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The Relationship between Households Average Formal Education Levels and Sanitation Practices in Mojo, Surabaya, Indonesia

Widhowati Kesoema Wardhani, Harmin Sulistiyaning Titah, Mas Agus Mardyanto, Eddy Setiadi Soedjono*

Department of Environmental Engineering, Faculty of Civil, Planning, and Geo-Engineering, Institut Teknologi Sepuluh Nopember, Kampus ITS Sukolilo, Surabaya, 60111, Indonesia

*Correspondence: soedjono@enviro.its.ac.id

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ABSTRACT: This study explored the relationship between households' average formal education levels and sanitation practices. Although formal education was intended to prepare individuals for personal and professional life situations, local habits and cultural practices could sometimes be more influential than educational background, as evidenced by urinary habits practiced in the country. These habits played a crucial role in determining whether urine was disposed of in the toilet, processed in a septic tank, or directly entered the drainage system when spilled on the bathroom floor. In this study, the definition of sanitation differed from that previously outlined by the Sustainable Development Goals (SDGs). The SDGs defined sanitation based on the percentage of households that used safely managed services, including handwashing facilities. This study, however, focused on excreta disposal, desludging intervals, septic tank types, and urinary habits, such as whether urine was disposed of on the bathroom floor or in the toilet. These factors were chosen for their ability to accurately reflect the actual conditions observed in the study area. A survey was conducted among 100 households, and data were analyzed using Analysis of Variance (ANOVA). The results revealed no relationship between households' average formal education levels and sanitation practices. This analysis suggested that other factors, such as cultural beliefs and environmental habits, may have influenced sanitation practices.

KEYWORDS: Desludging; education levels; sanitation; septic tank; urinary habit

1. Introduction

Maintaining good sanitation practices is essential because inadequate sanitary conditions can negatively impact the environment. The United Nations Sustainable Development Goals (SDGs) recognized the importance of proper sanitation and included it in Goal 6, *Clean Water and Sanitation*. According to Indonesia's SDG metadata on environmental development, Target 6.2 aims to ensure equal access to suitable sanitation facilities and hygiene for all while eliminating open defecation by 2030. Similarly, under Target 6.3, reducing untreated wastewater was prioritized, with a focus on increasing the proportion of safely treated

household wastewater proportionately [1]. This indicated that the indicator for good sanitation practices, based on the United Nations, was the percentage of households using safely managed sanitation services, including handwashing facilities with water and soap.

The assessment of sanitation practices in this study used a slightly unique method that should still be considered part of the broader concept. The evaluation criteria included desludging interval, septic tank type, and urinary habits, particularly whether urine was disposed of on the bathroom floor or in the toilet. Assessing urinary habits was necessary because improper disposal of urine on the bathroom floor could result in untreated urine entering the drainage system, contradicting the sanitation targets set by the SDGs. It also explained that achieving safe sanitation referred to an increase in the number of households with an elevated toilet connected to a desludged septic tank every five years [1]. According to the regulations of the Ministry of Public Works and Housing No. 04/PRT/M/2017, desludging should be carried out at least once every three years. Therefore, desludging interval, septic tank type, and urinary habits were used as factors to assess sanitation levels in this study.

This study examined whether households' average formal education levels influenced sanitation practices. Based on observations, culture, tradition, habits, and other acceptable norms in the community, these factors determined sanitation levels [2]. Although historical efforts have been made to reduce open defecation, little attention has been paid to the disposal of urine in toilets. This specific aspect of sanitation was selected over other factors, such as handwashing and water quality, due to the limited focus on the relationship between urine disposal habits and overall sanitation in existing research. While other aspects, particularly fecal disposal, had been extensively studied, proper urine disposal remained an overlooked issue. In Indonesia, improper urine disposal continues to be widely practiced, potentially contributing to the risk of disease transmission, underscoring the need for further investigation.

Therefore, formal education levels should ideally promote improved thinking patterns related to sanitation and habits. Previous reviews connected education levels to increased ownership and use of latrines or septic tanks [3]. However, there was a lack of exploration regarding the correlation between formal education levels and sanitation practices, which this study addressed through three key aspects. Bappenas also stated that education played a significant role in improving community participation in water and sanitation management, as outlined under Target 6.b of the SDGs [1].

In this study, Analysis of Variance (ANOVA) was used to examine the relationship between households' average formal education levels and sanitation practices. The analysis was conducted in Mojo urban village, Surabaya, Indonesia, due to the substantial number of COVID-19 cases. Samrot's research suggested that viral presence in urine might have been influenced by disease severity, making urinary habits a significant consideration in relation to sanitation practices [4]. Furthermore, the Central Bureau of Statistics stated that Mojo had widespread educational diversity, ranging from individuals with no formal schooling to university graduates. The area was also conveniently situated near major roads, making it easily accessible [5].

Various reviews had established a correlation between formal education levels and the ownership and use of latrines or septic tanks. In Jakarta, Indonesia, Sidabutar and Chotib discovered that higher education levels among household heads and women corresponded with a higher likelihood of owning a private toilet [6]. The factors that significantly influenced the transition from inadequate to sufficient sanitation facilities included recent non-migration

(26%), higher education levels or university attendance (20%), unemployment status (18%), household size of four or more members (16%), married couples (11%), female-headed households (9%), and high expenditures (1%). However, it was crucial to note that the investigation primarily compared education levels and toilet ownership. Previous reviews had predominantly examined the association between formal education levels and sanitation practices, focusing on income and sanitation by asking whether households "had" or "did not have" a healthy toilet or properly maintained septic tank.

Therefore, this study provided more detailed insights by exploring bathroom habits, such as urinating in the toilet or on the floor. Drawing on existing literature and preliminary observations, this study hypothesized a positive correlation between higher household education levels and improved sanitation practices in Mojo, Surabaya. Households with greater formal education were expected to demonstrate better waste disposal practices, regular septic tank maintenance, and lower open defecation rates, whereas lower education levels might have been linked to inadequate sanitation behaviors due to limited awareness and access to facilities. However, the association between formal education and sanitation practices remained a subject of debate, with no definitive evidence, highlighting the significance of this investigation.

2. Materials and Methods

2.1. Study area.

specifically carried out around 7°16'6.79"S, 112°46'15.56"E (Mojoklanggru Lor) in RW 04, covering RT 01, 02, 03, 04, 05, 06, and 09. *RW* (Rukun Warga) refers to a Community Association, while *RT* (Rukun Tetangga) refers to a Neighborhood Association. Both are administrative divisions under an urban village.

Figure 1. Sampling point.

2.2. Survey method.

The study employed a survey method, administering a questionnaire to each household. The sample size was determined using the Slovin formula with a 10% margin of error [7].

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

In Formula (1), *n* represents the minimum sample size, *N* denotes the population size, and *e* signifies the error margin of 10%. With *N* for Mojo set at 48,516 and *e* at 0.1, the calculated sample size (*n*) was 98.98, which was rounded up to 100 respondents for this study. The questionnaire included several questions necessary for data analysis using ANOVA (Table 1).

Table 1. Questionnaire.

No.	Parameter 1
1.	Date of survey
2.	Address
3.	Head of households name
4.	What is the average education level of family members?
5.	Desludging interval. How often (years) or never?
6.	Septic tank type?
	a) Pit latrines
	b) Standard septic tank
	c) Does not know
7.	Urinary habit
	a) Take a pee or dispose of urine on the floor of the toilet or bathroom
	b) Take a pee or dispose of urine in the toilet

2.3. Correlation analysis.

The correlation analysis between formal education levels and sanitation practices was conducted by first converting qualitative data into quantitative form (Table 2). After converting the data into quantitative form using Excel 2013, the desludging interval, septic tank type, and urinary habits were summed to determine the sanitation level. Consequently, the sanitation level was categorized as shown in Table 3.

Table 2. Scoring from the questionnaire.

Question	Answer	Score
Average formal education at home	Never attending school	0
	Elementary School	0
	Middle School	1
	High School	2
	University or College	3
Desludging interval	Never desludged	0
	> 5 years	1
	≤ 5 years	2
	≤ 3 years	3
Septic Tank type	Does not know	0
	Pit Latrines	1
	Standard Septic Tank	2
Urinary habit	On the floor of the toilet	0
	Both on the bathroom floor and in the toilet	1
	In the toilet	2

Table 3. Sanitation level score.

Total	Sanitation Level	Score
0-1	Very Bad	0
2-3	Adequate	1
4-5	Good	2
6-7	Very Good	3

Quantitative data were entered into the Stat-Ease 360 Trial program for analysis using ANOVA, a widely used statistical method for comparing means among three or more samples to identify significant differences [8]. This method helps determine the relationship between factors and responses within the program. In this study, formal education levels were analyzed as the factor, while sanitation practices served as the response.

3. Results and Discussion

The average education level in Mojo is presented in Table 4. Among the 100 respondents, the majority had attained education up to senior high school. The distribution of educational attainment, from lowest to highest, includes individuals who never attended school, followed by those who completed elementary school, middle school, and high school. Only a small number pursued higher education at universities. In this study, scores were summarized, revealing that most respondents practiced urination either on the toilet floor or in the toilet bowl. Additionally, Table 4 presents data on desludging intervals, septic tank types, and urination habits among the respondents. The relationship between formal education levels and sanitation practices was evaluated using a scoring method. ANOVA analysis resulted in a p-value of 0.2761 > 0.05, indicating no significant correlation, as shown in Table 5.

Table 4. Average formal education level and sanitation level factors.

Question	Answer	Respondents
Average formal education levels at home	Never attending School	1
	Elementary School	9
	Middle School	17
	High School	69
	University or College	4
	Total	**100**
Desludging interval	Never desludged	40
	> 5 years	25
	≤ 5 years	28
	≤ 3 years	7
	Total	**100**
Septic Tank type	Does not know	2
	Pit Latrines	34
	Standard Septic Tank	64
	Total	**100**
Urinary Habit	On the floor of the toilet	30
	Both on the bathroom floor and toilet	53
	In the toilet	17
	Total	**100**

Table 5. ANOVA results.

Source	Sum of Squares	df	Mean Square	F-value	p-Value	
Model	0.4232	1	0.4232	1.20	0.2761	not significant
A-Average Formal Education	0.2432	1	0.4232	1.20	0.2761	
Residual	34.57	98	0.3527			
Lack of Fit	0.0463	2	0.0231	0.0643	0.9377	not significant
Pure Error	34.52	96	0.3596			
Cor Total	34.99	99				
Std. Dev.	0.5939			**R^2**		0.0121
Mean	1.49			**Adjusted R^2**		0.0020
C.V. %	39.86			**Predicted R^2**		-0.0241
				Adeq Precision		3.2295

According to the ANOVA model, the F-value of 1.20 was not statistically significant, with a 27.61% probability of occurring by chance due to noise or data nonlinearity. Additionally, none

of the model terms were significant, as all p-values exceeded 0.05. The Lack of Fit F-value was 0.0643, indicating insignificance, with a 93.77% probability that this result occurred due to noise or data nonlinearity. A non-significant lack of fit is desirable, as it suggests the model fits well. Another key result from the ANOVA model was the Adeq Precision value (Table 5), which assesses the signal-to-noise ratio. A ratio of 3.2295 suggests an insufficient signal, indicating that this model should not be used to explore the design space. Additionally, the R-squared value of 0.0121 (1.21%) indicates an insignificant linear correlation between formal education levels and sanitation practices. Figure 2 shows diagnostic plot results that serve various purposes in assessing model assumptions. The Normal Plot of Residuals evaluates whether the residuals follow a normal distribution. The Residuals vs. Predicted Plot examines the homogeneity of variance, ensuring that residuals are evenly distributed across predicted values. The Box-Cox Plot suggests potential transformations to improve normality when necessary. Lastly, Cook's Distance helps detect influential data points that could disproportionately affect the model's results.

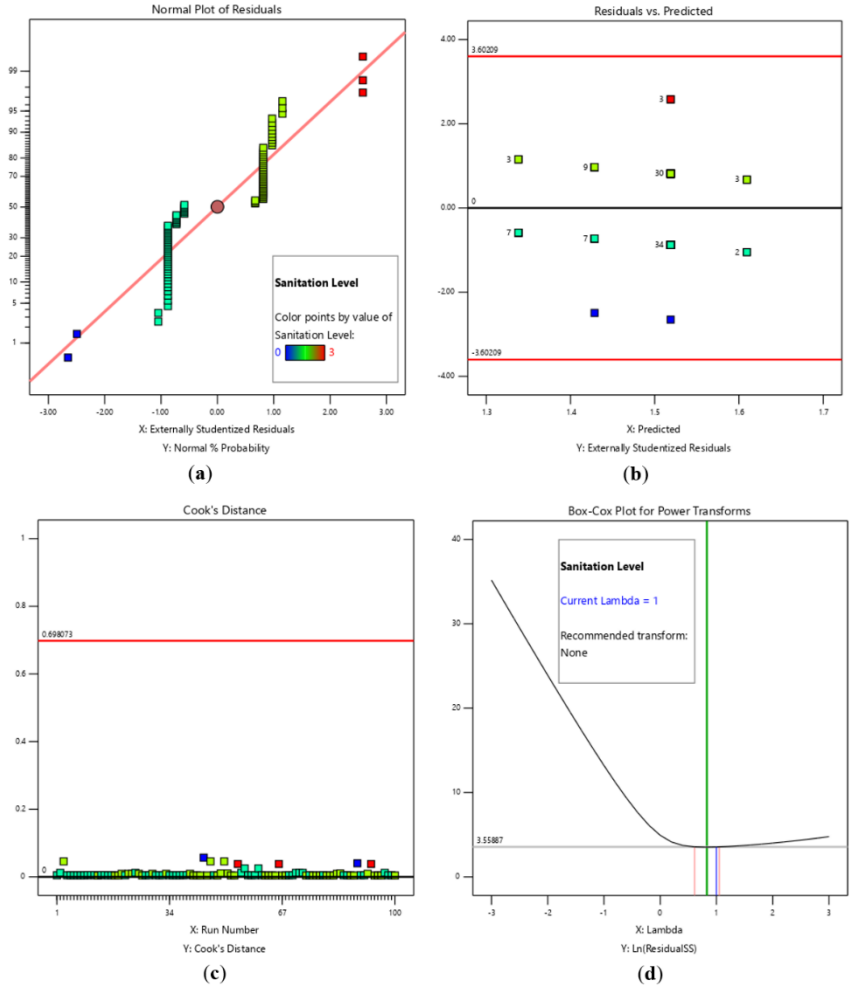

Figure 2. Normal plot of residuals result (a); Residuals vs. predicted result (b); Cook's distance result (c); Box-cox plot result (d).

The residuals exhibit a relatively normal distribution (Figure 2(a)); however, the presence of outliers suggests potential skewness or heavy tails. The residual plot (Figure 2(b)) indicates that the spread of residuals remains relatively consistent, suggesting that the assumption of homogeneity of variance is likely satisfied. However, the presence of outliers near the red

boundary may introduce slight deviations from this assumption, potentially impacting overall model accuracy and warranting further examination.

The Cook's Distance plot (Figure 2(c)) assesses the influence of individual data points on the regression model. In this analysis, all data points fall well below the critical threshold (red line at approximately 0.698), indicating that no single observation exerts an undue effect on the model's parameter estimates. This suggests the absence of highly influential points that could distort the regression results, reinforcing the model's stability and reliability. Furthermore, the Box-Cox plot (Figure 2(d)) shows that $\lambda = 1$, indicating that no data transformation is needed.

Education plays a crucial role in accelerating behavioral change by enhancing individuals' understanding of the importance of proper sanitation rather than merely improving their employment prospects [6]. However, in practice, cultural norms, traditions, habits, and perceptions of social acceptability significantly influence sanitation behaviors. The definition of proper sanitation in previous studies often differs from actual sanitation practices observed in communities.

A study in rural Indonesia, where inadequate sanitation services and high rates of open defecation persist [9], found that latrine ownership and open defecation practices are influenced by factors such as economic status, perceived construction costs, water availability during dry seasons, social acceptance of open defecation, communal latrine usage behaviors, and perceptions of latrine ownership. The study also highlights the importance of establishing and strengthening new social norms regarding sanitation [9,10]. Among the various factors influencing sanitation practices in Indonesia, economic conditions and habitual behaviors remain the most significant and challenging obstacles.

A survey of 100 respondents (Table 4) revealed that 64 respondents had standard septic tanks, 34 respondents used cubluk (pit latrines), and only two respondents were either unaware of their sanitation facilities or uncertain about their existence. Most respondents had never desludged their septic tanks since installation, and there was no significant difference in desludging intervals between those who desludged more than five years apart and those who did so within five years. Notably, only seven households out of 100 complied with the recommended desludging interval of three years or less, as stipulated by regulations.

Regular desludging is crucial to prevent blockages and potential groundwater contamination [11]. However, in reality, many households have never desludged their septic tanks. One primary challenge is septic tank placement, as they are often located beneath kitchens, living rooms, or dining rooms, making access difficult. Additionally, "willingness to pay" for sanitation services remains a significant barrier. The cost of local septic tank pumping services ranges from 750,000 to 1,500,000 IDR per session, making it financially inaccessible for many households. Furthermore, community awareness of sanitation regulations plays a crucial role. These challenges contribute to a critical issue—undetected septic tank leakage, which can result in environmental contamination [12].

Based on respondent data in Table 4, the overall sanitation level in Mojo (Figure 3) indicates that most respondents fall within the "adequate" sanitation category. In this study, "adequate" sanitation is defined as a score of two to three, signifying that respondents have a standard septic tank but dispose of urine on the floor and have never desludged their tanks. However, some respondents may practice proper urination habits but use a cubluk (pit latrine) and have never performed desludging.

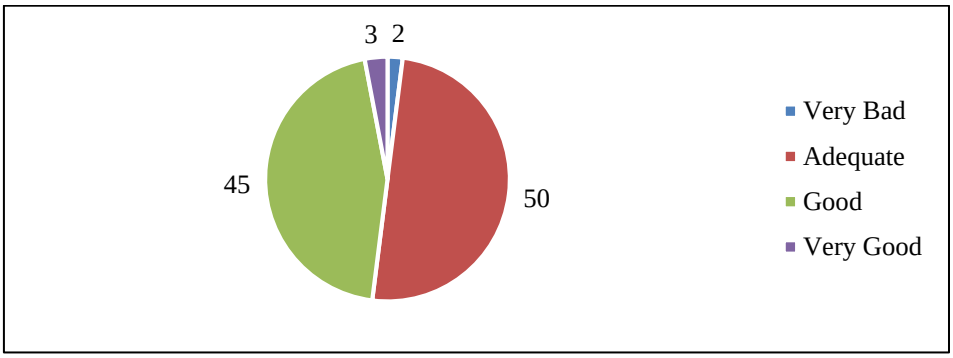

Figure 3. Sanitation level.

In this study, sanitation levels were categorized based on specific behaviors that do not align with the Joint Monitoring Programme (JMP) sanitation ladder. This approach provided a more detailed classification of sanitation levels based on prevailing sanitation practices in the survey area and those commonly observed in Indonesia [13]. When comparing the results with the JMP ladder classification, which categorizes sanitation into four levels, the survey results classified 83 out of 100 respondents as belonging to the "limited" or "basic" sanitation categories, while only 17 respondents met the criteria for "safely managed" sanitation.

The primary reason only 17 out of 100 respondents were classified as "safely managed" was that only these respondents practiced good urinary habits (i.e., safely disposing of urine in a toilet). The remaining 83 respondents did not safely contain and dispose of excreta in situ. Another reason for classification into the "limited" or "basic" sanitation categories was whether sanitation facilities were shared with other households. In this area, some houses accommodate multiple households, which affects their classification.

Despite these results, RW 4 in Mojo still maintains an overall adequate sanitation level. However, many households dispose of urine on the floor or in water closets, and the local drainage system discharges directly into the river. This poses significant environmental risks, as wastewater can introduce contaminants into the water supply. Urine has been found to contain remnants of pharmaceuticals such as caffeine, diclofenac, acetaminophen, and paracetamol. These findings align with a previous study that examined pharmaceutical micropollutants in Indonesian septic tanks [14]. Even after passing through a septic system, traces of these substances remain detectable. If urine is directly discharged into a sewer or drainage system, it can threaten aquatic life and ecosystem health.

Sanitation is primarily an effort to prevent disease and ensure environmental health [15]. Proper excreta management is essential in any sanitation program, as the safe containment and disposal of human waste serve as the first line of defense against excreta-related diseases [16]. Although urine poses a lower health risk than feces, it still contains pathogenic microorganisms. Recent studies have raised concerns about SARS-CoV-2 RNA detected in urine and wastewater, highlighting the potential transmission of infectious diseases through contaminated water [17]. This underscores the necessity of implementing proper sanitation practices and infrastructure.

In contrast to this study's approach, Sidabutar and Chotib (2017) examined the correlation between formal education and sanitation levels using microdata from Indonesia's National Socio-Economic Survey (Susenas). Their study employed multinomial logistic regression to determine sanitation adequacy based on the JMP sanitation ladder [6]. The

sanitation level was based on the sanitation ladder (JMP) which are 3 levels. Level 0 was open defecation or unimproved sanitation, level 1 was shared sanitation, and level 3 was basic sanitation or safely managed sanitation. The difference compared to previous study of Sidabutar and Chotib as stated in the papers' limitation of study that the analysis conducted in their study relies on the availability of variables within the *Susenas* dataset and it was conducted. Furthermore, a thorough analysis through a household survey is highly recommended for assessing the feasibility of disposal facilities in Jakarta. Therefore, this study provides more detailed insights by exploring bathroom habits, such as urinating in the toilet or on the floor (safely disposed excreta).

In contrast, societies tend to adhere to previous sanitation practices despite the presence of improved sanitation facilities. Habitual behavior is often considered a crucial factor in behavioral change and maintenance [18]. To modify habits, environmental cues can be adjusted to encourage repetition and reinforcement of the desired behavior. Interventions aimed at addressing open defecation frequently focus on modifying the environment or social norms or on providing incentives for adopting proper sanitation practices. However, in practice, changing the habit of using toilets for urination remains a challenge in the field. This behavior is deeply ingrained and is perceived as normal within certain communities.

Ideally, individuals should have the right to protect their environment. Environmental awareness refers to attitudes or actions that seek to prevent environmental degradation while also undertaking efforts to restore damaged ecosystems. Such awareness is not an innate talent or instinct but rather the result of a broader educational process [19]. However, in reality, entrenched habits and unequal access to education have contributed to persistent environmentally harmful behaviors.

The significance of this study lies in expanding our understanding of the definition of sanitation as outlined by the United Nations. In practice, activists, educators, and even government authorities should update their perspectives on sanitation. It is essential to revise indicators, programs, and definitions of proper sanitation, particularly in a country like Indonesia, where urinating on bathroom floors remains a common practice, and wastewater management services are inadequate, often leading to direct disposal into drainage systems. As mentioned in the introduction, COVID-19 and other diseases can be transmitted through urine. Therefore, education should not only focus on the frequency with which septic tanks should be desludged but also on urination habits to prevent disease transmission through urine.

Environmental health is closely linked to sanitation, as it directly impacts public health. Consequently, poor sanitation can negatively affect the overall quality of life [20]. Education about environmental sanitation plays a critical role in raising awareness about the impact of sanitation practices on environmental health [21]. This indicates that in addition to formal education, environmental sanitation education must be taught and implemented within communities to ensure the protection of public health. Based on WaterAid report about "Towards total sanitation: Socio-cultural barriers and triggers to total sanitation in West Africa", to improve sanitation practices within communities, some action must be made [22]. Engaging with and strengthening existing community social organizations is essential. Many of these groups, along with certain elected officials, demonstrate strong traditional leadership. Before implementing interventions, it is crucial to assess cultural practices, leadership structures, and other change drivers within ethnic groups. Understanding the local context helps identify opportunities and challenges for behavior change, allowing for the development of

effective strategies to encourage improved sanitation practices. Investing in education, healthcare, and proper sanitation infrastructure is essential for promoting hygienic practices and maintaining long-term community well-being. By integrating these efforts with cultural awareness and community engagement, sustainable behavior change can be achieved, ultimately improving public health and environmental conditions.

4. Conclusions

This study demonstrates that education levels alone do not determine a community's sanitation habits. While formal education may improve the ownership of proper sanitation facilities, it does not necessarily lead to better sanitary practices. For instance, in Indonesia, urine disposal on the floor and in toilets remains common, regardless of educational background. To foster sustainable sanitation practices and improve public health, it is essential to integrate formal education with community-based environmental sanitation programs, cultural awareness initiatives, and local leadership engagement. The ANOVA test results indicated no significant relationship between education levels and sanitation behaviors, such as desludging intervals, septic tank types, and urinary habits ($p = 0.2761 > 0.05$). However, this study is limited by its small sample size (100 households) and localized study area, which may introduce biases in self-reported data. As a result, the findings may only be applicable to Mojo or regions with similar socioeconomic conditions.

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Author Contribution

Widhowati Kesoema Wardhani: conceptualization, methodology, data collection, data analysis, writing, and funding. Harmin Sulistiyaning Titah: conceptualization, methodology, writing, and supervision. Mas Agus Mardyanto: conceptualization, writing, and supervision. Eddy Setiadi Soedjono: conceptualization, methodology, writing, supervision, funding.

Competing Interest

The authors declare that there is no conflict of interest.

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