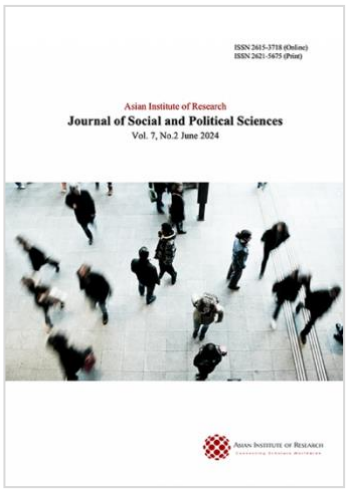

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Social Perception and Support of a Public Sanitation Service in Bandung: Community Insights and Engagement Strategies

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Abstract
This paper presents findings and recommendations to improve wastewater treatment service policy outreach and infrastructure development strategies, aiming to garner better public support and prevent social rejection. Focusing on Bandung City's municipal wastewater management, the study surveyed 400 households to assess community perceptions regarding the expansion of wastewater services and the construction of Fecal Sludge Treatment Plants (FSTPs) by 2032, as outlined in the 2011 Wastewater Management Masterplan. The survey, conducted through face-to-face interviews with household decision-makers, employed a structured questionnaire. Significant correlations were found between various factors and public perceptions of the wastewater treatment service in Bandung City, with positive perception strongly linked to infrastructure support. The study highlights the importance of targeted educational efforts to enhance positive perceptions and support for wastewater treatment infrastructure, emphasizing maintenance awareness and engagement. Additionally, door-to-door socialization emerges as the preferred engagement method, highlighting the necessity for tailored approaches to enhance community involvement in wastewater management.

Keywords: Public Service, Local Support, Sanitation, Engagement Strategy, Correlation Analysis

1. Introduction

Safe water supply and sanitation are crucial for sustaining human life, as they play a vital role in preserving public health and well-being. Properly managed disposal of human wastewater prevents the spread of infectious diseases (Cairncross et al., 2010), averts stunted growth in children (Torlesse et al., 2016), maintains water resource quality, and protects communities from the severe impact of waterborne illnesses (Ferreira et al., 2021). Additionally, inadequate sanitation infrastructure places a significant burden on healthcare systems, which could otherwise address other critical health issues (Ferreira et al., 2021). Safe water access and sanitation are stated in the sixth indicator of the UN's SDGs (Sustainable Development Goals) which is also used by Indonesia's Ministry of National Development Planning/National Development Planning Agency (BAPPENAS) as a benchmark for the country's sustainable development. In the SDGs —more specifically sub-goal 6.3— the ministry targets safe disposal of wastewater should be increased by half in 2030 (BAPPENAS, 2023).

The Indonesian government regards decentralized wastewater treatment systems (DEWATS) as a promising solution to its wastewater disposal challenges. This commitment is demonstrated through initiatives by the central government to assist local authorities in planning and implementing public sanitation services. However, public acceptance and adoption remain hindered by social stigma. For instance, in Bantul Regency, Yogyakarta, locals rejected a 40 billion Indonesian Rupiah plan to build a Fecal Sludge Treatment Plant (FSTP), citing concerns about environmental damage, such as unpleasant odors and water pollution (Yohanes, D., 2023, September 19). Socio-economic issues were also raised, with doubts about local employment opportunities. Similarly, in Tulungagung Regency, Central Java, a DEWATS installation operated for only five years before ceasing services due to similar public concerns (Setyawan, E., 2024). This resistance has led to significant financial losses and continued rejection of renovation or revival efforts.

Despite its history of rejection, this type of public sanitation system is still planned to be implemented in other cities. One location being Bandung City. Bandung's local government with their wastewater management expansion plans. The success of the Bandung public service plan is dependent on the residents' adoption of policies (Bruch & Atwell, 2015; Xu et al., 2023). The public has the right to choose whether to engage and participate in the service or reject its implementation. Therefore, it is crucial that residents in the targeted area maintain a positive perception of the system and their roles, which will influence their adoption decisions. Conversely, social stigma will lead to low acceptance and adoption (Bruch & Atwell, 2015; Ligtenberg & Bregt, 2014). Thus, it is crucial to understand the current state of public perception to garner public compliance and support for the sanitation policy. This study aims to bridge the analysis of public perception with several factors and characteristics of the targeted service area. To understand which factors may have a correlation with positive perception and support for the sanitation service.

Msaki et al. (2022) uncovered significant differences in the knowledge, attitudes, and perception of treated wastewater were observed across different demographic variables such as age, sex, and education level. Sintondji (2017) and Mosimane & Kamwi (2020) both found that low education levels were associated with poor sanitation practices and limited access to sanitation facilities. This suggests that education plays a significant role in compliance with wastewater sanitation services. Additionally, Mosimane & Kamwi (2020) identified a significant difference in access to sanitation and water services based on education and income levels. (Robinson et al. (2005) also noted that lower income and education levels were associated with less knowledge about wastewater reuse, which could impact compliance with related sanitation services.

A range of factors influence sanitation service compliance, with home ownership and residential status playing a significant role. In India, non-economic factors such as gender, age, education, occupation, religion, and caste, as well as access to water supply and dwelling materials, have a greater impact on latrine use than income (De, 2018). In rural India, the amount of dwelling space owned by households is associated with latrine ownership, and there is significant variation in ownership at the village and state levels (Jain et al., 2019).

Research on public perception of sanitation regulation and services reveals a complex interplay of factors. Friedler & Lahav, 2006; Kandiah et al. (2017) found that public support for wastewater technology is influenced by the perceived benefits and risks. Similarly, Poortvliet et al. (2018) identified pro-environmental personal norms and risk and benefit perceptions as key drivers of acceptance of new sanitation systems. Garnett & Cooper (2014) found that effective dialogue between government and public is crucial for resolving controversial waste management issues and fostering progress through changes in individuals and communities thus facilitating the support for waste sanitation policies.

This study offers a novel exploration into the factors influencing household acceptance of the sanitation service of DEWATS in Bandung City, providing a comprehensive analysis of community perceptions ahead of significant infrastructure developments outlined in the 2011 Wastewater Management Masterplan (Setiyawan et al., 2021). Employing a quantitative approach, the study uses Pearson's correlation analysis to investigate relationships among various demographic factors (including position within the family, age, gender, employment, education, and income), residency status (home ownership and duration of residency), familiarity with decentralized

wastewater services (including septic tank maintenance history), and general perceptions of DEWATS. Additionally, it examines preferences for outreach programs to identify effective social outreach strategies. This multifaceted analysis not only addresses the practical implications of wastewater management but also contributes to the broader understanding of community engagement and acceptance in environmental infrastructure projects.

2. Methods

The methodology employed in this research involves primary data collection through the distribution of door-to-door direct questionnaires in the study area, followed by comprehensive statistical analysis. The detailed steps of the study process are elaborated below.

2.1. Data Collection

2.1.1. Study Area

To ensure the proper management of municipal wastewater, especially fecal waste management, Bandung City conducted studies and developed a Wastewater Management Masterplan in 2011 The plans showed several areas which will be the focus of wastewater service expansion plans in the time span of 2011 to 2032. The east districts of Bandung City areas to be the focus of on-site and off-site communal wastewater treatment development with plans of building a Fecal Sludge Treatment Plant (FSTP) in each area (Setiyawan et al., 2021). The plan for new infrastructure creates an urgency to understand and see the perception of the local community in anticipation of rejection and to promote adoption.

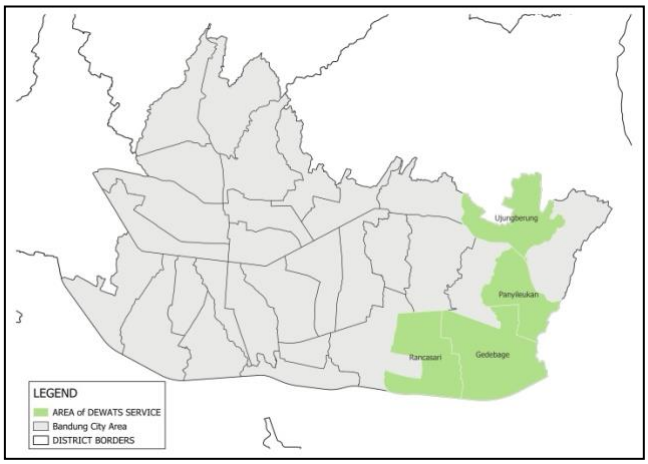

Figure 1: Study Area - Districts in East Bandung

2.1.2. Sample Population

The survey respondents are representatives from each household (Heads of Families). The family representative selected as a respondent is the mother/matriarch of the household. The number of respondents is determined to represent the population of 67,467 households in Gedebage District, Panyileukan District, and Rancasari District. By using the Slovin sampling method, a total of 400 households from the selected sites were involved in the study.

2.2. Survey Process

Quantitative data collection methods were used to obtain primary data. A questionnaire, with structured and semi-structured questions, was the main instrument, which involved face-to-face interviews with one respondent from each of the selected households. Interviews were conducted in February 2024 with the assistance of a trained research assistant who was a local resident of the site being surveyed. The decision makers of the households were chosen as respondents, this meant that it could either be father or mother or any other elder of the family. Although,

in some cases, the decision maker was the adult children of the household. The questionnaire was designed in English and translated into Indonesian, which is the language spoken and understood by the respondents.

Prior to administering the questionnaire to the respondent, a short definition and elaboration on wastewater, wastewater recycling, reuse, and treatment technologies were given and can be seen in Figure 2. The questionnaire was also divided in parts for conciseness as follows:

1. Demographical data of the respondents including position of the respondent in family, age, gender, employment, education, and income.
2. Data concerning residency status was also asked, which included the ownership status of the house, the duration of residency.
3. The history and familiarity of the participants with the decentralized wastewater management service was asked which included their experience in emptying the septic tanks.
4. Their general perception of DEWATS was asked through several questions that represented negative and positive perception.
5. The preferences of outreach program methods were asked for gaining insight into future promising social communication strategies.

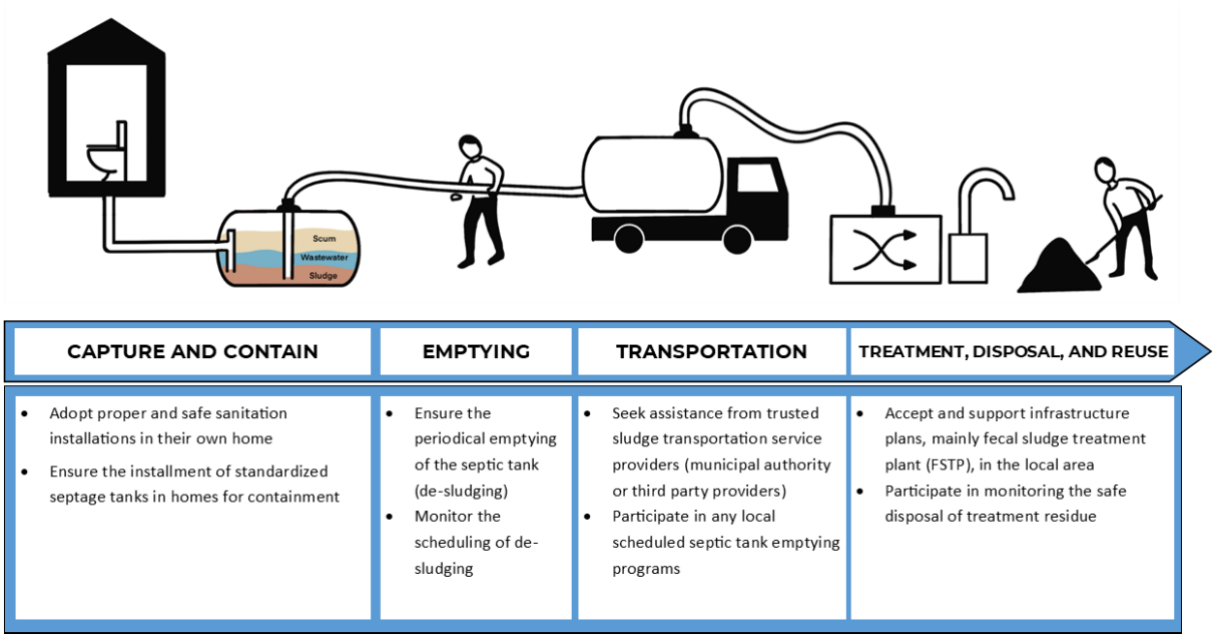

Figure 2: Information given on the public role in the sanitation service

2.3. Variables and sub-variables

The following table outlines various factors influencing household sanitation practices and perceptions. These factors are categorized into demographic, residential, familiarity and history, and perception and support variables. Each variable is defined clearly, with corresponding sub-variables providing further granularity. Sources cited for each definition provide empirical backing and context for the variables. This structured overview aids in understanding the complex dynamics at play in household decision-making and attitudes toward sanitation services.

Table 1: Variables and Sub-variables collected.

Variable	Sub-Variable	Definition	Source
Demographic Factor	Decision Makers of the family	Individuals in the household responsible for making decisions regarding sanitation.	(Msaki et al., 2022)

Variable	Sub-Variable	Definition	Source
	Education Level	The highest degree or level of school completed by members of the household.	(Msaki et al., 2022)
	Income Bracket	The total earnings or income bracket of the household.	(Msaki et al., 2022)
Residential Factor	Home Ownership	Whether the household owns or rents their home.	(De, 2018; Jain et al., 2019)
	Residential Duration	The length of time the household has lived at their current residence.	(De, 2018; Jain et al., 2019)
Familiarity and History	Familiarity with the sanitation service	How well the household knows and understands the local wastewater sanitation services.	(Gómez-Román et al., 2020)
	Septic tank ownership	Whether the household owns a septic tank.	(Velazquez et al., 2015)
	Septic Tank Maintenance History	The record of past maintenance (emptying) activities for the household's septic tank.	(Velazquez et al., 2015)
Perception and Support	Positive perception	Positive perception of wastewater sanitation service	(Friedler & Lahav, 2006; Kandiah et al., 2017)
	Negative Perception	Positive perception of wastewater sanitation service	(Friedler & Lahav, 2006; Kandiah et al., 2017)
	Support for Treatment Infrastructure	Agreement to support of wastewater sanitation service	(Setiyawan et al., 2021)

2.4. Data Analysis

The collected data were catalogued into Microsoft Excel and imported to the R software for analysis. Descriptive statistics were used to compute frequencies and percentages of respondents' demographic characteristics. Pearson's correlation coefficient was used in this study to measure the strength and direction of a linear relationship between a respondent's knowledge of wastewater and reuse option by age and educational level. The correlation coefficient is represented by r. Pearson correlation analysis was chosen as it provided means to evaluate the strength and direction of the linear relationship between two continuous variables. It is considered the most effective method for assessing associations due to its reliance on covariance. This coefficient not only reveals the magnitude of the correlation but also its direction. All statistical tests were considered significant at a confidence level of 95% (P,0.05).

3. Results

This section provides a comprehensive analysis of the data collected from the respondents. This begins with an overview of the demographic characteristics of the participants, detailing aspects such as age, gender, education level, and socioeconomic status to contextualize the sample population. Following this, a descriptive analysis of public preference is presented, highlighting key trends and patterns in the data. Lastly, the section delves into a correlation analysis, examining the relationships between various demographic factors and public preferences to uncover significant associations and potential influences.

3.1. Demographic characteristics of respondents

The provided dataset contains information about participants sampled from different neighborhoods within specific districts. Each row corresponds to a neighborhood within a district, detailing the number of participants sampled and the proportion of the sample relative to the total surveyed population in that district.

In the district of Rancasari, several neighborhoods were surveyed. The neighborhood of Cipamokolan had 34 participants, accounting for 9% of the total sample from Rancasari. Derwati and Manjahlega had 33 and 39 participants, respectively, making up 8% and 10% of the sample from Rancasari. Mekarmulya had 23 participants, representing 6% of the sampled population in Rancasari. In Ujung Berung district, several neighborhoods were also included in the survey. Pasir Endah had 21 participants (5%), Cigending had 38 (10%), Pasirwangi had 25 (6%), Pasirjati had 26 (7%), and Pasanggrahan had 28 participants (7%) sampled from Ujung Berung. In the Gedebage district, neighborhoods such as Cisantren Kidul had 34 participants (9%), Rancabolang had 21 (5%), Rancanumpang had 8 (2%), and Cimenerang had 7 participants (2%). Lastly, the district of Panyileukan surveyed participants from Cipadung Kulon (25 participants, 6%), Cipadung Kidul (20 participants, 5%), Cipadung Wetan (6 participants, 2%), and Mekar Mulya (12 participants, 3%).

This dataset provides a structured overview of participant sampling across various neighborhoods within the four districts of the study area, offering insights into the distribution and representation of surveyed individuals within specific geographical areas.

Table 2: Sample Proportion of Each District

District	Neighborhood	Participants	Sample Portion
RANCASARI	CIPAMOKOLAN	34	9%
RANCASARI	DERWATI	33	8%
RANCASARI	MANJAHLEGA	39	10%
RANCASARI	MEKARMULYA	23	6%
UJUNG BERUNG	PASIR ENDAH	21	5%
UJUNG BERUNG	CIGENDING	38	10%
UJUNG BERUNG	PASIRWANGI	25	6%
UJUNG BERUNG	PASIRJATI	26	7%
UJUNG BERUNG	PASANGGRAHAN	28	7%
GEDEBAGE	CIMENERANG	7	2%
GEDEBAGE	CISANTREN KIDUL	34	9%
GEDEBAGE	RANCABOLANG	21	5%
GEDEBAGE	RANCANUMPANG	8	2%
PANYILEUKAN	CIPADUNG KULON	25	6%
PANYILEUKAN	CIPADUNG KIDUL	20	5%
PANYILEUKAN	CIPADUNG WETAN	6	2%
PANYILEUKAN	MEKAR MULYA	12	3%

Figure 3 presents a breakdown of respondents' occupational statuses in the survey. Most participants, accounting for 56%, identified as housewives, making this the largest single group. Manual laborers constitute the second-largest group at 17%, followed by private sector employees at 13%. Business owners and entrepreneurs make up 7% of the respondents. Those who are currently unemployed or not yet employed represent 3% of the sample. Freelance workers, including digital content creators, account for 2%, while retirees, individuals in the "others" category, and online transportation partners/drivers each constitute 1% of the respondents. Notably, there are no student or university student respondents, as this category is represented by 0%. This distribution highlights the diverse occupational backgrounds of the survey participants, with a significant representation of non-working individuals and manual laborers.

The respondents had an average age of 42 years old. The educational distribution within the surveyed population reveals a predominant presence of individuals with a high school education (SMA), constituting the majority at 57%. This is followed by respondents who completed junior high school (SMP) at 30%, while primary school

graduates (SD) comprise a smaller yet notable portion at 13%. Notably, only a minimal percentage of participants hold a bachelor's degree (S1), representing just 1% of the sample. Surprisingly, no respondents reported having education beyond the undergraduate level (Higher Education). This breakdown underscores the prevalence of high school education among the surveyed group, suggesting potential implications for educational completion levels and their impact on various aspects of the population's perspectives and experiences.

The income distribution among respondents highlights a significant majority falling within the middle-income bracket, with 67% reporting monthly earnings between Rp 2.500.000 and Rp 4.999.999. Additionally, 12% of participants reported earning between Rp 5.000.000 and Rp 9.999.999 per month. Surprisingly, none of the respondents reported an income below Rp 2.500.000. This distribution suggests a concentration of respondents within the middle-income range, possibly reflecting broader economic trends and the financial circumstances of the surveyed population.

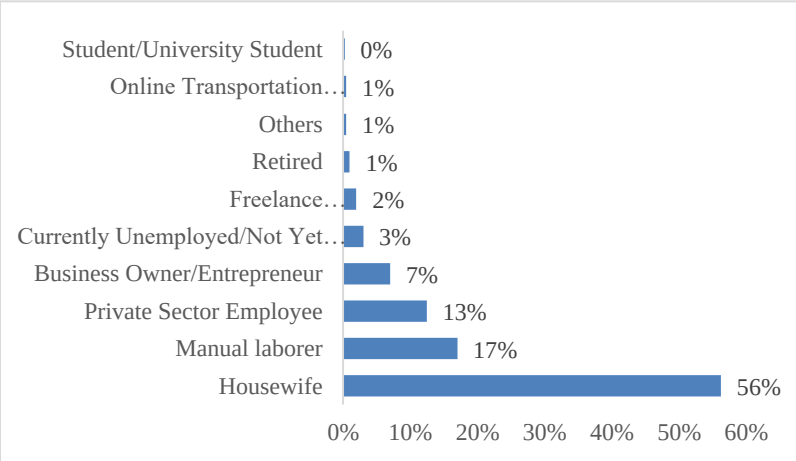

Figure 3: Occupation of respondents.

3.2. Correlation Analysis Results

To analyze the correlation between demographic factors and perception, we examined how various demographic variables relate to individuals' perceptions. Our study focused on understanding the interrelationships between demographic characteristics such as age, gender, education level, income, and occupation, and individuals' perceptions regarding the sanitation service. By collecting and analyzing survey data from a diverse sample population, we were able to quantify these relationships using Pearson’s correlation analysis.

3.2.1. Demographic factors and correlation with perception

The correlation analysis reveals the relationships between Positive and Negative Perception of Familial Position, Age, Education Level, and Income Level. Familial Position shows a very weak positive correlation with Positive Perception (< 0.1), suggesting a slight association with higher positive perceptions, and a weak negative correlation with Negative Perception (< 0.1), indicating a slight association with lower negative perceptions. Age has almost no correlation with Positive Perception (-0.0072) but shows a weak negative correlation with Negative Perception (-0.1510), suggesting that younger age slightly relates to lower negative perceptions. Education Level has a very weak positive correlation with Positive Perception (0.0509) and a very weak negative correlation with Negative Perception (-0.0533), indicating minimal correlation in both cases. Lastly, Income Level has a weak positive correlation with Positive Perception (0.1608), suggesting that higher income levels modestly relate to higher positive perceptions, and a weak negative correlation with Negative Perception (-0.1089), indicating a slight association with lower negative perceptions. Overall, demographic factors exhibit generally weak relationships with positive and negative perceptions.

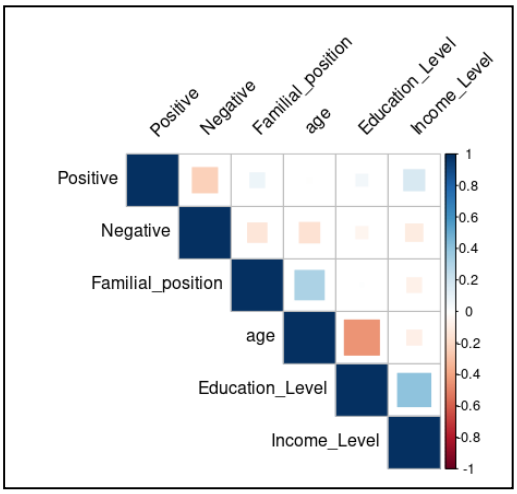

Figure 4: Correlation analysis result between demographic factors and perception

3.2.2. Correlation between residential factors and perception

The majority of participants (74%) own their homes outright (Self ownership), representing 294 individuals. A very small percentage (1%) have the right to utilize or lend the property (Hak Guna), consisting of only 2 individuals. The remaining participants (26%) are renters, totaling 104 individuals. Participants with a residential duration of more than 20 years constitute the largest proportion (56%), with 223 individuals falling into this category. Those with a duration of 0-5 years represent 18% of participants (70 individuals). The categories of 5-10 years and 10-20 years each account for 14% (56 and 51 individuals, respectively) of the surveyed population. These distributions provide a clear snapshot of the home ownership statuses and residential durations among the participants, highlighting variations in housing arrangements and tenure lengths within the surveyed group. Understanding these patterns can offer valuable insights into housing dynamics and demographic characteristics that may influence perceptions and experiences related to the sanitation service.

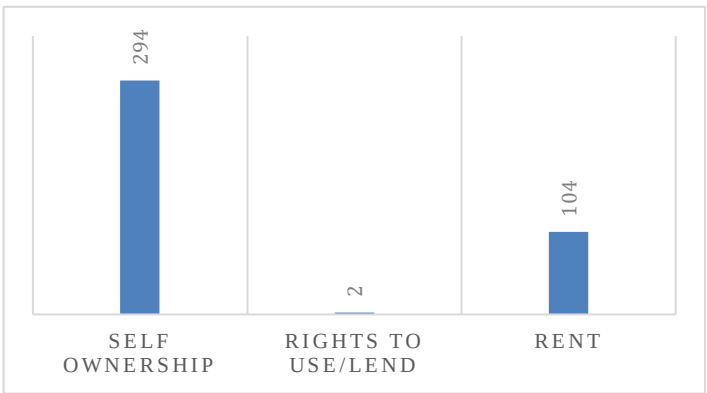

Figure 5: Resident's house ownership status

The results from the analysis of correlations between variables reveal interesting insights into the relationships within the dataset. Regarding housing-related variables, there is a positive correlation (0.2057) between positive perceptions and home ownership status, suggesting a potential association between positive outlooks and owning one's home. However, negative perceptions show a negative correlation (-0.1829) with home ownership status, which shows the probability of internally conflicting opinions of the respondents. Furthermore, the analysis reveals a strong positive correlation (0.7297) between home ownership status and residential duration, implying that the homeowners have been living in that area for a long time, by indication of their residential durations. Consequently, residential duration shows a positive correlation (0.2046) with positive perceptions, suggesting a potential link between longer residential stays and positive outlooks

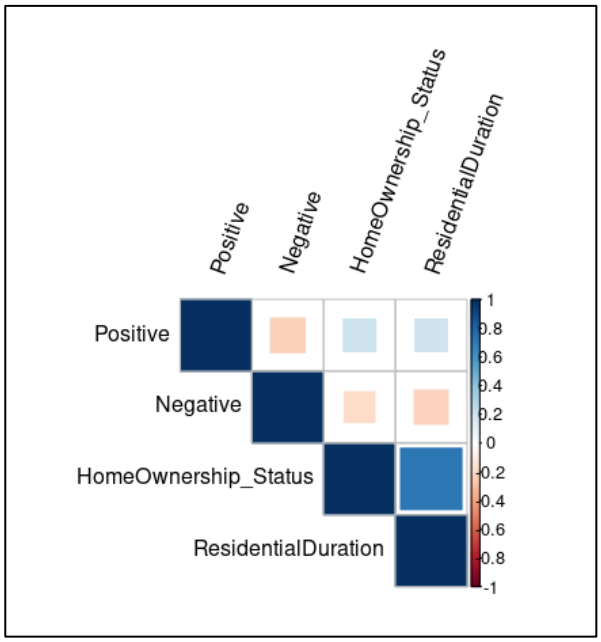

Figure 6: Correlation results between residential factors and perception level

The p-value associated with the correlation between positive perceptions and home ownership status is 3.38e-05, indicating a statistically significant positive relationship. This suggests that there is likely a meaningful association between positive perceptions and the ownership of one's home. Similarly, the correlation between negative perceptions and home ownership status exhibits a low p-value of 2.36e-04, indicating statistical significance. This implies that negative perceptions may be linked to certain aspects of home ownership. Moreover, the p-value of the correlation between home ownership status and residential duration is remarkably low (1.05e-67), confirming an extremely strong and significant positive relationship for the case of this study area. Overall, these low p-values across the correlations underscore the statistical significance of the observed relationships between perceptions, home ownership status, and residential duration within the dataset.

3.2.3. Correlation between wastewater treatment familiarity and history with perception

The survey results provide valuable insights into the participant's experience with the sanitation service and their perceptions. In terms of septic tank ownership, most respondents (61%) reported owning individual septic tanks, reflecting a preference for private sanitation solutions. This group comprised 243 individuals. Additionally, 23% of respondents (92 individuals) indicated using communal sanitation facilities, suggesting a reliance on shared resources for sanitation needs. However, a notable portion (16%) expressed uncertainty about their septic tank ownership status, with 65 individuals indicating they were unsure.

When examining maintenance history related to septic tanks, the survey found that a large majority (76% or 304 individuals) reported never conducting maintenance on their septic tanks. This finding raises concerns about potential neglect and the long-term sustainability of sanitation infrastructure. Additionally, smaller proportions of respondents reported maintenance intervals exceeding 5 years (7% or 28 individuals) and intervals of 2 to 5 years (10% or 39 individuals). A further 7% (29 individuals) reported maintaining their septic tanks within intervals of less than 2 years, reflecting varying levels of adherence to recommended maintenance schedules. These findings underscore the importance of promoting regular maintenance practices to ensure the effective and sustainable operation of sanitation systems within communities.

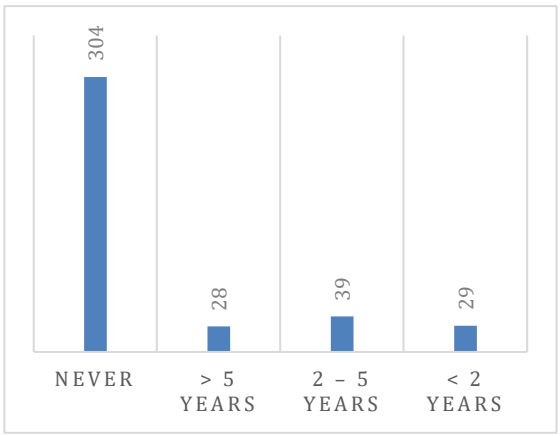

Figure 7: Maintenance history of septic tanks

The analysis shows a positive correlation (0.2378) between positive perceptions and the frequency of maintenance, indicating that individuals with more positive outlooks may be more inclined to adhere to recommended maintenance schedules for septic tanks. Conversely, there is a strong negative correlation (-0.3914) between negative perceptions and the frequency of maintenance, suggesting that individuals with more negative feelings may be less likely to engage in regular septic tank maintenance practices. Furthermore, the analysis reveals a moderate positive correlation (0.2817) between positive perceptions and septic tank ownership, implying that individuals with positive outlooks may be more likely to own their own septic tanks, although this correlation is relatively weak. There is a strong positive correlation (0.3920) between familiarity with sanitation services and positive perceptions, indicating that individuals who are more familiar with sanitation services tend to report more positive emotions. Similarly, there is a moderate positive correlation (0.4639) between familiarity with sanitation services and the frequency of maintenance, suggesting that individuals with greater familiarity may be more proactive in maintaining their septic tanks.

The analysis shows significant relationships, including a very low p-value (1.50e-06) between maintenance frequency and positive perceptions, indicating significance of correlation. Similarly, there are significant negative correlations between negative perceptions and both maintenance frequency (4.28e-16) and septic tank ownership (6.19e-16), suggesting that individuals with more negative feelings may be less likely to maintain their septic tanks regularly or own their own septic tanks. Furthermore, the analysis reveals statistically significant correlations between familiarity with sanitation services and both negative perceptions (9.13e-06) and maintenance frequency (3.85e-16).

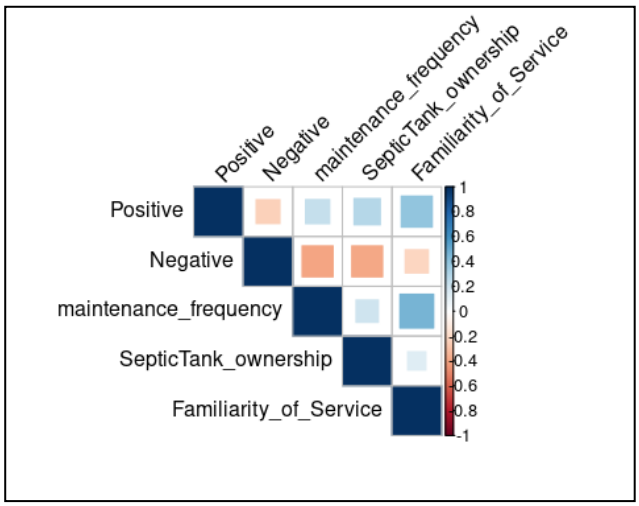

Figure 8: Correlation analysis results between wastewater treatment familiarity and history with perception

3.2.4. Correlation between Positive and Negative Perception and Support for Infrastructure

The analysis of perceptions and support ratings reveals notable trends in the data. On average, Positive Perception scores significantly higher at 4.18 compared to Negative Perception at 3.34, indicating a generally positive outlook. The Support rating, with an average score of 3.92, suggests a moderate level of backing or agreement among respondents. This distribution highlights a consistent pattern where positive perceptions tend to outweigh negative ones, while overall support levels are slightly higher than the midpoint, reflecting a generally favorable perception toward the subject of study.

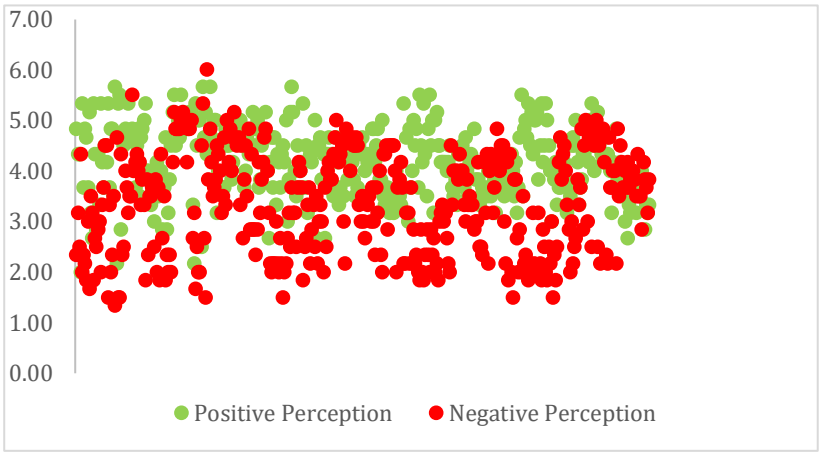

Figure 9: Positive and negative perception distribution

The correlation analysis reveals several key insights among the variables examined. There is a moderate negative correlation of -0.2308 between "Negative" and "Positive", suggesting that as one variable increases, the other tends to decrease to a certain extent which generally show no internally conflicting opinions. The relationship between "Support" and "Positive" is notably positive with a correlation coefficient of 0.5337, indicating a moderate positive relationship between these variables. Conversely, the correlation between "Support" and "Negative" is negative at -0.1574, albeit weaker than other correlations observed. These findings highlight the nuanced associations and dynamics among these variables, emphasizing the complexity of their interrelationships in the context of the analysis.

According to the p-values, the relationship between Positive and Negative perceptions has a p-value of 3.08e-06, which is extremely small and well below the common significance level of 0.05. This suggests that the inverse relationship between Positive and Negative perceptions is statistically significant, meaning it is unlikely to have occurred by chance. Second, the p-value for the relationship between Negative perception and Support is 0.00637, below 0.05, indicating that the inverse relationship between Negative perception and Support is statistically significant, and it is unlikely to be due to random variation.

Lastly, the relationship between Positive perception and Support has a p-value of 7.75e-31, an extraordinarily small value, signifying an exceptionally strong statistical significance. This implies that the positive relationship between Positive perception and Support is almost certainly not due to chance. In summary, the analysis shows that the inverse relationship between Positive and Negative perceptions, the inverse relationship between Negative perception and Support, and the positive relationship between Positive perception and Support are all statistically significant.

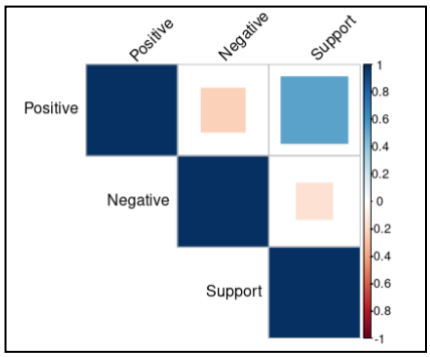

Figure 10: Correlation of public perception with support for infrastructure

3.2.5. Outreach Method Preferences

The analysis of public outreach methods based on their associated codes and preference points highlights interesting patterns in respondent preferences. Among the methods surveyed, door-to-door socialization emerges as the most preferred with a high score of 2139 preference points, indicating strong support for this direct engagement approach. Following closely behind are public socialization and focus group discussions with 2016 and 1709 preference points, respectively, suggesting a favorable reception for these interactive methods. Field trips to existing systems also garnered notable support with 1683 preference points, indicating interest in practical, hands-on experiences. In contrast, methods like exhibition, door-to-door distribution of pamphlets and printed media, and online media and social media received lower preference points, suggesting less enthusiasm for these outreach strategies among respondents.

4. Discussion and Conclusions

Utilizing Pearson's correlation analysis, several key points can be examined to understand the relationship between familiarity with wastewater treatment and individual perceptions. This analysis allows us to quantify the strength and direction of the associations between variables such as awareness of wastewater treatment processes, personal history with these systems, and various demographic factors including age, education, occupation, home ownership, residential duration, and income. By exploring these correlations, we can identify significant patterns that reveal how familiarity and past experiences with wastewater treatment influence perceptions, which can provide valuable insights for improving public engagement and policymaking in environmental management.

4.1. Factors with significant correlation to the formation of Public Perception of DEWATS

Understanding the public perception of decentralized wastewater treatment systems (DEWATS) is critical for the successful implementation of these systems, particularly in urban areas like Bandung City. This subsection explores the various factors that significantly influence how households perceive DEWATS. By analyzing correlations between demographic, residential, and familiarity-related variables, and public perceptions, we can identify the key drivers of both positive and negative attitudes towards wastewater management infrastructure. The insights gained from these correlations provide valuable guidance for policymakers and stakeholders aiming to enhance community acceptance and support for DEWATS initiatives. This analysis underscores the multifaceted nature of public perception and the need for targeted communication and educational strategies to foster positive attitudes and support for sustainable wastewater management solutions.

Table 3: Summary of correlation analysis

Association	Pearson's r	P-value
Strong Correlation (r = 0.5 – 0.1)		
Positive perception and Support for infrastructure	0.5340	0.000***
Moderate Correlation (r = 0.3 – 0.5)		
Maintenance history and Negative Perception	-0.3910	0.000***
Septic Tank ownership and Negative perception	-0.3890	0.000***
Familiarity of Service and positive perception	0.3920	0.000***
Weak Correlation (r = 0.1 – 0.3)		
Income and Positive Perception	0.1610	0.001***
Income and Negative Perception	-0.1090	0.029*
Decision maker familial position and Negative Perception	-0.1360	0.006**
Maintenance history and Positive Perception	0.2380	0.000***
Septic Tank ownership and positive perception	0.2820	0.000***
Familiarity of Service and negative perception	-0.2200	0.000***
Home Ownership Status and positive perception	0.2060	0.000***
Home Ownership Status and negative perception	-0.1830	0.000***
Residential Duration and positive perception	0.2050	0.000***
Residential Duration and negative perception	-0.2240	0.000***
Negative perception and support for infrastructure	-0.1570	0.002**
Very Weak Correlation (r = <0.1)		
Decision maker familial position and Positive Perception	0.0760	0.117*
Age and Positive Perception	-0.0070	0.886
Age and Negative Perception	-0.1510	0.002**
Education level and Positive Perception	0.0510	0.310
Education level and Negative Perception	-0.0530	0.288

***p < .001; **p < .01; *p < .05

The analysis reveals several significant correlations between various factors and perceptions of decentralized wastewater treatment systems (DEWATS) in Bandung City. A strong positive correlation ($r = 0.5340$, $p < 0.001$) exists between positive perception and support for infrastructure, indicating that households with a favorable view of the sanitation service are more likely to support the development of related infrastructure. Interestingly, negative perception shows a weak negative correlation with support for infrastructure ($r = -0.1570$, $p < 0.01$), highlighting that negative attitudes can slightly diminish support for new infrastructure projects. This shows the importance of fostering positive public perception in the implementation of a wastewater service plan. This also further highlights that diminishing social stigma will effectively reduce the probability of public rejection (Bruch & Atwell, 2015).

Maintenance history and septic tank ownership both show moderate negative correlations with negative perception ($r = -0.3910$ and $r = -0.3890$ respectively, $p < 0.001$), suggesting that familiarity and involvement in septic tank maintenance reduce negative attitudes towards DEWATS. Conversely, familiarity with the service correlates moderately with positive perception ($r = 0.3920$, $p < 0.001$), emphasizing the importance of awareness and experience in shaping favorable opinions. This indicates that individuals who are more familiar with sanitation services tend to report fewer negative emotions and engage in more frequent maintenance practices. These findings underscore the importance of delivering information about the importance and existence of maintenance services to the public such as septic tank emptying. This will foster initial traction of public engagement and positive perception among the public. Furthermore, the significance of these associations can inform targeted strategies to encourage proactive maintenance behaviors for better community health outcomes. This result show similar results with Gómez-Román et al.'s (2020) findings. Although, the significance of experience in maintenance history is a new finding.

Weak correlations also provide insights into the nuanced relationships between other variables. For instance, income shows a weak positive correlation with positive perception ($r = 0.1610$, $p < 0.001$) and a weak negative

correlation with negative perception ($r = -0.1090$, $p < 0.05$). Ownership status and residential duration also weakly correlate with perceptions; both factors positively correlate with positive perception ($r = 0.2060$ and $r = 0.2050$ respectively, $p < 0.001$) and negatively with negative perception ($r = -0.1830$ and $r = -0.2240$ respectively, $p < 0.001$). Most of the respondents were homeowning, old residents of the area, good for this analysis as newer built houses may already sufficiently use the DEWATS sanitation service. The findings provide compelling evidence of meaningful associations that warrant further exploration and analysis in understanding the dynamics of perceptions of sanitation and housing-related factors among the surveyed population.

Very weak correlations were observed between factors such as the decision maker's familial position and positive perception, age, and education level with perceptions, indicating minimal impact of demographic factors on the perception level. For example, age shows no significant correlation with positive perception ($r = -0.0070$, $p = 0.886$) but a weak negative correlation with negative perception ($r = -0.1510$, $p < 0.01$), suggesting older individuals may slightly disfavor DEWATS. Interestingly, this is the opposite of the results from Msaki et al. (2022). Education level has very weak and non-significant correlations with both positive and negative perceptions. This gives insight that public outreach programs could be done relatively uniformly in the area without needing deep consideration of demographic segmentations.

Overall, these insights underscore the importance of targeted educational and engagement strategies to enhance positive perceptions and support for wastewater treatment infrastructure, focusing particularly on enhancing familiarity with the service and fostering public participation in septic tank maintenance practice.

4.2. Strategies for engagement enhancement through public outreach programs

The analysis of public outreach methods reveals intriguing patterns in respondent preferences, offering valuable insights for enhancing engagement through outreach programs. Door-to-door socialization emerges as the most preferred method indicating strong support for direct engagement approaches. This preference suggests that personalized interactions play a crucial role in effectively conveying information and fostering community participation. Following closely behind are public socialization and focus group discussions underscoring the importance of interactive methods that allow for open dialogue and exchange of ideas, this aligns with the results of Garnett & Cooper (2014) which emphasized the importance of effective dialogue between government and the public in the early stages of sanitation policy implementation.

Field trips to existing systems garnered notable preference, indicating a desire for practical, hands-on experiences that offer tangible insights into wastewater management practices. These results also correlate with the analysis result which reveals people with higher maintenance history tend to have a more positive perception. In contrast, more passive methods such as exhibition, door-to-door distribution of pamphlets and printed media, and online media and social media received lower preference points, suggesting less enthusiasm for these outreach strategies among respondents. These findings emphasize the need for tailored approaches that prioritize direct engagement and experiential learning to effectively enhance community participation and understanding of wastewater management initiatives.

4.3. Limitations and future studies

The cross-sectional nature of the study captures perceptions at a single point in time, limiting the ability to infer causality or track changes in perception over time. Longitudinal studies are needed to observe how perceptions evolve with increased exposure to DEWATS and related outreach efforts. Future studies can conduct longitudinal studies to track changes in public perception over time, particularly before and after the implementation of DEWATS or other similar sanitation projects. This can help identify the impact of real-world experiences on attitudes and support.

The study focused on specific demographic, residential, and familiarity-related variables, potentially overlooking other influential factors such as environmental awareness, cultural attitudes towards sanitation, and political trust. Future studies should incorporate a broader range of variables to provide a more comprehensive understanding of

public perceptions. Furthermore, the study's findings are specific to Bandung City and may not be applicable to other regions with different infrastructural, cultural, and socioeconomic contexts. Comparative studies across different regions could provide insights into how contextual factors influence public perceptions of DEWATS.

Intervention-based studies can also be conducted to evaluate the effectiveness of various outreach and educational interventions designed to improve public perception and support for DEWATS. Experimental designs could be used to test different outreach strategies and their impact on perception.

Meanwhile, in-depth qualitative research such as focus groups, in-depth interviews, and ethnographic could be incorporated in future studies to gain deeper insights into the underlying reasons behind public attitudes and perceptions. This approach can uncover nuanced views and provide rich contextual data.

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