Jurnal Sains dan Kesehatan (J. Sains Kes.)

Journal homepage: https://jsk.farmasi.unmul.ac.id

Public Acceptance of Utilization of Water Reuse in Community-Based Sanitation Infrastructure (Case Study: Bandung City)

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Abstract

The difficulty of sustainable development is hampered by water scarcity and increased water demands, particularly in urban areas. Domestic wastewater discharges contaminate surface water bodies, such as the Citarum River. These difficulties, which disproportionately affect low-income populations, contribute to health consequences like diarrhoea and stunting. The Reinvented Toilet Project, a community-based sanitation programme, was put into place in Pasirluyu Village, Bandung, to combat water pollution. In order to lower water demand and sewage generation, it includes water reuse, reusing processed wastewater for other applications. This study assesses Pasirluyu Village infrastructure users' attitudes towards social water reuse. Surveys gathered data on demographics, views on water recycling, and information about sanitary facilities. Spearman correlation tests and descriptive analysis were carried out. The outcomes show that infrastructure users have a positive impression of water reuse. However, some people are hesitant to use reclaimed water for activities that require close personal touch. The relationship between public acceptability of water reuse for flushing toilets and acceptance for other purposes raises the possibility of a cascading expansion of water reuse practises.

Keywords: community-based infrastructure, households, water reuse, water reuse aceptance

Received: 14 June 2023 **Accepted**: 30 October 2023

DOI: https://doi.org/10.25026/jsk.v5i5.1869

How to Cite:

Lizmawan, F., Putri, D. W., Maryati, S., 2023. Public Acceptance of Utilization of Water Reuse in Community-Based Sanitation Infrastructure (Case Study: Bandung City). *J. Sains Kes.*, **5**(5). 829-836. **DOI**: https://doi.org/10.25026/jsk.v5i5.1869

1 Introduction

The achievement of sustainable development is impeded to a considerable extent by the issue of water scarcity and the escalating demands for water resources, particularly in urban regions. According to Kardono's [1] research, the predominant challenges encountered by urban communities residing in Java Island, Indonesia are primarily attributed to pollution and alterations in the function of water catchment areas. Based on Nahib [2] in Citarum Watreshed, between 2000-2010 and 2010-2020, the water supply decreased by 19.01×10^8 m^3 (18.28%) and 12.97×10^8 m^3 (15.27%) respectively.

Groundwater serves as a primary source of water for diverse applications in prominent urban centers of Indonesia, such as Bandung. The rise in population in Bandung has resulted in escalated exploitation of groundwater, leading to a decline in the quality and quantity of the resource. The augmented utilization of groundwater has led to a discernible outcome of land subsidience, as stated by Tirtomihardjo [3]. According to [4], the depletion of groundwater levels in the Bandung Basin has occurred as a result of urban expansion and changes in land use, with a reduction of over 50 meters being observed. The examination of groundwater samples in South Bandung District revealed an average pollution index of 11.42, indicating a heavily polluted category [5].

Surface water is an additional water source in Bandung. The Citarum River serves as a primary source of potable water for numerous cities situated along it's path, such as Bandung. According to [6], the river's status is classified as polluted based on its quality index score of 55. According to [7], domestic wastewater is a major contributor to the pollution of the Citarum River, accounting for 68% of the total pollution.

The deteriorating quality of clean water sources poses additional challenges for the community of Bandung. According to scholarly research, water pollution is a significant contributor to health problems in humans, such as bacterial, viral, and parasitic infections [8]. Diarrhoea is the most prevalent ailment resulting from water contamination, primarily disseminated by enteroviruses present in the aquatic environment [9]. Further research has revealed a correlation between WASH (Water, Sanitation and Hygiene) and the incidence of stunting in toddlers [10]. The impact of water pollution on health outcomes exhibited a greater magnitude among those who have lower income, as per the findings of a study [11].

The government and other stakeholders are implementing various programs to address the issue of water pollution in the City of Bandung. A program known as the Reinvented Toilet Project was implemented to revitalize a community-based communal MCK in Pasirluyu Village, Bandung. The program aimed to enhance waste management in the infrastructure by incorporating the concept of water reuse. The notion of water reuse, whereby wastewater is subjected to treatment for the objective of being repurposed as usable water, has been shown to promote sustainable development by mitigating water demand and reducing overall sewage production [12]. The practice of water reuse is gaining popularity as a feasible alternative for communities striving to fulfill their water requirements while mitigating the strain on freshwater resources.

The practice of water reuse is an effective means of resource conservation as it reduces the demand for freshwater resources and facilitates the utilization of treated wastewater for diverse applications, thereby reducing potential health concerns in the community.

The implementation of water reuse practices is a feasible approach to address the issue of water scarcity and promote sustainability within the framework of decentralized community-based sanitation infrastructure in urban areas. According to [13] research, the practice of water reuse is frequently impeded by a dearth of acceptance and a dismissive demeanor. Hence, it is imperative to conduct research pertaining to the societal acceptance of utilizing processed water and the factors that impact it.

2 Methods

This study was conducted at the site of the construction of a community-based water reuse sanitation infrastructure in Pasirluyu Village, Bandung. The data to be collected includes demographic data, sanitation facilities and infrastructure, and opinions regarding water reuse.

Demographic data collected through a survey utilizing a questionnaire. The data collection questionnaire for demographic information is designed in a format that includes both multiple-choice and fill-in-the-blank questions. The data analyzed using descriptive analysis.

Data pertaining to household sanitation facility ownership was collected through a survey utilizing a questionnaire. A questionnaire consisting of multiple-choice and fill-in-the-blank questions is utilized to gather data on the sanitation facilities and infrastructure. The data results analyzed using descriptive analysis.

The data pertaining to the opinions of infrastructure users regarding water reuse was collected through a survey utilizing a questionnaire. The questionnaire designed for data collection of stakeholder user opinions is comprised of multiple-choice questions and open-ended inquiries aimed at eliciting the reasoning behind their selected responses. The data analyzed using descriptive and correlational analysis by spearman.

The respondents for this data collection are to be collected from residents of RT 02 and RT 03 in Pasirluyu Village, Bandung. RT 02 and RT 03 respectively have populations of 75 households and 80 households. Not all members of the population utilize the infrastructure. The sampling technique employed was purposive sampling in order to gather data from individuals who are users of the infrastructure.In order to ensure that the respondents in this study are able to accurately depict the location's conditions in a representative manner, inclusion and exclusion criteria have been established for the selection of respondents.

The inclusion criteria for the respondents of this study are as follows:

1. Individuals who are above the age of 17 years old, or
2. Individuals who are already married (assuming that at this age, there is already a certain level of attitude and awareness towards environmental management in the surrounding area).
3. One respondent will be considered as representing one household.

The exclusion criteria for the participants of this study include:

1. The individual in question is above the age of 65. It is assumed that at that age, individuals may encounter difficulties in utilizing infrastructure, leading to a tendency to avoid its use.
2. The individual in question is not a resident of RT 02 and RT 03. On several occasions, there have been non-residents of RT 02 and RT 03 who utilize the infrastructure, such as individuals who visit the surrounding area due to the occurrence of a celebration or other community event.

3 Results and Discussions

According to the information that was obtained from the location of the study, the number of infrastructure users from RT 02 and RT 03 in Pasirluyu Village, Bandung is 50 households. This information was obtained based on the data that was collected from the study site. The facts regarding the demographics as well as the household sanitation facilities are shown in Table 1.

Table 1. Demographic Information of Infrastructure Users

Demographic Information	n	%
Sex		
Male	15	30
Female	35	70
Age		
17 - 25	4	8
26 - 35	9	18
36 - 45	12	24
46 - 55	17	34
56 - 65	8	16
Marital Status		
Single	4	8
Married	39	78
Widow	7	14
Education		
Not Finished Elementary School	2	4
Elementary School	17	34
Junior High School	9	18
Senior High School	21	42
Bachelor Degree	1	2
Monthly Income		
Less than 1 million (Rp)	15	30
1 - 2 million (Rp)	17	34
2 - 3 million (Rp)	13	26
3 - 4 million (Rp)	4	8
4 - 5 million (Rp)	1	2
Family Member		
1	2	4
2	9	18
3	16	32
4	12	24
5	10	20
6	2	4

Table 2. Sanitation Facility Information of Infrastructure Users

Sanitation Facility	n	%
Private Toilet Ownership		
Yes	46	92
No	4	8
Reason of No: Lack of Land	4	100
Water Supply Access		
Yes	49	98
No	1	2
Source of Water Supply		
Common Groundwater	29	58
Private Groundwater	19	38
Private Groundwater + Local Water Company	1	2
Bottled Water	1	2
Price of Water Supplied		
Expensive	8	16
Cheap	24	48
Very Cheap	18	36

The users of the infrastructure are predominantly female, aged between 36 to 55 years. Apart from using the toilet, the main activities carried out include washing clothes and kitchen utensils. The majority of respondents' highest level of education is high school graduation, and the total monthly income of most respondents' households is less than 1 million Rupiah with some earning around 1-2 million Rupiah The majority of respondents are housewives and self-employed/traders. The average number of family members among the respondents is 3-4 individuals, with some families having as many as 6 members. Based on the observation conducted, it is known that 2-3 families can reside in a single household. Given that the location is densely populated, it is reasonable that this phenomenon occurs due to the issue of limited land being a primary concern.

Based on the data presented in Table 2 obtained from the location, it can be observed that nearly all infrastructure users possess private sanitation facilities and have access to clean water. The sole reason for not having a private toilet is the lack of land. The primary source of clean water for the community in the area is dominated by groundwater derived from both common and private sources. There are families who, despite having access to private groundwater sources, opt to utilize the services of local water companies due to concerns regarding the insufficient quality of their groundwater. On the other hand, families without access to clean water sources fulfill their drinking water needs by purchasing bottled water, while their sanitation water needs are met through the use of infrastructure. The majority of the population considers the cost of clean water to be relatively inexpensive, when considering the overall expenses spent by the community.

Table 3 displays the public's opinions regarding infrastructure and the utilization of water reuse. According to the data gathered from infrastructure users, it has been observed that around 25% of users remain uninformed about the utilization of recycled water in infrastructure toilets. Merely a minor segment of the populace employs the infrastructure on a daily basis, while almost 20% of the population has utilized the infrastructure only once. According to the data pertaining to the utilization of recycled water, it has been observed that fifty percent of the individuals who have access to the infrastructure have not availed themselves of the recycled water that is intended for flushing purposes in the toilet. Overall, the utilization of processed water in this infrastructure is viewed positively by the majority of the community.

Table 3. Opinion of Infrastructure and Water Reuse

Opinion of Infrastructure and Water Reuse	n	%
Knowledge of the Use of Recycled Water In Infrastructure		
Yes	36	72
No	14	28
Intensity of Infrastructure Utilization		
Every Day	3	6
Often	16	32
Seldom	13	26
Once	18	36
Intensity of Recycled Water Utilization		
Every Day	1	2
Often	9	18
Seldom	8	16
Once	7	14
Never	25	50
Opinion About Utilization of Recycled Water		
Positive	31	62
Negative	15	30
Neutral	4	8

According to the findings depicted in Figure 1, a high level of willingness exists regarding the utilization of recycled water for pursuits that are not immediately associated with the performance of bodily functions. When there is more bodily contact between people, there is a lower level of approval for the usage of recycled water. This is the case regardless of the level of contact. In the end, it was discovered that the consumption of recycled water was met with the least amount of acceptance as a resource. This is similar with the findings of Brown and Davies' [14] study, which found that the community's readiness to accept water reuse was greatest for exterior applications, such as watering gardens and flushing toilets, and that this willingness decreased as the level of personal exposure increased.

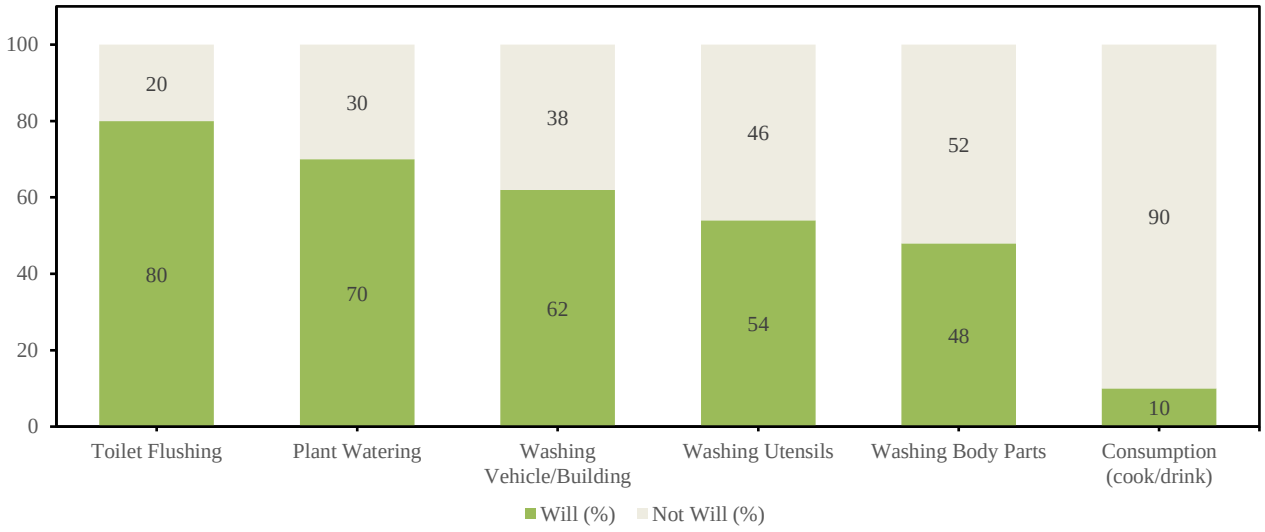

Figure 1 Acceptance of Reused Water Utilization

Table 4. Correlation of Water Reuse Acceptance and Demographic Information

Acceptance of Utilization		Age	Marital Status	Education	Monthly Income	Family Member
Toilet Flushing	Coef.	0,095	-0,078	-0,079	0,165	0,120
	Sig.	0,510	0,593	0,587	0,253	0,407
Plant Watering	Coef.	0,199	-0,170	-0,004	0,151	0,044
	Sig.	0,167	0,238	0,976	0,296	0,761
Washing Vehicle/Building	Coef.	0,184	-0,104	-0,069	0,166	0,264
	Sig.	0,200	0,472	0,636	0,251	0,064
Washing Utensils	Coef.	0,106	-0,074	0,017	0,194	0,278
	Sig.	0,464	0,609	0,906	0,176	0,050
Washing Body Parts	Coef.	0,053	-0,241	0,096	0,255	0,065
	Sig.	0,716	0,092	0,508	0,074	0,653
Consumption (cook/drink)	Coef.	-0,005	-0,081	0,079	0,104	0,176
	Sig.	0,975	0,575	0,587	0,473	0,222

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed).

The findings from the field interview process indicate that individuals who declined to engage in a particular form of usage took into thought technical considerations pertaining to their familial conditions when formulating their responses. In the context of water utilization for flushing, there arises a concern as to whether individuals would be required to procure recycled water from the processing source to their respective houses. Similarly, the employment of reclaimed water for plant watering is met with partial reluctance on the part of some individuals who perceive the absence of plants that require watering. Furthermore, the use of recycled water for vehicle washing is met with resistance from certain members of society who assert an absence of vehicles necessitating such action..

In order to gain a deeper understanding of the reasons behind the acceptance of recycled water usage among the community in the study location, a correlation test was conducted between the level of community acceptance and the demographic data. Table 4 demonstrates that there is a connection between demographic data and the acceptance of reusing water, but that this connection is statistically insignificant and continuously weak. This connection has been found to exist on multiple occasions. The fact that there is no statistically significant correlation between the two variables makes this abundantly evident. This finding is not consistent with the findings of a number of previous studies that tested the hypothesis that there is a connection between the acceptability of recycled water and age [15], [16], educational level [15], [17], and income [18], [19]. The context in which the concept of water reuse is used, namely within the ambit of community-based sanitation infrastructure, is the aspect of earlier research that stands out as the most significant difference between that research and this new study. This is the most important distinction that can be made between the two. This distinction is essential because it plays a role in the contextual framework that decides how the idea of water reuse is implemented in different situations.

Based on the fact that communities included technical considerations of their respective family conditions in answering questions about their acceptance of the type of recycled water use, another correlation test was performed to better understand the current reception of communities to the use of recycled water at the study site. The use of recycled water in infrastructure for flushing operations, in accordance with one of the forms of acceptance investigated. In this situation, data on recycled water utilization at the site can be employed as a baseline for community acceptance of the use in the form of toilet flushing. It will also remove technical issues from respondents' family situations, allowing the core of public opinion to be acquired.

The use of recycled water for toilet flushing can help assist the beginning of community acceptance of the utilization of recycled water for a variety of activities. This can be an important step in the process. The use of recycled water for flushing purposes in the communal MCK infrastructure located in Pasirluyu Village could be a good starting point for this procedure. The information shown in Table 5 demonstrates that there is a significant correlation between the intensity of the utilization of recycled water in infrastructure and the overall intensity of the utilization of infrastructure, which extends beyond the utilization of toilets.

Table 5. Correlation of Water Reuse Acceptance and Sanitation Facility

Factors		Knowledge of the Use of Recycled Water In Infrastructure	Intensity of Infrastructure Utilization	Intensity of Recycled Water Utilization
Knowledge of the Use of Recycled Water In Infrastructure	Coef.	1,000		
	Sig.			
Intensity of Infrastructure Utilization	Coef.	-0,234	1,000	
	Sig.	0,102		
Intensity of Recycled Water Utilization	Coef.	-0,266	.535**	1,000
	Sig.	0,062	0,000	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 6. Correlation Between Water Reuse Acceptance Type and Utilization

Acceptance of Utilization		Toilet Flushing	Plant Watering	Washing Vehicle/ Building	Washing Utensils	Washing Body Parts	Consumption (cook/drink)
Toilet Flushing	Coef.	1,000					
	Sig.						
Plant Watering	Coef.	.612**	1,000				
	Sig.	0,000					
Washing Vehicle/Building	Coef.	.480**	.458**	1,000			
	Sig.	0,000	0,001				
Washing Utensils	Coef.	.764**	.802**	.454**	1,000		
	Sig.	0,000	0,000	0,001			
Washing Body Parts	Coef.	.500**	.490**	.560**	.393**	1,000	
	Sig.	0,000	0,000	0,000	0,005		
Consumption (cook/drink)	Coef.	0,167	0,272	0,214	0,218	.333*	1,000
	Sig.	0,247	0,056	0,137	0,128	0,018	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

According to the information presented in Table 6, it is common knowledge that the willingness of the general public to use recycled water for plant watering, washing vehicle/building, washing utensils, and washing body parts has a substantial relationship with the acceptance of the community in the use of recycled water for flushing. Although the public's acceptance of using recycled water for toilet flushing does not significantly and directly affect the public's acceptance of drinking recycled water, it is clear that the public's acceptance of the various types of recycled water uses correlates significantly and simultaneously with one another. This is the case even though the public's acceptance of using recycled water for toilet flushing does not significantly and directly affect the public's acceptance of drinking recycled water. The same correlation of this domino effect enables the community to gradually accept the many forms of uses of recycled water, beginning with activities that are external applications and working their way up to personal exposure. According to the findings of [14] study, the public's acceptance of the use of recycled water for personal exposure is still relatively low at the present time. However, with this data, it can be analyzed that the acceptance by the public of the usage of recycleable water for flushing can open the public's acceptance to use the water for other activities, even up to consumption activities. It is essential to have an understanding that the participation of a community in using of infrastructure can lead to a gradual increase in the acceptance of the utilization of recycled water in the future.

4 Conclusions

There is a high level of acceptance among respondents to make use of recycled water for activities that are not directly related with bodily functions. Nevertheless, increased physical contact is associated with reduced acceptance of recycled water usage. While the acceptance of recycled water for toilet flushing by the general public may not have a direct impact on the acceptance of consumption of recycled water for drinking purposes, there exists a significant correlation between the different applications of recycled water. The phenomenon of a domino effect facilitates the gradual acceptance of various recycled water applications by the community, beginning with external applications and progressing to personal exposure.

The use of recycled water for toilet flushing can help initiate community acceptance of using recycled water for various activities. The intensity of recycling water usage in infrastructure is significant to the intensity of infrastructure as a whole, and community participation in infrastructure usage can lead to a gradual increase in the acceptance of recycled water usage in the future.

5 Declaration

5.1 Authors Contributions

The names of the authors listed in this journal contributed to this research.

5.2 Funding

This research was not supported by any funding sources.

5.3 Conflict of Interest

The authors declare no conflict of interest

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