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RESEARCH ARTICLE

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THE CONDITIONS OF SCHEDULED FECAL SLUDGE SERVICE IN KENDARI CITY, SOUTHEAST SULAWESI

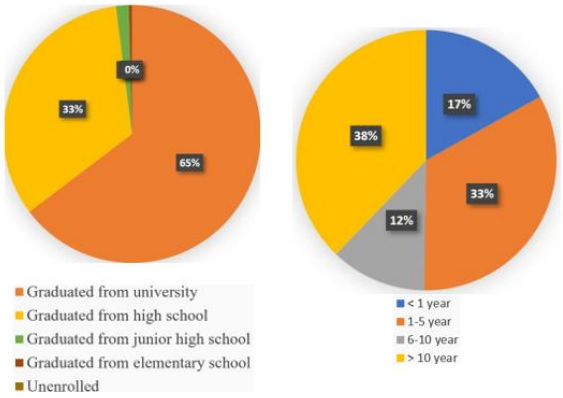
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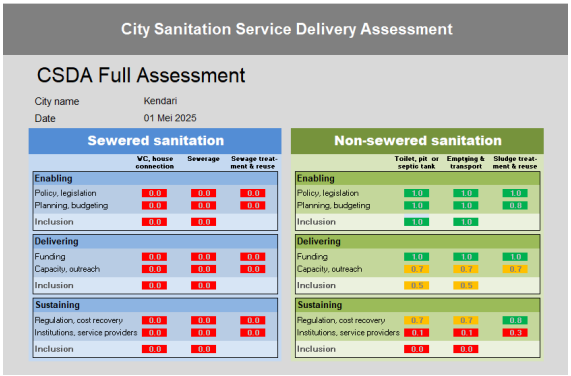
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Graphical abstract





ABSTRACT

The purpose of this study was to determine the existing condition, the knowledge, and the interest of the community regarding fecal sludge services. Qualitative data collected from interviews with stakeholders and random sampling questionnaire surveys to be analyzed using WEKA 3.9.8 software. Technical and management evaluations using the shit flow diagrams, as well as self-assessment of fecal sludge management. City Sanitation Service Delivery (CSDA) is used to collect data and formulate comprehensive conclusions. The results showed that the low service coverage (0.004%) of the total population occurred because the obligation to subscribe to the program was only carried out within the scope of the Regional Government Organization. The readiness of service implementation so far is only 63%. The questionnaire analysis using WEKA 3.9.8 shows that the lack of socialization is the main issue contributing to low service coverage. 82.6% are unaware of the L2T2 program, while only 17.4% are familiar with it. 74.1% of the community has not received information regarding sludge services, even though 72.1% of the community is interested in this program. The Shit Flow Diagram shows that only 6% of services are included in the safe category, in line with the City Sanitation Service Delivery, which shows that improving the data collection system, service inclusion, and strengthening the institutional framework have a high urgency to achieve the sustainability of this program.

Keywords: City Sanitation Service Delivery, Fecal Sludge, Scheduled Service, Shit Flow Diagram, Management

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1. INTRODUCTION

Urban fecal waste management is a crucial issue in the development and expansion of a region, particularly in areas experiencing rapid population growth and urbanization. The ineffectiveness of fecal waste management systems has been discussed by several previous researchers, demonstrating the need for improvements with affordable and effective methods to optimize them (Z. Cao et al., 2021). Kendari City, located in Southeast Sulawesi Province, manages fecal waste under the responsibility of the Public Works and Public Housing Agency. Fecal waste suction is mostly carried out from septic tanks in the homes of State Civil Servants (ASN) who have been registered and are required to undergo suction through the Scheduled Fecal Sludge Service (L2T2) program. On the other hand, Unscheduled Fecal Sludge Service (L2T3) activities are also carried out if there are residents who need suction. However, the Unscheduled Fecal Sludge Service (L2T3) program is not discussed specifically in this study because its implementation has not been optimally implemented due to the fact that many members of the public are still unaware of the impacts that will be caused with or without fecal waste management.

The Ministry of Public Works and Housing (PUPR) also stated in 2020 that the Scheduled Sludge Service (L2T2) is a more effective system in ensuring that sludge from septic tanks is properly managed according to a predetermined schedule. A study by the World Bank (2019) also showed that the Scheduled Sludge Service (L2T2) can reduce the risk of groundwater and drinking water pollution because sludge desludging is carried out routinely before septic tanks fail. Therefore, the statements above are strong reasons for this study to focus only on the implementation of the Scheduled Sludge Service, where this system still requires many improvements and developments for more sustainable implementation in Kendari City. Therefore, as an effort to support the implementation of an integrated and sustainable fecal waste management system in Kendari City, an analysis and discussion will be conducted regarding the existing conditions and the level of public knowledge regarding this program, as a basis or initial step to determine future strategic development plans.

2. MATERIALS AND METHODS

A. Research Overview

The first stage in this study was to determine the target respondents, namely households (as service recipients), IPLT managers, and local governments (PUPR Agency, Health Agency, Development Planning Agency at the Sub-National Level). Next, selecting a sampling method. The survey was conducted using a random sampling system in 11 (eleven) subdistrict in Kendari City using a Google Form questionnaire (Link: Kajian L2T2 Kota Kendari). The number of respondents was determined using the Slovin method (Sugiyono, 2017), namely:

Number of respondents (n) = $N / 1+N(d)^2$
Notes :
N : Population Size
D : health tolerance limits.

Based on 2024 data from the Central Statistics Agency, Kendari City is known to have a population of 355670, assuming 4 people per household, resulting in 88,918 households. Using a 7% error

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tolerance limit, the number of respondents was 204. Questionnaire data were analyzed using WEKA 3.9.6 (Waikato Environment for Knowledge Analysis) to visualize data distribution based on predetermined classifications. Analysis related to technical aspects used a shit flow diagram, while evaluation related to service management was conducted based on the Self-Assessment of Fecal Sludge Services, referring to the Ministry of Public Works and Public Housing's Scheduled Fecal Sludge Services Pocket Book. The City Sanitation Delivery Assessment was used to determine the Action Plan for sanitation development in Kendari City

3. RESULT AND DISCUSSION

The Kendari City Government has implemented efforts to improve environmental quality through the implementation of wastewater management. Currently, Kendari City has a Fecal Sludge Treatment Plant (IPLT) which was built in 2015 and optimized in 2018 so that its first operation was in 2019. If we look back at Kendari City's journey related to its domestic wastewater management, we can refer to the 2019 Kendari City Sanitation Strategy (SSK). The document explains that in order to implement the wastewater management policy, it will be carried out through scheduled non-cash fecal sludge services and the provision of rewards to the community, efforts to build safe septic tanks through the construction of septic tank grants for Low-Income Communities (MBR), the provision of "SERASI" credit intended for the development of wastewater and drinking water infrastructure with low interest and socialization to the community.

This program has not succeeded in increasing public interest in becoming customers of the L2T2 program. Regarding the progress of the wastewater sector in 2019, 2.18% of residents were indicated to be practicing open defecation (BABs) and 30.7% of feces were not channeled to septic tanks. In 2023, there will be improvements in waste management and sanitation, with people no longer practicing open defecation, while access to proper sanitation will increase to 90.38% and access to safe sanitation to 6.12%. However, this still needs to be improved because by 2024, access to safe sanitation in Kendari City should reach 15%.

A. Existing Conditions

Currently, Kendari City has a Fecal Sludge Treatment Plant (IPLT) named IPLT Puulonggida, built since 2015 and optimized in 2018 so that its first operation in 2019. IPLT Puulonggida is located in Watulondo Village, Puuwatu District, Kendari City. If we look back at Kendari City's journey related to its domestic wastewater management, we can refer to the Kendari City Sanitation Strategy (SSK) in 2019.

Based on technical aspects related to the desludging carried out by the wastewater technical implementation unit (UPTD), the majority still comes from the septic tanks of civil servants (ASN) who have been registered and are required to have desludging carried out through the scheduled sludge desludging service (L2T2). In terms of operations, the desludging service is not yet optimal due to the large number of users who are not willing to have desludging carried out when the desludging schedule arrives. Furthermore, it is indicated that the septic tanks owned by residents are not watertight, and the socialization process has not been optimal.

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Figure 1. Kendari City Wastewater Treatment Plant (Coordinates x = 440434.00; y = 9564416.00)

Table 1. Existing Service

Description	2020	2021	2022	2023	2024
1.L2T2	279	175	84	106	391
2.L2T3	531	569	411	423	-
2.1 By request	561	609	437	462	314
2.2 By trip	840	784	521	568	705
Total Service	4200	3920	2605	2840	3525

Table 1 shows the development of sludge services in Kendari City under two schemes, namely L2T2 (Scheduled Sludge Services) and L2T3 (Unscheduled Services), over the past five years. Based on this data, it can be seen that in 2022 the service frequency was the lowest, namely 84 suctions, but increased again until 2024 to 391 services. The fluctuations that occurred indicate the need for more stable and sustainable management initiatives and strategies. Referring to the trend of customer interest in L2T2 services in Table 1, an independent assessment of the condition of sludge management in Kendari City was conducted in Table 2, which contains 10 (ten) main assessment indicators to reflect priorities in domestic wastewater management. The assessment was conducted based on the results of direct interviews with the Kendari City Wastewater Treatment Plant (IPLT) referring to the Scheduled Fecal Sludge Services Pocket Book (L2T2), Ministry of Public Works and Public Housing 2023. Kendari City received a score of 63% out of a total score of 100% regarding the extent to which the implementing institution's capacity in implementing the L2T2 program effectively and efficiently.

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Table 2. Self-Assessment of Fecal Sludge Management

No.	Criteria	Weight	Value	Notes
1.	Are there any regulations regarding Domestic Wastewater Management (PALD), specifically those governing septic tanks and their drainage?	15	10	Exist and complete, in the form of a Regional Regulation or Decree of the Regional Head
2.	Regulations (Regional Head Regulations/Decrees) regarding PALD Cooperation with Third Parties	10	6	It already exists, but there is no/lack of law enforcement, and no supervision/monitoring.
3.	Institutional Forms for Domestic Wastewater Management	10	7	In the form of UPTD PALD
4.	Number of transport vehicles (sewage trucks, sewage cars, sewage motorbikes) owned by the manager (including third parties) and in operational condition	10	5	Total between 2-5 Units
5.	Condition of the building and operation of the wastewater treatment plant	15	10	Good building, operating sub optimally (idle capacity more than 50%)
6.	The existence of private (third party) suction service companies	10	2	Exist, but no identified mud disposal activity/originating from other areas
7.	Recording of sludge entering the IPLT	5	3	There is no recording and the fecal sludge is directly dumped into the wastewater treatment plant (IPLT).
8.	Budget Allocation for Operational & Maintenance (O&M) Costs of Wastewater Treatment Plants and Transportation	10	10	All costs are allocated (investment, rehabilitation, O&M IPLT and transportation) with adequate capacity.
9.	Sanitation socialization and campaign activities, especially regarding domestic wastewater	10	7	Complete PHBS socialization and campaigns have been held in only a few areas.
10.	Program planning for the development of technical, regulatory, institutional, financial, and socio-economic aspects related to IPLT Management	5	3	There are several programs and have implemented some of the program plans.
	Total	**100**	**63**	
	Maximum Score	**100**	**63**	
	Percentage	**100%**	**100%**	

These overall scores indicate that while the basic foundations for sludge management are in place, improvements are still needed in monitoring, recording systems, participation by private sludge services, and optimization of existing infrastructure. These factors are crucial for promoting a sustainable and more efficient sludge management system in the future.

B. Evaluation of Community Knowledge Level

One important aspect to understand is the community's interest in and knowledge of the L2T2 program. The success of scheduled sludge management services in urban environments is closely linked to the dynamics of community socialization, the process through which individuals internalize norms, values, and behaviors deemed appropriate by their community (Tumwebaze & Mosler, 2014). This internalization has a significant impact on the implementation and utilization of sustainable sanitation services, including the acceptance and appropriate use of scheduled sludge disposal programs (Moledo et al., 2021). This urgency stems from the need to map strategic steps to increase community participation and support the determination of appropriate and targeted socialization patterns. The graph shown below shows some important information regarding the social characteristics and knowledge of the community regarding sanitation in Kendari City from 200 identified respondents.

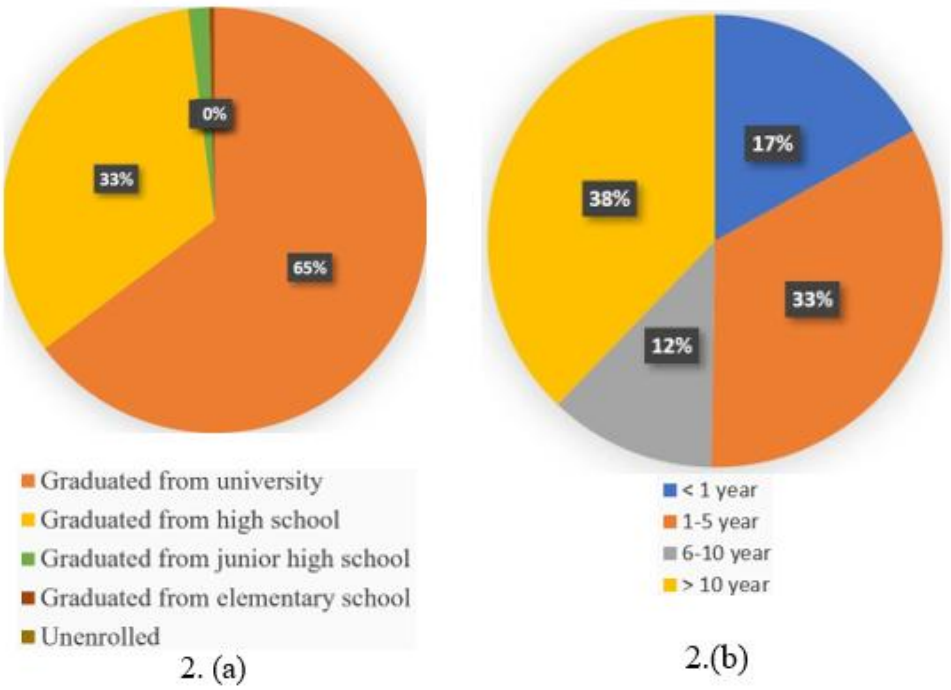


Figure 2. (a) Respondent's education level, (b) Length of residence at current location

The demographic profile of survey respondents often includes variables such as age, gender, education level, occupation, and socioeconomic status, which collectively paint a comprehensive picture of the surveyed population (Abbas et al., 2020). Analysis of consumers' gender, age, and education level influences their decisions about market attributes, particularly consumer behavior and product and service awareness (Alpert, 2012; Muzayyanah et al., 2021). Respondents' education (Figure 2.a) shows that 65% had completed college, while 33% had completed high

school. These data indicate that most respondents have a relatively high level of education. However, the data in Figure 4.(a) shows that even though respondents' education levels are high, this does not directly affect their knowledge of the L2T2 program. Figure 2.b shows that 38% of respondents have lived in the location for more than 10 years. As many as 33% lived for 1-5 years, 17% less than one year, and only 12% lived for 6-10 years, which shows that most of the respondents are residents who have lived in the area for a long time.

Figure 3.a shows that 90% of the population lives in permanent houses (brick or concrete block construction), indicating that the respondents' living conditions allow for the implementation of a better sanitation system. Figure 3.b shows that 56% of the population is aware of the existence of the wastewater treatment plant (IPLT), while 44% are unaware.

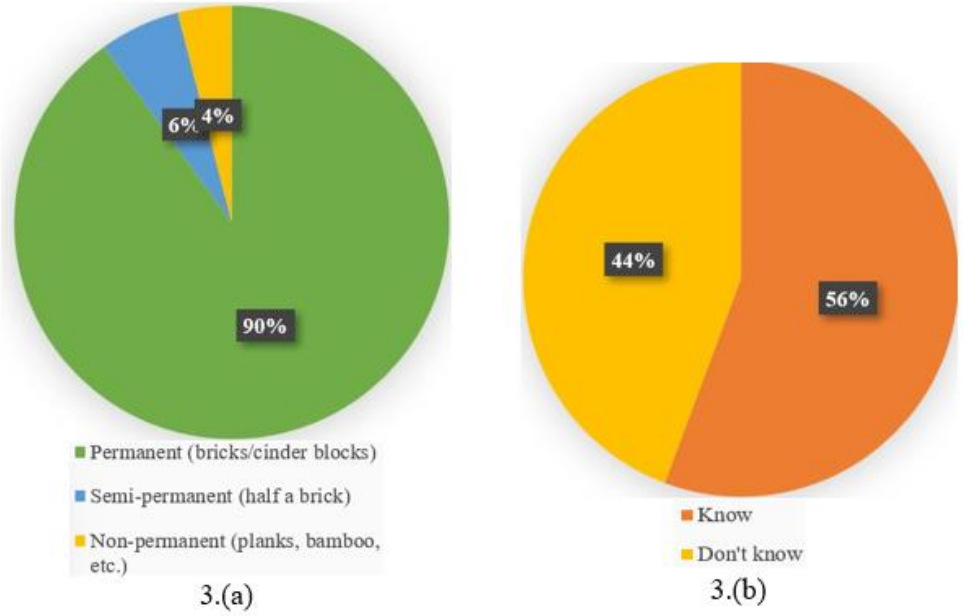


Figure 3. (a) Type of physical building of the house, (b) Knowledge about IPLT

Knowledge of the L2T2 Program (Figure 4.a) shows that 83% were unaware of the L2T2 program, while only 17% were aware of it. This indicates the need for increased education and more intensive outreach on the L2T2 program in safe and sustainable sanitation management. As stated in the study by Kazora and Mourad (2018), understanding the various ways in which community outreach influences these services is crucial for optimizing outcomes related to public health and environmental sustainability, particularly in areas experiencing rapid urbanization where sanitation infrastructure often lags behind population growth. Community participation is crucial for effective waste management, yet residents often fail to recognize their role and are unwilling to pay for services or participate in environmental campaigns (Rangeti and Zwairo, 2021).

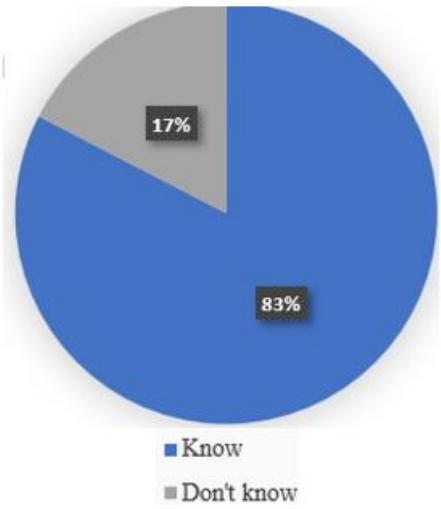


Figure 4. Knowledge of the L2T2 program

Figure 5.a shows that the community has not received information regarding the service, even though 72% (Figure 5.b) of the community are interested in L2T2 services, assuming the number of customers will increase significantly if socialization can be carried out properly. In this case, the majority of the community agrees with the program of periodic and paid septic tank emptying. The findings of this study reveal that community outreach plays a crucial role in shaping attitudes and behaviors towards scheduled sludge services. Effective strategies, such as educational workshops and community outreach, can raise awareness and foster a sense of ownership, thereby improving social sustainability performance (Bag et al., 2023). This underscores the importance of integrating community-based approaches into the design and implementation of sanitation programs, ensuring that they are not only technically sound but also socially acceptable and culturally relevant (Puspitawati & Rahdriawan, 2012).

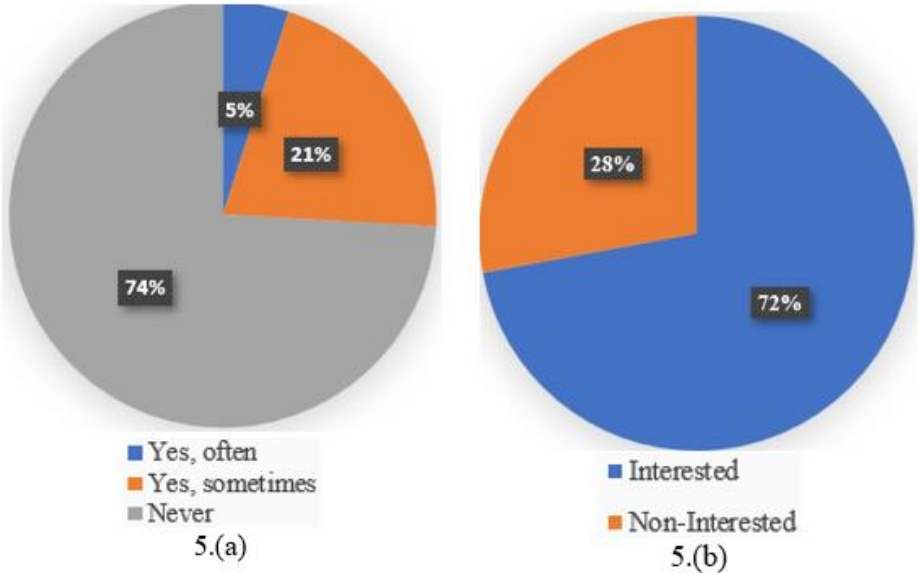
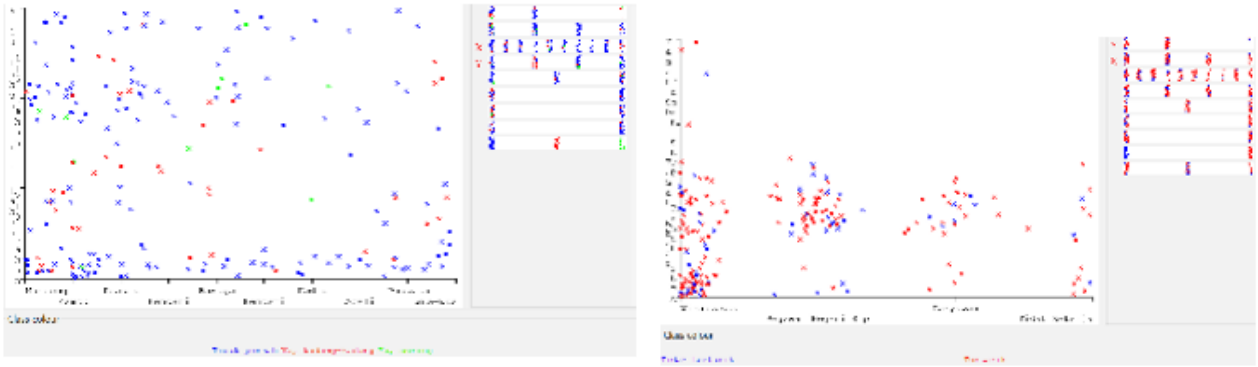


Figure 5. (a) Information related to socialization, (b) Customer interest in L2T2

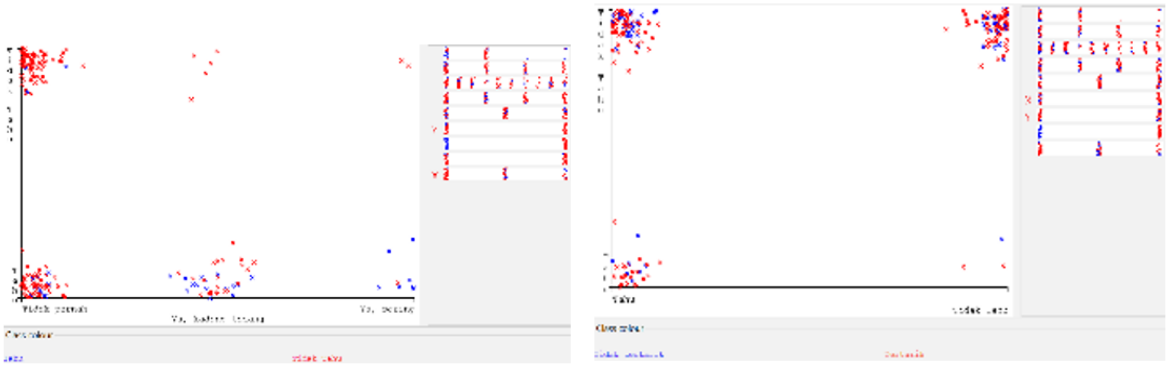
The analysis results were visualized in the form of a scatterplot diagram using WEKA 3.9.6 software as a graphical representation of the relationship between two continuous variables, their direction, and the form of the association. A scatterplot is obtained by plotting data points on a two-dimensional graph, with the position of each point determined by the corresponding value for the two variables being examined (Han & Kwak, 2023). The arrangement of these points reveals a pattern that can indicate the nature of the relationship between the variables, which can be assessed visually (Stockemer, 2018).



(a) (b)

Figure 6. (a) X: Address, Y: Length of residence at current residence in relation to socialization, (b) X = Occupation, Y = Education in relation to interest in becoming a customer

The correlation between residential address (X-axis) and length of residence in the current residence (Y-axis) to the socialization of L2T2 services (Figure 6.a) is classified into 3 (three) warning categories: blue (never received socialization), red (sometimes received socialization), and green (often received socialization). The graph above shows a random distribution of colors that does not form a clear linear pattern, indicating that length of residence at an address is not necessarily directly proportional to the level of socialization received. This means that even though someone has lived in an area for a long time, they may not have received information or education related to a particular program or issue. This visualization emphasizes the importance of evaluating information dissemination strategies to ensure that socialization activities truly reach the entire population, including both long-time residents and newcomers, thus ensuring a more equitable distribution of public knowledge across the region.



(a) (b)

Figure 7. (a) X = Socialization, Y = IPLT Knowledge of L2T2 Service Knowledge, (b) X = Knowledge of IPLT, Y = L2T2 Knowledge of Interest in Becoming a Customer

Figure 6.b. displays a scatter plot visualizing the relationship between respondents' occupations on the X-axis and their education levels and their interest in becoming customers on the Y-axis. The X-axis is divided into three occupational categories: ASN (State Civil Apparatus), non-OPD ASN, and non-ASN. The Y-axis displays education levels ranging from elementary school incomplete, elementary school completed, junior high school completed, high school completed, and higher education levels. The points on the graph are distinguished by color: blue represents respondents who are not interested in becoming customers, while red represents respondents who are interested in becoming customers. The distribution of the points shows that the non-ASN group dominates the respondent population in this graph, with a wider variety of educational levels. Meanwhile, respondents working as ASN and non-OPD ASN are much smaller in number and tend to be concentrated at the secondary or higher education level. Within the ASN group, the majority of the points are blue, indicating a tendency for more ASN respondents to be uninterested in becoming customers. The same trend is seen in the non-OPD ASN group, although the distribution is more even. On the other hand, in the non-ASN category, the distribution of red and blue dots looks more balanced, indicating that the level of interest in becoming a customer in the non-ASN group tends to be higher than that of ASN.

Figure 7.a illustrates the relationship between the frequency of socialization (X-axis) and knowledge about the Sludge Treatment Plant (IPLT) on the Y-axis, which is classified into two color categories: blue (knowledgeable) and red (unknowable) regarding the community's knowledge about the Sludge Treatment Plant (L2T2). Based on the graph, it can be concluded that the group that never participated in socialization is dominated by respondents who are unaware of both the Sludge Treatment Plant and the Sludge Treatment Plant (L2T2), as indicated by the number of red crosses at the top (unknowable) on the Y-axis. Conversely, in the group that occasionally to frequently participated in socialization, there was an increase in the number of respondents who knew about the Sludge Treatment Plant, indicated by the greater number of blue crosses at the bottom of the graph (unknowable). However, a number of respondents remained unaware despite having participated in socialization, indicating that the effectiveness of socialization can vary depending on the method and content. Overall, this graph shows a positive correlation between participation in socialization and the level of community knowledge about the Sludge Treatment Plant and the Sludge Treatment Plant. This means that the more frequently the community participates in outreach activities, the more likely they are to have good knowledge about scheduled sludge management. This underscores the importance of the intensity and quality of outreach activities in increasing public understanding of sanitation services.

Figure 7.b illustrates the correlation between knowledge of wastewater treatment plants (IPLT) and wastewater treatment plants (L2T2) and interest in becoming a customer. The graph shows that although many people are unfamiliar with the IPLT and L2T2, they still show interest in becoming customers. However, increasing knowledge about both tends to strengthen interest. Therefore, public education is believed to be key to increasing participation in urban wastewater services. To improve sanitation services, community participation is crucial to acquire local knowledge and ensure that programs meet specific requirements, ultimately resulting in community empowerment and improved health outcomes (Menon & Palackal, 2021).

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C. Evaluation of Sanitation Conditions Using Shit Flow Diagrams

The SFD chart (Figure 8) visualizes the condition of the sanitation management system in Kendari City based on data from the Kendari City Government, which still faces serious challenges. The entire existing sanitation system is onsite, meaning there is no offsite sanitation network that drains wastewater directly to the treatment plant. This graph illustrates the flow of faecal sludge (FS) and wastewater (WW) management from containment, emptying, transport, to treatment. The diagram shows two main pathways: the green pathway represents safely managed management, while the red pathway indicates unsafely managed management. The dominant distribution of the red pathway shows that the majority of faecal sludge directly pollutes the local environment, the neighborhood, and even impacts the city.

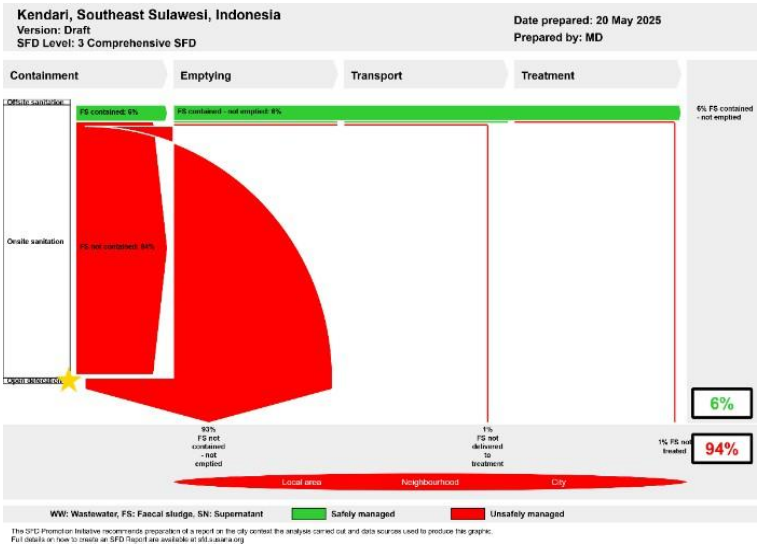


Figure 8. SFD graph

Based on data from the Kendari City SSK Instrument, wastewater access achievement shows that 6.12% of the population has safe access, 89.75% has individual adequate access, 0.63% has shared adequate access, 3.49% has inadequate access, and there is no practice of open defecation. However, when compared to the SFD graph results, there is a significant disparity. The graph shows that only 6% of fecal sludge is managed safely, while the remaining 94% is not managed safely (unsafely managed). Most fecal sludge is not emptied (93%), and only 1% is successfully emptied but does not reach the processing stage. Although the level of access to adequate sanitation is quite high, the low level of emptying and processing indicates that the wastewater management system is not running optimally.

D. City Sanitation Delivery Assessment (CSDA)

The City Service Delivery Assessment (CSDA) is a complementary tool to assess the enabling environment for citywide inclusive sanitation, and to present the results in a simple and accessible way. It also includes an Action Checklist to help stakeholders identify and prioritise immediate and follow-up actions to improve the enabling environment for the delivery and sustained operation of inclusive sanitation services across the city (SuSanA, 2018). After conducting a full CSDA analysis, the results are shown in Figure 9.

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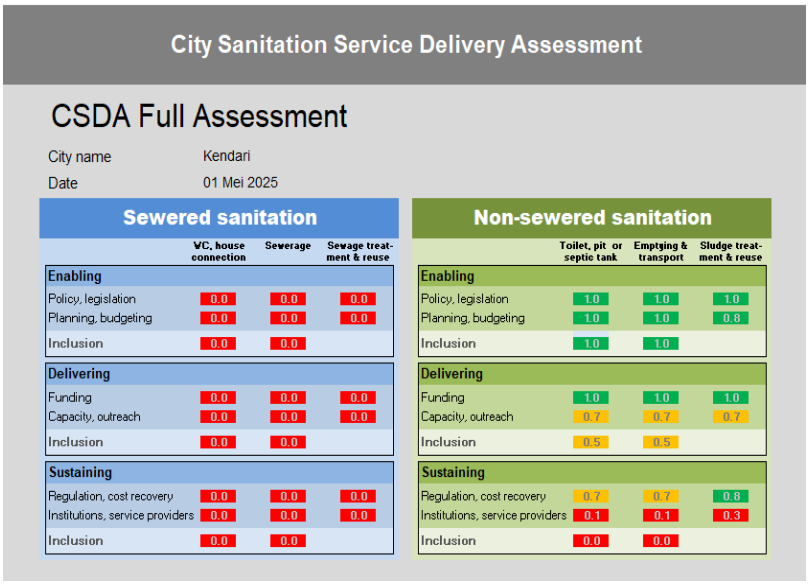


Figure 9. CSDA graph

Kendari City has not implemented Sewered Sanitation, therefore the analysis result for Sewered Sanitation in Figure 9 is valued at 0 (zero). The Non-sewered sanitation aspect has 3 (three) main components, namely septic tanks or toilets, sludge transportation (emptying & transport), and sludge treatment and utilization (sludge reuse). This system has shown quite good progress in the enabling and delivering stages, although it still faces challenges in the sustaining aspect. At the delivering stage which reflects the capacity of implementation and service delivery. The capacity and reach of services (capacity and outreach) show slight weaknesses, especially in sludge treatment & reuse which only obtained a score of 0.7, indicating that the management and outreach of sludge processing services are not optimal. The inclusion aspect at this stage shows a score of 0.5 to 0.7, which indicates that in practice, there are still challenges in reaching all community groups evenly. Meanwhile, at the sustaining stage, which includes the long-term sustainability of services, the score shows significant weaknesses, especially in sludge treatment & reuse which only obtained a score of 0.3. This indicates that although sludge removal is underway, final sludge management is not yet systematic and sustainable and may lack a clear cost recovery scheme. The regulatory and institutional scores for toilets and transportation range from 0.7 to 0.8, indicating that there is still room for improvement in institutional strengthening and oversight systems.

4. CONCLUSION

The results of the observations conducted indicate that the tria model of the Scheduled Sludge Service which requires all ASN (State Civil Apparatus) from all Regional Government Organizations (OPD) to become customers has not in fact provided a significant impact on the implementation of this program. Identification based on the Ministry of PUPR's sanitation pocket book shows that the readiness condition for implementing this service is only 63%. Referring to the results of a random survey in 11 (eleven) sub-districts in Kendari City, shows that public knowledge of the availability of services tends to be low, where 82.6% are not aware of the existence of this program. As many as 74% of the community did not receive socialization, even though 72 of the respondents were interested in becoming customers of this service. These results are reinforced by analysis using WEKA 3.9.8 software, showing that the lack of socialization to the community is the main issue why this program has not developed and been implemented optimally. Analysis of the service system

using the Shit Flow Diagram shows that only 6% of services are included in the safe sanitation category. The CSDA analysis shows that the non-piped sanitation system in Kendari City generally has a sound policy framework and implementation system. However, indicators that need improvement include sludge utilization and operational sustainability. Therefore, efforts are needed to improve the data collection system and service inclusion, as well as strengthen the institutional framework so that the program functions sustainably and reaches all levels of society. This can be realized in a roadmap and action plan for the next few years.

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