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ASSESSING THE SUITABILITY OF COMMUNAL TOILET MODELS FOR ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS IN URBAN SETTLEMENTS OF WEST JAVA

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Abstract:
This study investigates communal toilet models as an alternative sanitation solution for densely populated urban settlements and their potential contribution to sustainable development targets related to safe sanitation. In many high-density settlements, limited land availability and infrastructure constraints prevent households from having private sanitation facilities, leading communities to rely on shared sanitation systems. This research applies a mixed- method approach combining quantitative and qualitative data. Primary data were collected from four sub-districts in Bandung, West Java, Indonesia, involving 40 household respondents and 100 key informants during the period 2024-2025. Additional information on social, economic, and demographic characteristics was obtained through structured questionnaires. The analysis evaluates communal toilet construction models that consider land availability and water supply conditions, as well as two waste treatment scenarios designed for facilities serving up to 120 users. The results indicate that the second scenario provides greater flexibility in spatial adaptation and more manageable waste treatment for dense settlements. The findings emphasize that appropriate design, effective waste management, accessibility, and affordability are essential factors for improving sanitation services in high-density urban areas. This study highlights the importance of adaptive communal sanitation systems as a practical approach to expanding sanitation access and supporting sustainable urban development in densely populated settlements.

Keywords: Sustainable Development Goal, Urban Settlement, Toilet, West Java

INTRODUCTION

Appropriate conditions for individual health are part of health goals that can be accessed by all levels of society (Hyun et al., 2019). Provides an explanation for access to sanitation by the community. Sanitation is not only seen as a clean toilet with a sufficient water supply that is conveniently managed (Sinharoy et al., 2019; Anggoro et al., 2023). The SDGs set 17 universal goals, 169 targets, and 230 indicators (Gong et al., 2024; Biggeri et al., 2019). With a common set of generally accepted goals, it will evolve into a comprehensive policy framework that includes considerations for international organizations (Bogers et al., 2023). Sanitation as part of the complexity of health is certainly an obligation in a government program to synergize with the whole community, so that the basic needs in life, culture, and different policies in each country still make sanitation a priority for its citizens.

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Indonesia's sanitation sector strategy policy is STBM (Sanitasi Total Berbasis Masyarakat or CLTS (Community Led Total Sanitation). The focus of this strategy is to subsidize latrine facilities as a means of community empowerment and behavior change. The government's approach as a facilitator for community users of facilities and improved access can be adequate. Within the CLTS program, there are three components, namely increasing demand for sanitation services, fulfilling sanitation needs by strengthening supply, and supporting an active environment (Syairudin et al., 2015).

Toilets are accessible, sustainable, and convenient public infrastructure (Dancer et al., 2021). Communal toilet facilities for achieving safely managed sanitation are lacking (Seleman et al., 2021). Previous research found that 47% of sanitation infrastructure for public health is poor (Nasim et al., 2022). The ratio of good public toilet use is only 32%, and the value chain of sanitation services needs to be optimized; even in some Asian countries, communal toilets still use squat toilets (Luo et al., 2023a). Sanitation and public environmental health conditions in densely populated settlements are certainly a concern for the entire community, with planning and implementation of programs and evaluation of their sustainability (Kementrian Kesehatan, 2014).

According to Statistics Indonesia, approximately 80.92% of households have access to sanitation; however, several challenges remain a problem. These include insufficient development planning, high initial costs, limited participation of the community, poor management and maintenance, and the underutilization of fecal resources. The design of communal toilets must consider a lot of factors, such as the surrounding environment, user needs, facilities that are available, and efficient management of waste (Cobbinah et al., 2020). Additionally, the UN General Assembly outlined the key principles for the human right to water and sanitation in public spaces in 2019, emphasizing availability, accessibility, affordability, acceptability, safety, and quality (Moreira et al., 2022).

Communal toilets play a critical role in serving the right to sanitation in public areas and are trying to promote inclusive, sustainable urban development (Akaishi et al., 2021). They are important in improving the public health sector and overall well-being (Leavitt et al., 2021). Even with their importance, several challenges persist, for example, the lack of systems for the sewer, limited space for additional facilities, and the high costs of waste disposal, which often results in waste being dumped into rivers, lakes, or the sea (Eticha & Adisu, 2022). Developed and adequate facilities and infrastructure are essential to support sanitation needs (Woltersdorf et al., 2016). Moreover, with the help of government-sponsored sanitation programs, a changing role can be played in the support of maintenance costs through cross-subsidization (Acey et al., 2019; Luo et al., 2023).

Insufficient and unsafe sanitation facilities pose significant risks to public health, dignity, and economic development (Hashemi & Boudaghpour, 2020). Many public/communal toilets are often shared by 5 or more households, and they are poorly maintained, offering little privacy, failing to support menstrual hygiene needs, and are inaccessible to people with limited movements/mobility (Michiani & Asano, 2019). When the disposal pits reach their capacity, households often depend on manual emptying services that lack protective equipment, leading to improper waste disposal in the local environment (Delaire et al., 2021). The high rate of usage of communal toilets increases the risk of disease breakout, especially with squat toilets, which are commonly used in Asia (Purwar et al., 2020).

Millions of people lack access to normal/clean water and sanitation services due to a number of factors, such as insufficient infrastructure, low household income, and location. Achieving the sanitation program goals by 2030 presents a significant financial challenge, requiring planned

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development initiatives in the water and sanitation sectors. Properly designed pit latrines with ventilation can ensure the safe disposal of human waste by reducing odors and pests (Kerstens et al., 2015). However, in many urban areas, the shared usage of toilets and latrines fails to meet basic health standards for basic and clean sanitation. While 20% of urban residents have access to improved individual sanitation facilities and only 7% practice open defecation, most existing toilets rely on on- site technologies (Kipkoech et al., 2023; Schelbert et al., 2020). Therefore, establishing consistent standards for constructing, maintaining, and using communal toilets in line with Indonesian national standards (SNI 03-2399-2002) is critically important. This study aims to analyze the condition of the community in the dense settlements of Bandung City and the scenario of a feasible and safe communal toilet development model.

METHODS

Research Location and Sampling. Primary data collection in four sub-districts in Bandung City, West Java, Indonesia. The research location is in dense settlements spread across four sub-districts, namely in sub-districts: Sukajadi, Bojongloa Kaler, Astana Anyar, and Andir. Bandung City, the capital of West Java Province, is located at 1070 East Longitude and 60 55' South Latitude. The research period is from 2020 to 2024. Data collection methods include surveys and interviews. The data collected were analyzed using descriptive statistical methods. Direct observation of sanitation conditions and communal toilet facilities, involving communal toilet users. Interviews with 100 key informants living in dense settlements to explore preferences and constraints related to sanitation. Questionnaires to 400 respondents were obtained based on the total population in four sub-districts using Yamane's Quota sampling formula (Abanyie et al., 2022):

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

$$n = \frac{399740}{1 + 399740(5)2} = 400$$

Description:
n = number of samples needed
N= population
e = sampling error 5%.

Table 1. Location, Population, and Respondents

Location	Population	Respondent
Bojongloa Kaler	124.323	124
Astana Anyar	73.232	73
Andir	99.119	99
Sukajadi	103.060	103
Total	399.734	400

Source: Document Data 2024

Data Collection and Analysis Methods. This research uses qualitative and quantitative research types (Pagani, 2020). The model in the design of communal toilet construction in dense settlements is guided by the STBM sanitation program and SNI (SNI 2398, 2017). Individual WTP offers for the construction of communal toilet facilities and waste management were obtained from

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the questionnaire survey. The WTP offers were then entered into the Statistical Program for Social Sciences (SPSS) for further analysis. Based on individual WTP offers, average WTP and total WTP. The hypothetical market with scenarios that can be created in this study is that communal toilets refer to a conceptual system where communal toilet facilities are provided as public facilities and shared as a service that has the potential to be monetized, and managed based on a market-based framework.

The variables for the social and economic environment component are the economic valuation of the environment towards sanitation with a hypothetical market. Sustainable development is used so that communal toilet development variables are adjusted to WTP and Polluter Pays, so that two scenarios are obtained in the communal toilet governance model, including: scenario 1, domestic waste management in communal toilets and scenario 2, communal toilet design in dense settlements.

a. Scenario 1: Construction of communal toilets. Construction of communal toilets on land at the main water supply source, i.e., dug wells.
b. Scenario 2: Construction of SRAB sewage treatment plant, in place of dug wells as the main source of water supply
c. Horizontal flow model of a square basin (concrete material)
d. Vertical flow model of cylindrical basin (plastic material).

The survey directly involved users of communal toilets so that data on willingness to pay can be obtained. What is the maximum fee that community users of communal toilets can voluntarily pay, based on averages of survey and questionnaire data? Willingness to pay (WTP) for sanitation improvements is an important factor in understanding how people value sanitation services and the potential to invest in better facilities. The method of obtaining the value of the community's willingness to pay for the construction and management of communal toilets in this study was using the Open-ended Question method, where respondents were asked about the maximum WTP they were willing to pay, noting that no other bid values were given, so that respondents were given the freedom to state the value they wanted to achieve. Average WTP value after the data is collected, then determine the median and mean of the WTP value (Gunawan et al., 2020). The estimated average WTP value is calculated using the following formula:

$$EWTP = \frac{\sum_{i=1}^{n} W1}{n}$$

Description:
EWTP = Estimated average WTP
W_i= Value i WTP
n = Number of respondents
i= Respondent $_i$ WTP (i=1,2..., n).

Then the data is processed and averaged to be converted to the total population with the formula:

$$TWTP = \frac{\sum_{i=1}^{n} WTPi}{n} \frac{(n1)}{(N)} P$$

With:
TWTP = Total WTP
WTP_i= Total sample $_i$ WTP
n_i = Sample $_i$ willing to WTP

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N = Total sample
P= Population
i= respondent i WTP (i=1,2, ..., n).

RESULT AND DISCUSSION

The Characteristics of the Dense Settlements. Based on the research results, the occupancy rate is increasing, but there is limited land or property. In terms of toilet use, people pay fees according to the agreement, and people in dense settlements also use water from wells. Poor drainage, direct disposal of household waste, septic tanks, and communal toilets are problems in settlements. Planning the construction of communal toilets refers to (SNI 03-2399-2002). The planning procedures for communal toilet buildings, where the toilet capacity needs to be adjusted to the number of potential users around the location. This research makes a communal toilet design plan for a capacity of 100 people by considering the availability of land. The characteristics of the community based on social, economic, and household demographics in the research location are in Table 2:

Table 2. Social Character, Economy, and Household Demography

Variable		Respondents (n)	Percentage (%)
Sex Type	Male	120	30
	Female	280	70
Age	15- 29 years	16	4
	30- 44 years	38	9,5
	45- 59 years	319	79,7
	≥ 60 years	27	6,8
Education Level	Middle	12	3
	High	267	91,7
	College	21	5,3
Marital Status	Married	351	87,7
	Not Married	7	1,8
Living Status	Widow	28	7
	Widower	14	3,5
	Private House	295	73,8
	Rent	105	26,2
Main Water Source	PDAM	358	89,5
	Private Well	23	5,7
	Publics Wells	19	4,8
Need to pay for a water source?	Yes	368	92
	No	32	8
Sanitation Facilities	Private Toilet	319	79,8
	Public Toilet	81	20,2
Satisfied with the current toilet?	Yes	56	14
	No	344	86
Monthly Income	Rp.2.500.000-Rp.5.000.000	376	94
	Rp.5.000.000-Rp.7.500.000-	24	6

Source: Data Processed 2024

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Based on the answers of 400 respondents representing households in the study, the majority of respondents were female (70%), aged 45-59 years (79.7%), had the last education as mostly high school (91.7%), and most were married (87.7%). Living in a private house (73.8%) and using a PDAM water source (89.5%). The community has a private toilet (79.8%), and others use shared toilet facilities, but the majority are not satisfied with the condition (86%). Monthly household income was mostly in the range of Rp 2,500,000- Rp 5,000,000 (94%). Efforts to address sanitation issues with national policy through the STBM program for a sustainable environment. Approaches need to be taken to achieve the target pillars of CLTS success and motivate the community to be aware of changing behavior related to sanitation. Demand for sanitation services is effectively met by communities that need sanitation improvements and are willing to invest funds and resources jointly and voluntarily.

Table 3. Number of households willing to contribute to the construction of communal toilets and domestic sewage treatment plants

Number of Questions	Answer	Sources	Percentage (%)
1. Willingness to contribute to the operational and maintenance costs of communal toilets.	Strongly Agree	46	46
	Agree	53	53
	Disagree	1	1
2. Willing to pay a fee of Rp. 15,000 per month for the operation and construction of communal toilets.	Strongly Agree	41	41
	Agree	55	55
	Disagree	4	4
3. Willing to contribute to the construction of the sewage treatment plant Rp. 15,000/month.	Strongly Agree	7	7
	Agree	89	89
	Disagree	3	3
	Strongly Disagree	1	1

Source: Data Processed 2025

Table 3 shows that the majority of respondents indicated a high willingness to pay sanitation fees, both for the operation and construction of sanitation facilities. Most agreed with the payment of Rp 15,000/month for sewage treatment (89%) and communal toilets (55%). It reflects potential community support for sanitation facility improvement programs in their neighborhoods. Densely populated settlements in Bandung City have access difficulties in septic tank desludging.

Models of Communal Toilet in Urban City. The construction model of communal toilets was adjusted to ensure safe drainage, and organic waste was treated under anaerobic conditions. Sludge removal is required while maintaining the capacity and efficiency of the system. The toilet construction model in dense urban settlements has limited land. Waste management of sanitation activities with available land and access, in scenario 1, is made with centralized waste treatment using concrete and impermeable basins. Scenario 2 separates waste treatment with the use of plastic barrels. Both scenarios have similarities in the location of communal toilets, but the difference is the waste treatment.

Toilets are designed by SNI 03-2399-2002 standards with a maximum user capacity of 120 people. The toilet consists of: 1 conventional/manual tube well; 4 latrines (2 for men and 2 for women); 4 bathrooms (2 for men and 2 for women); washing area (8 people); area of 5.5 m2 x 5.5 m2 (excluding waste treatment). Calculation of operational time per day: maximum number of users is 120 people; capacity for 4 people; time requirement is 5- 15 minutes/person; total service time is 2.5-7.7 hours. The development model can be more clearly visualized in Figure 1:

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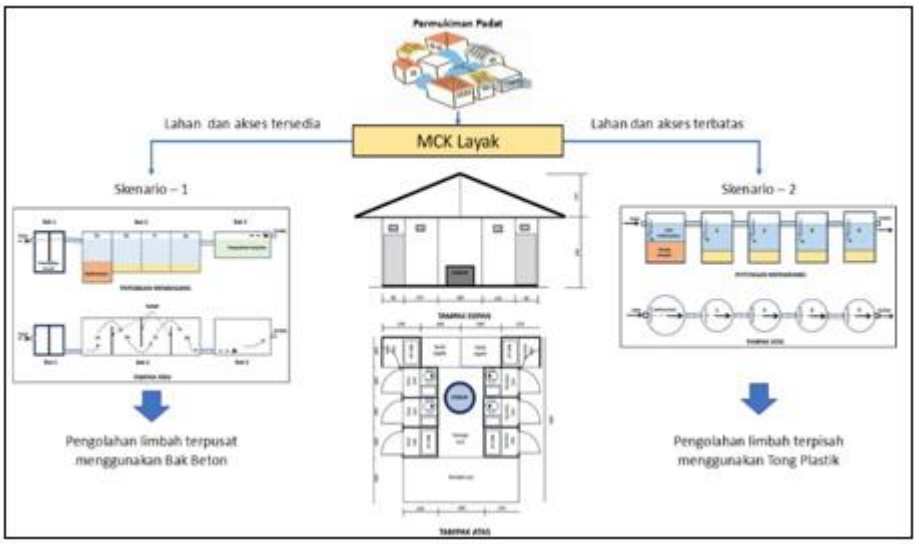

Figure 1. Scenario Model of Urban Dense Settlement Communal Toilet

Figure 1, the communal toilet model with communal toilet construction plan refers to (SNI 03-2399- 2002) on the planning procedures for communal toilet buildings. The toilet capacity needs to be adjusted to the number of potential users around the location. This research makes a communal toilet design plan for a maximum capacity of 120 people by considering the availability of land. The toilet design consists of 4 bathrooms with 4 latrines, 2 septic tanks, 1 dug well, and a washing area. Densely populated settlements in Bandung City have access difficulties in septic tank desludging. Sewage treatment in the SRAB scenario needs to be planned for safe implementation, and organic waste is treated under anaerobic conditions. It is necessary to drain the sludge by maintaining the capacity and efficiency of the system.

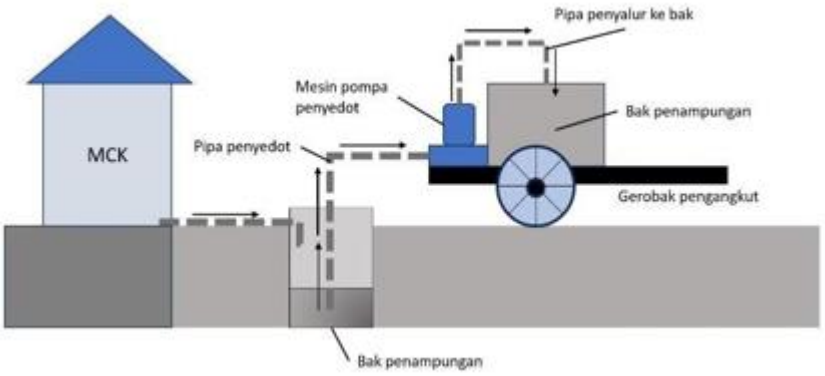

Figure 2. Desludging System in Urban Solid Settlements, West Java

Based on Figure 2, it is assumed that desludging is conducted once per year for both scenarios 1 and 2. The desludging system is carried out by a suction car. However, for dense settlements with limited land and access difficulties, scenario 2 is the best, considering that the plastic catch basin is more flexible and can be disassembled to suit the land condition of the communal toilet. The desludging system can be adjusted according to the size of the sumps. For 4 sumps with a height of 1 m and a diameter of 1.5 m, the desludging is specialized with a smaller sump tank size so that it

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can be transported using a wheelbarrow from the settlement to a collection van outside the settlement.

Costs associated with the construction of household latrines (including labor and materials, and excluding land costs) and connection to the municipal sewerage system. From a household perspective, on-site services are not necessarily cheaper than off-site services, and in many cases on-site services are more expensive. Sanitation involves a relatively large one-time capital investment, unless people purchase services on a pay-per-use basis. For customers who can access sewerage, the cost of connection and construction for households is not supported by people's economic ability to pay the cost of their monthly obligations. For households using on-site sanitation (private latrines and communal latrines), shared sewers are the most affordable option for households to achieve safe and reliable sanitation.

To address sanitation issues, Indonesia's national policy through the CLTS/ STBM program is that households must have access to sanitation, clean water, proper hygiene and a sustainable environment. Approaches need to be taken to achieve the target pillars of STBM success and motivate the community to be aware of changing behavior related to sanitation. Effective demand for sanitation by communities that need sanitation improvements, and are willing to invest funds and resources jointly and voluntarily.

CONCLUSION

This research produced a model for the construction of communal toilets in dense settlements with two waste treatment scenarios: scenario 1 with an integrated horizontal concrete basin system, which requires more land but has a lower risk of leakage. Scenario 2 with a flexible plastic cylinder basin system that is suitable for limited space, but requires more intensive maintenance. Both scenarios are designed according to the SNI 03-2399-2002 standard, with a maximum capacity of 120 people. The best option for dense settlements is scenario 2, due to its flexibility and ease of waste management. The results of this study emphasize the importance of safe waste management, accessibility, and affordability of sanitation facilities to support a decent and safe SDGs program in dense settlements.

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