25,2	5.357
<b>Average</b>			3.060

#### 3. Analysis of Public Clean Water Quality

From the water used type by 5 Ulu residents, laboratory tests are conducted to determine whether the water source meets clean water standards or not. If they use standardized water, it can improve public health and also reduce the level of water-related diseases caused by unstandardized water consumption [10]. The water quality test results used by 5 Ulu residents, in accordance with the Indonesian Ministry of Health Rules No. 492 / MENKES / PER / IV / 2010 about Government Rules Limit of Drinking Water and No.32/2017 about Hygiene Sanitation Water. From the 3 types of samples tested, refill drinking water, Water Supply Company, and well/river water, it was found that the 3 specimens had met the physical and chemical requirements, but biologically, the eligible one is only refill drinking water. Where the content of each test object is as shown in Table 6 below.

**Table 5. Biological, Physical, and Chemical Test of Water Quality**

Parameter	Unit	Government Rules Limit *	Government Rules Limit **	River Water	Water Supply Company	Drinking Water
<b>Physical</b>						
Turbidity	NTU	25	5	-	0,54	1,92
Color	TCU	50	15	-	6	5
Taste		Tasteless	Tasteless	-	Normal	Normal
Odor		Odorless	Odorless	-	Negative	Negative
Temperature	°C	Air Temp ± 3	Air Temp ± 3	22,6	22,6	22,4
TDS	mg/l	1000	500	18,2	48	41
<b>Biological</b>						
Coliform	CFU/100ml	50	0	1000	50	0
<b>Chemical</b>						
pH	mg/l	6,5 - 8,5	6,5 - 8,5	7,14	6,42	4,74
Iron (Fe)	mg/l	1	0,3	0,36	0,03	<0,0035
Fluoride	mg/l	1,5	1,5	0,12	0,09	0,03
Total Hardness (CaCO <sub>3</sub> )	mg/l	500	500	-	144,9	102,9
Manganese	mg/l	0,5	0,4	0,04	0,01	<0,0030
Nitrat, as N	mg/l	10	50	7,8	6	1,2
Nitrit, as N	mg/l	1	3	0,041	0,003	0,006
Cyanide	mg/l	0,1	0,07	0,007	0,004	0,004
Cadmium	mg/l	0,005	0,003	<0,0025	<0,0015	<0,0015
Zinc	mg/l	15	3	0,02	0,01	0,01
Sulphate	mg/l	400	250	14	23	7
Lead (Pb)	mg/l	0,05	0,01	<0,0042	<0,0031	-

\* Indonesian Ministry of Health Rules No. 32 / 2017 about Government Rules Limit of Hygiene Sanitation Water

\*\* Indonesian Ministry of Health Rules No. 492 / MENKES / PER / IV / 2010 about Government Rules Limit of Drinking Water

While based on the quality fulfillment survey results taken from the total sample, it is found that the water use that does not meet the standards is still much as summarized in the following Table 7.

**Table 7. Fulfillment Tests of Water Quality Standards Based on Water Sources**

Water Quality	Total
Meet the standards River Water ( chemical processing), Refil Drinking water, Water Supply Company	43
Does not Meet the standards River Water	57

#### 4. Characteristics of Piped Water Supply in 5 Ulu Region

Piped clean water in this case Seberang Ulu 1 Water Supply Company unit which the raw water is sourced from the Ogan River has 1,555,200 m<sup>3</sup>/month production and for distribution capacity, the volume distributed to the Seberang Ulu 1 Area is around 311,040 m<sup>3</sup>/month with 20% loss rate and total service hours for 6 hours per day. However, based on the interviews results with the 5 Ulu residents, in some areas the water from the Water Supply Company does not come out at all and only comes out at certain times at night.

Most of the 5 Ulu Regions in 5 Ulu Darat have been connected to the Water Supply Company pipeline, and most of the people who have not been connected to Water Supply Company services are in the 5 Ulu Laut area, some of the causes are; locations are difficult to reach by Water Supply Company pipelines, the initial installation fee is Rp.

1,250,000,- while their houses locations still need to be added to the pipe connection, and the cost per meter is burdensome for them to subscribe. In quality, based on the laboratory tests, the Water Supply Company water production has a good quality to meet the needs of clean water for bathing and washing, but still need some additional treatments to be suitable for drinking water use.

From the description of the two types of clean water supply, both piping and non-piping. It can be seen that each type has advantages and disadvantages. Non-piped clean water is not sufficient to cover all water needs, and the price is expensive even though it is not paid directly in large quantities so that its use is limited to certain needs. While piped water has a quality to meet the clean water needs, but the 5 Ulu residents is constrained in the installation costs that felt quite expensive based on the survey results.

#### 4 CONCLUSION

In general, the analysis results above can be concluded as follows :

1. In clean water needs volume analysis of the community, some 5 Ulu residents that have been supplied by Water Supply Company have a clean water need level ranging from 140 - 160 liters/person/day. However, most of the 5 Ulu residents that have not been supplied by Water Supply Company have not been able to fully meet the need for clean water. So that the clean water needs amount that are met for 5 Ulu residents is still at a low access level.
2. For the distance and travel time to get clean water, 40% of the 5 Ulu residents traveled <100m or 5 minutes and 31% traveled 100-1000m for about 5-30 minutes to get clean water where this condition is still at a low access level [6].
3. 88% 5 Ulu residents spent over Rp.100.001,- / m<sup>3</sup> for clean water costs. It is 33 times more expensive than clean water average price from Water Supply Company per m<sup>3</sup>. This means the access level is still low.
4. 57% of 5 Ulu residents use unqualified clean water based on Ministry of Health rules No.492/IV/2010 and No.32/2017. It means that the access level is still low.

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