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Identifying Public Awareness and Implementation Challenges in 3R-Based Household Waste Management: A Case Study of Kendari City, Southeast Sulawesi

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Abstract. *Household waste management is an increasingly complex environmental issue in line with population growth and rising community activities. This study aims to examine household waste management practices based on the 3R principles (Reduce, Reuse, Recycle) in Kambu Urban Village (Kendari, City, Southeast Sulawesi) and to analyze the level of public awareness and the constraints encountered in its implementation. A mixed-methods approach was employed, using questionnaires, interviews, and observations for data collection. Respondents were selected through random sampling from the local community. The results indicate that household waste management based on the 3R principles is perceived as very poor, with a mean score of 4.43. The availability of 3R facilities and infrastructure is also categorized as very inadequate, with a mean score of 4.39. Community participation and support remain very low, reflected by a mean score of 4.27. However, respondents demonstrated relatively good awareness of the environmental benefits of implementing the 3R concept, with a mean score of 4.31. The main constraints in optimizing 3R-based waste management include limited availability of waste segregation bins, absence of waste banks, and inadequate waste collection services in narrow residential alleys. This study reveals that household-level 3R waste management in Kambu Village has not been optimally implemented due to infrastructural limitations and low community engagement.*

Keywords: *Waste; Hosehold; Management; 3R; domestic.*

Pendahuluan

Household waste management is a critical issue in sustainable urban development because it is directly linked to environmental pollution and public health (Jurumai et al., 2023). Household waste is one of the main contributors to waste generation in Indonesia, which continues to rise alongside population growth and changing consumption patterns (Sumarlin et al., 2021). The imbalance between the volume of waste generated and the limitations of local management systems calls for a source-reduction approach, one of which is the Reduce, Reuse, Recycle (3R) concept as a more sustainable and participatory management strategy (Wibowo et al., 2025). Empirically, the Kambu subdistrict in Kendari City (Southeast Sulawesi) faces significant challenges in household waste management. The Kambu neighborhood, with a population of approximately 8,039, has numerous illegal dumping sites, particularly in narrow alleys and areas with student housing and urban worker accommodations (Munawir et al., 2024; Rusdiyanto et al., 2024). This situation is exacerbated by the social characteristics of the community, which is dominated by a transient population with high mobility, low environmental awareness, and a lack of oversight, as well as uneven waste collection services (Prathna et al., 2025). This indicates that social and institutional factors play a significant role in the failure of waste management at the local level (Aparcana, 2017; Awino & Apitz, 2024).

Based on social factors, limited waste management infrastructure also poses a major obstacle to the implementation of 3R-based management (Akramila et al., 2025; Hendra & Arisanty, 2025). In Kambu Village, facilities such as sorted waste bins, waste banks, 3R collection points, and waste collection services in narrow alleys remain very limited; in fact, there is only one 3R collection point in certain areas (Haryati, 2022; Rosmawaty et al., 2025). Previous research indicates that a weak door-to-door collection system leads to waste accumulation and low community participation in 3R programs (Laurieri et al., 2020; Zheng et al., 2017). More broadly, this situation reflects the lack of integration between technical and institutional systems in urban waste management. Currently, waste volumes across the country have also fluctuated in recent years, with consistently high levels, and plastic waste accounts for around 30% of total daily waste (Rafizul et al., 2024). This situation underscores the urgency of implementing a more effective source-separated management system, given that plastic waste primarily originates from household activities and markets (Dharia et al., 2023; Sukholthaman & Sharp, 2016). Several studies also indicate that budget constraints, low public awareness, and weak enforcement of regulations are multidimensional factors exacerbating waste management systems in Indonesia (Maskun et al., 2025; Salsabila et al., 2023).

Therefore, the 3R concept is viewed as a strategic approach that not only focuses on waste reduction but also promotes a circular economy, enhances the value of waste, and strengthens community participation (Chareonvong et al., 2025; Nirmani, 2024). However, its implementation at the household level still faces various challenges, particularly in developing urban areas such as Kambu Village, Kendari City. Consequently, this study is significant as it offers a novel empirical analysis of 3R practices, integrating aspects of public awareness, infrastructure availability, and barriers to waste management implementation in Kendari City. The findings are expected to serve as a scientific foundation for formulating more effective, participatory, and context-specific waste management policies.

Method

This study employs a mixed-methods approach using a sequential explanatory research design. The sample of respondents consists of heads of households (HHs), with the study focusing on Kambu Village, Kendari City, Southeast Sulawesi. Respondents were selected using random sampling, with a total of 94 households (based on the Slovin formula with a total population of 1,608 and a margin of error of 0.1), where each household had an equal chance of being selected (Prihandari & Wahyuni, 2023). Finally, the selected households were designated as research respondents and were subsequently given questionnaires to collect the necessary data. The data sources in this study fall into two categories: primary data and secondary data. Primary data was collected directly from the community through questionnaires, interviews, and field observations. Secondary data was obtained from various sources, including official government documents, previous research reports, and relevant scientific publications (Wibowo et al., 2026). The research flowchart begins with a literature review and a survey. This is followed by data collection, which consists of primary and secondary data. The primary data collected includes field observations (of existing waste management practices), a questionnaire assessing public understanding of the 3R implementation, and in-depth interviews regarding challenges and the role of sanitation workers in implementing the 3R. Additionally, secondary data was obtained, such as population data, waste volume data, and waste management regulations. This is presented in the research flowchart in Figure 1.

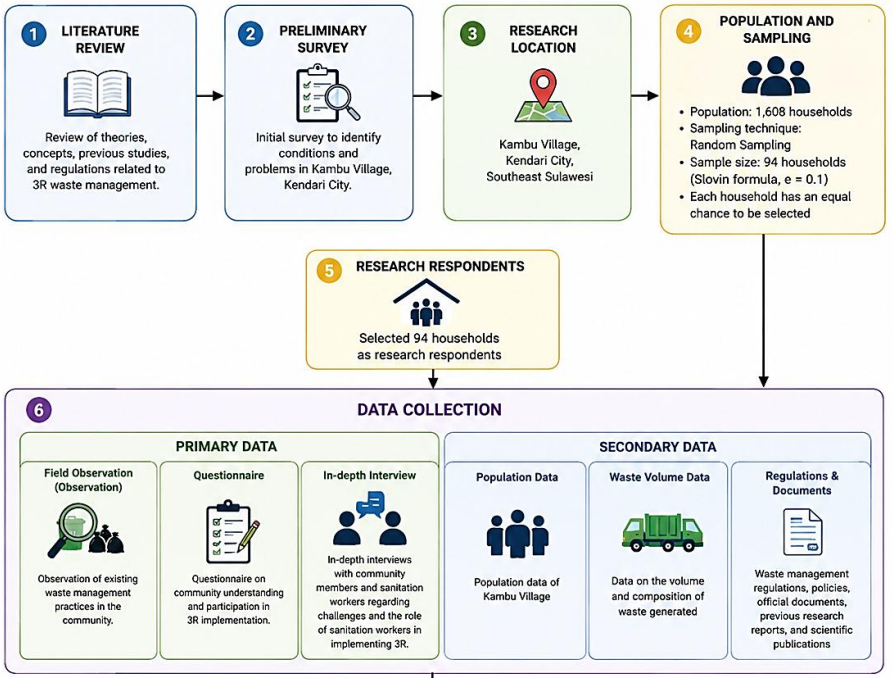

Figure 1. The research flowchart for identifying household waste management

Result and Discussion

Overview the research location

Kambu Village is one of four (4) administrative villages located in Kambu Sub-district, Kendari City, Southeast Sulawesi Province, Indonesia. The village forms part of the residential area of Kendari City and is one of the largest villages in Kambu Sub-district, with

a high population density. The subdistrict encompasses several higher education campuses, schools, government offices, and numerous markets or other economic hubs (Figure 2).

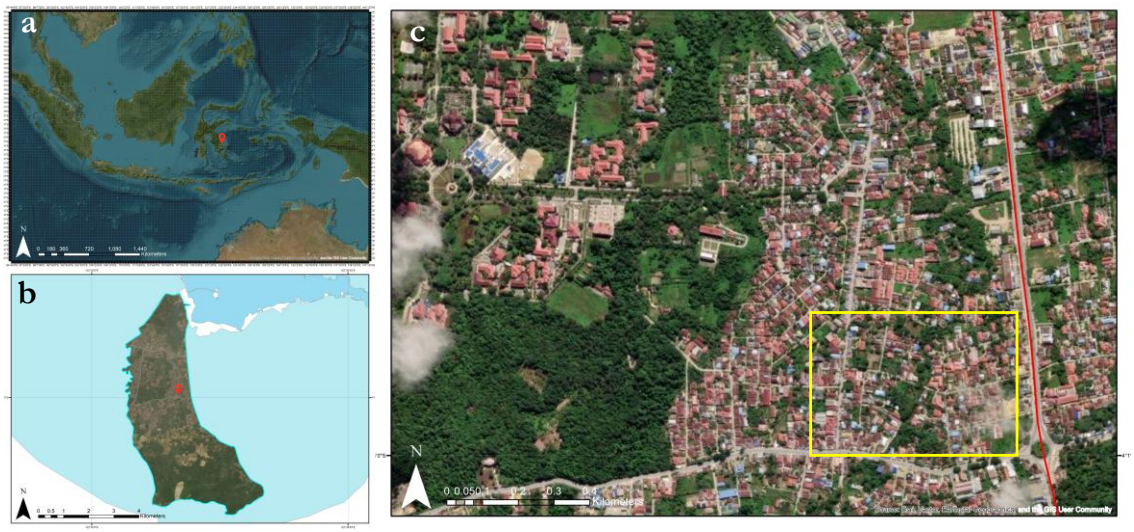

Figure 2. Overview the research location "Kambu Sub-district, Kendari City, Southeast Sulawesi Province, Indonesia"

This sub-district also faces challenges in waste management, which is not yet optimal, as initial observations by the researchers indicate that a large amount of household waste is still being disposed of not at temporary waste collection points, but along the edges of main roads, riverbanks, and narrow alleys. The results of the field observations can be seen in Table 1.

Table 1. The State of Household Waste Management in Kambu Sub-district

Question(s)	Answer
Is there a waste collection/transport service available?	Yes
Is there a temporary waste collection point available?	Yes
Is there an illegal waste disposal point?	Yes
Is there a 3R waste treatment facility?	Yes
Is there a waste segregation facility available?	No
Is there a waste collection vehicle available?	Yes
Handcart (waste cart)	No
Three-wheeled motorized waste vehicle	No
Truck	Yes

Table 1 shows that the management of household waste in Kambu Sub-district is still not optimal. This area already has waste collection and transport services, and there is even a 3R waste transfer station in Kambu Sub-district. However, the sub-optimal management of 3R-based waste is caused by high population density that is not matched by the availability of adequate waste sorting facilities, as well as the limited availability of small-scale transport vehicles such as handcarts or three-wheeled vehicles (motorised tricycles). This situation has led to the continued presence of numerous illegal waste dumping sites around residential areas. An example of an illegal waste collection point in Kambu Sub-district is shown in Figure 3.

Figure 3. Overview the management of household waste in Kambu Sub-district is still not optimal

Analysis of respondent demographics

Based on the gender breakdown of the total 94 respondents, there were 63 male respondents (67%) and 31 female respondents (33%). This composition indicates that the sample was predominantly male; nevertheless, the information obtained reflects the views of both groups proportionally in assessing the participation in and implementation of 3R-based waste management at the household and community levels. Respondents were in the 17–25 age group, comprising 43 people (46%), followed by the 46–55 age group with 20 people (21%), then the 26–35 age group with 16 people (17%) and the 36–45 age group with 15 people (16%). This composition indicates that the respondents were predominantly young people who generally play an active role in socio-economic activities and are therefore likely to support engagement in the promotion of 3R-based household waste management (sorting, separate collection, and institutional participation). In terms of educational attainment, the respondents held a bachelor's degree (S1), totalling 64 people (68%), followed by those with a high school qualification or equivalent, totalling 23 people (24%). Meanwhile, there were 7 respondents (7%) with a postgraduate qualification. This composition indicates that many respondents have a higher education background, which generally has the potential to support their ability to understand information, participate in awareness-raising activities, and adopt 3R-based household waste management practices.

Table 2. Characteristics of Respondents in the Study

No.	Variable	Category	Frequency (n)	Percentage (%)
1	Gender	Male	63	67
		Female	31	33
2	Age (years)	17–25	43	46
		26-35	16	17
		36-45	15	16
		46-55	20	21
3	Education Level	Senior High School / Equivalent	23	24
		Bachelor's degree (S1)	64	68
		Master's degree (S2)	7	7
4	Occupation	Civil Servant (ASN)	29	31
		Private Employee	26	28
		Entrepreneur	26	28
		Daily Laborer	3	2
		Housewife	10	11
5	Monthly Income (IDR/month)	< 1,000,000	12	13
		1,000,000 – 1,999,999	13	14
		2,000,000 – 2,999,999	23	24
		3,000,000 – 3,999,999	33	35
		≥ 4,000,000	13	14

Twenty-nine respondents (31%) worked as civil servants, followed by 26 private-sector employees and 26 self-employed individuals (28% each), and 10 housewives (11%). Meanwhile, there were 3 daily wage earners (3%). This composition indicates a dominance of government workers, primary sector jobs and self-employment, which generally involve varying work schedules and may affect the consistency of engagement in 3R activities. Civil servants tend to have better access to information, but their participation is often limited by time constraints, whereas housewives can participate at a high level if the 3R service mechanisms are flexible, offer good economic benefits, and if they understand the rules and have access to easy-to-understand sorting facilities. The respondents fell within the Rp3,000,000–Rp3,999,999 per month bracket, totalling 33 people (35%), followed by the Rp2,000,000–Rp2,999,999 bracket with 23 people (24%). Respondents with an income of ≥ Rp4,000,000 and Rp1,000,000–Rp1,999,999 each numbered 13 people (14%), whilst those with an income of < Rp1,000,000 constituted the smallest group at 12 people (13%). This composition indicates the dominance of the middle-income group; therefore, the strengthening of the 3R programme should emphasise community self-reliance schemes that are low-cost yet provide direct benefits (e.g. transparent waste bank incentives, reductions in waste costs/volume, and simple 3R-based sorting facilities), as this group tends to be more responsive to tangible economic benefits than to approaches that are merely advisory in nature.

Analysis of respondent data

The meaning of the categories used in interpreting the results of this study is based on the respondents' scores. The data on respondents' responses from the study regarding the factors under investigation were analysed using the average score of the respondents' statements. Based on the research findings obtained through the questionnaire, the objective conditions for 3R-based household waste management referred to in this study were measured using four indicators, namely: community behaviour in 3R-based waste management, the availability of facilities and infrastructure, community support and participation, and the impact of 3R implementation on the environment (Table 3).

Table 3. Mean Score Range and Categories of Respondents' Perceptions

Mean Score	Category of Respondents' Perception	Community Behavior in 3R-Based Waste Management	Availability of 3R Facilities & Infrastructure	Community Support & Participation
1.00 – 1.79	Very Good	Very Good	Very Good	Very Good
1.80 – 2.59	Good	Good	Good	Good
2.60 – 3.39	Fairly Good	Fairly Good	Fairly Good	Fairly Good
3.40 – 4.19	Poor	Poor	Poor	Poor
4.20 – 5.00	Very Poor	Very Poor	Very Poor	Very Poor

According to respondents (Table 4), household waste management based on the 3R principles falls into the 'very poor' or 'strongly disagree' category, as indicated by an average rating of 4.43. Like the first indicator, the indicator for the availability of 3R facilities and infrastructure also falls into the 'very poor' category, with an average score of 4.39. The indicator for community support and participation was also very low, with an average score of 4.27. The indicator for the environmental impact of 3R implementation showed positive results, as the community is aware of the benefits of 3R implementation, with an average score of 4.31.

Table 4. Freqsuency of Respondents' Answers

Item (Ques.)	Frequency of Respondents' Answers (F) and Percentage (%)										Mean
	Very Poor (5)		Poor (4)		Fairly Good (3)		Good (2)		Very Good (1)		
	F	%	F	%	F	%	F	%	F	%	
A1	35	37	53	56	5	6	1	1	0	0	4.30
A2	52	55	40	43	2	2	0	0	0	0	4.53
A3	46	49	46	49	2	2	0	0	0	0	4.47
(A) Average Community Behavior Factor in 3R-Based Waste Management											**4.43**
B1	37	39	52	55	5	6	0	0	0	0	4.34
B2	39	41	51	54	4	5	0	0	0	0	4.37
B3	45	48	46	49	3	3	0	0	0	0	4.45
(B) Average Availability of 3R Facilities & Infrastructure Factor											**4.39**
C1	29	30	55	59	10	11	0	0	0	0	4.20
C2	36	38	49	52	9	10	0	0	0	0	4.29
C3	38	40	49	52	7	8	0	0	0	0	4.33
(C) Average Community Support & Participation Factor											**4.27**
D1	44	47	46	48	3	4	1	1	0	0	4.41
D2	31	33	53	56	9	10	0	0	1	1	4.20
D3	40	43	45	47	9	10	0	0	0	0	4.33
(D) Average Environmental Impact of 3R Implementation Factor											**4.31**
Overall Mean Score of 3R-Based Household Waste Management											**4.35**

Referring to Table 4, the indicator of community behavior in 3R-based waste management (A) shows that household practices in Kelurahan Kambu remain very low. Respondents (over 90%) reported not practicing waste segregation, reuse of materials, or composting organic waste. Specifically, respondents indicated that waste separation is not conducted at source, reusable items are generally discarded rather than reused, and organic waste is not processed into compost. These data demonstrate that the implementation of 3R principles at the household level is still not embedded in daily community behavior. The indicator of 3R facilities and infrastructure availability (B) reveals similar conditions of inadequacy. Most respondents (above 94%) stated that there is no separation of waste bins for organic and inorganic waste, no waste bank services in the surrounding area, and no waste collection services operating in narrow residential alleys. This indicates that the supporting infrastructure required to implement effective 3R-based waste management is still very limited, thereby constraining behavioral adoption at the community level.

The indicator of community support and participation (C) also reflects low engagement. More than 89% of respondents expressed unwillingness to allocate time for communal cleaning activities, to encourage neighbors to adopt 3R practices, or to serve as role models in waste management. This suggests that social participation and collective responsibility in environmental management remain weak in Kelurahan Kambu, which further hampers the implementation of sustainable waste management practices. In contrast, the indicator of perceived environmental impact of 3R implementation (D) shows a relatively better level of awareness. Although actual implementation remains low, many respondents acknowledged that proper waste management contributes to a cleaner and healthier environment and helps reduce waste accumulation. Furthermore, most respondents disagreed with the statement that 3R programs should be discontinued, indicating public acceptance of the need to continue and develop 3R-based waste management initiatives. The findings from all indicators suggest that while community awareness of environmental benefits exists, the actual behavior, supporting infrastructure, and participation levels in 3R-based household waste management are still very low.

Table 5. Validity Test Results of Respondents' Perceptions of Household Waste Management Based on the 3R Principles in Kelurahan Kambu

No	Statement	Result	Description
A. Community Behavior in 3R-Based Waste Management			
A1	Conducting separation of organic and inorganic waste	0.751	Valid
A2	Reusing used goods	0.781	Valid
A3	Processing organic waste into compost	0.726	Valid
B. Availability of 3R Facilities and Infrastructure			
B1	Availability of separate bins for organic and inorganic waste	0.847	Valid
B2	Availability of waste bank services in the surrounding area	0.739	Valid
B3	Availability of waste collection services in narrow alleys	0.682	Valid
C. Community Support and Participation			
C1	Willingness to allocate time for cleaning activities	0.792	Valid
C2	Willingness to encourage neighbors to implement 3R practices	0.773	Valid
C3	Willingness to serve as a role model in waste management practices	0.721	Valid
D. Environmental Impact of 3R Implementation			
D1	The environment becomes unhealthy and uncomfortable	0.767	Valid
D2	Waste volume continues to increase	0.772	Valid
D3	The 3R program does not need to be continued and developed	0.810	Valid

The validity test results (Table 5) show that all items in the 3R-based household waste management variable (A1–D3) were deemed valid, as each item has a correlation coefficient (calculated r) ranging from 0.682 to 0.847, which is greater than the table r value of 0.1689 and meets the measurement validity criteria, where the significance value is 0—that is, less than 0.05 for a one-tailed test. Regarding the indicators of community behavior in 3R-based waste management, the highest value was found in A2 (0.781), indicating that the community does not reuse used items, while A1 (0.751) and A3 (0.726) also showed the same relationship. Regarding the indicators of the availability of 3R facilities and infrastructure, all statements showed strong validity (0.682–0.847), indicating that the availability of 3R facilities and infrastructure is not yet optimal. Results for the community support and participation indicator: C1 (0.792) is the most dominant indicator, while C2 (0.773) and C3 (0.721) remain in the valid category and are therefore worth retaining. Regarding the indicators of the environmental impact of 3R implementation, D3 (0.810) and D2 (0.772) showed strong validity, whereas D1 (0.767) had the lowest value but still met the validity criteria. These results indicate that the instrument used was able to consistently measure the construct of household waste management based on the 3R principles across all four indicators, making all items suitable for use in further analysis. The results demonstrate that all indicators are valid and significant.

The results of the reliability test (Cronbach's alpha) (Table 6) indicate that all indicators of household waste management based on the 3R principles are reliable, as the alpha values fall within the range of 0.616–0.685, indicating that the internal consistency of the items within each indicator is good. The commonly used standard is that an α value $\geq$ 0.60 is considered to meet acceptable reliability for research, and an α value $\geq$ 0.70 is generally interpreted as good reliability. These four indicators are suitable for further analysis as they provide stable and consistent measurement results in describing household waste management based on the 3R principles through community behaviour in 3R-based waste management, the availability of 3R facilities and infrastructure, community support and participation, as well as the environmental impact of implementing the 3R principles.

Table 6. Reliability test results of respondents' perceptions of household waste management based on the 3R principles

No.	Description	Result	Description
A	Community Behavior in 3R-Based Waste Management	0.616	Reliable
B	Availability of 3R Facilities and Infrastructure	0.628	Reliable
C	Community Support and Participation	0.640	Reliable
D	Environmental Impact of 3R Implementation	0.685	Reliable

The validity test results (Table 6) show that the indicator of community behaviour regarding 3R-based waste management (A) is reliable with a value of 0.616, indicating that the community does not sort waste, does not reuse used items that are still in good condition, and does not process organic waste into compost. The indicator of the availability of facilities and infrastructure (B) obtained a reliability value of 0.628, indicating that in the study area there are currently no separate bins for organic and inorganic waste, no waste banks around residential areas, and no waste collection services in narrow alleys. The indicator for community support and participation (C) yielded a reliability score of 0.640, indicating a lack of support and participation from the community. The indicator for the environmental impact of 3R implementation (D) yielded a reliability score of 0.685, indicating that the community is aware of the positive environmental impact of 3R-based waste management on their surrounding environment.

Public Awareness, Understanding, Challenges, and Solutions for 3R-Based Household Waste Management

The research findings indicate that public awareness and understanding of 3R-based household waste management remain relatively low, particularly in terms of public support and participation. The respondents were unwilling to set aside time for clean-up activities, did not actively encourage neighbours to adopt the 3R concept, and were unwilling to set an example in waste management. This situation indicates that the community's ecological awareness and social participation have not yet been optimally established, despite the research instruments having been statistically validated and found to be reliable (Febrianti et al., 2022). Furthermore, the main obstacles to implementing 3R-based waste management also stem from aspects of community behaviour and the availability of facilities and infrastructure (Kambu et al., 2022).

The community has yet to sort waste at source, reuse second-hand items, or process organic waste into compost. On the other hand, supporting facilities such as segregated waste bins, waste banks, 3R waste transfer stations, and collection services in narrow alleys remain severely limited. This situation highlights a gap between the ideal concept of 3R-based waste management and the existing conditions on the ground. In terms of regulations, these conditions do not yet fully comply with the provisions of Law No. 18 of 2008 (Undang-Undang Republik Indonesia Nomor 18 Tahun 2008 Tentang Pengelolaan Sampah, 2008) on Waste Management and Government Regulation No. 81 of 2012 (Peraturan Pemerintah (PP) Nomor 81 Tahun 2012 Tentang Pengelolaan Sampah Rumah Tangga Dan Sampah Sejenis Sampah Rumah Tangga, 2012), which emphasise the importance of waste reduction at source through the 3R approach (reduce, reuse, recycle). These regulations also state that waste management is not solely the responsibility of the government but also requires the active participation of the community. Consequently, low community participation and limited infrastructure indicate that the implementation of waste management policies is still not functioning optimally at the local level.

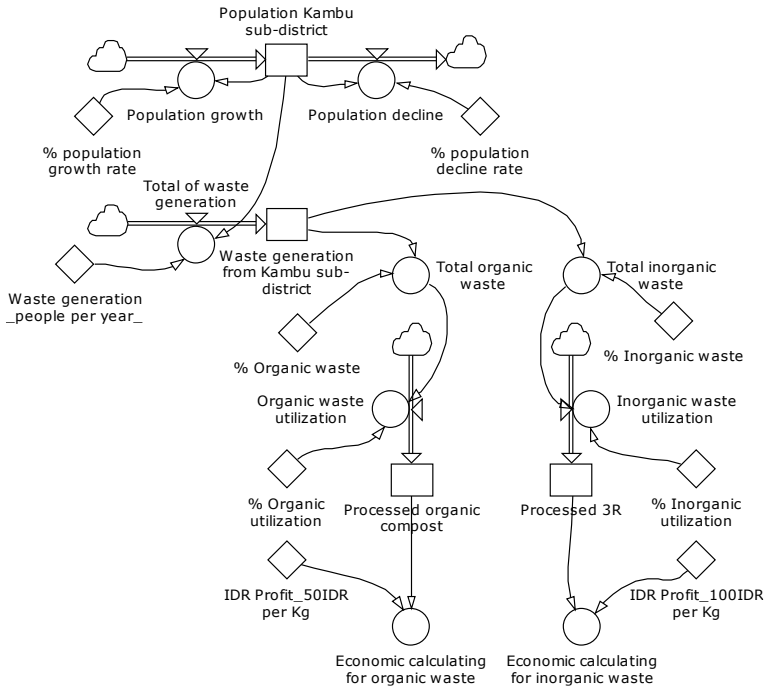

Figure 4. The CLD model from waste generation

From a systems thinking perspective, the issue of waste management in Kambu Sub-district can be modelled using a system dynamics approach (Figure 4) to illustrate the relationship between the variables of population growth, waste generation, and the effectiveness of waste reduction through the 3R approach. This model represents the interconnections between social, environmental, and economic subsystems within a single, mutually influencing system. It includes a reinforcing loop, whereby an increase in population leads to increased waste generation, which in turn places greater pressure on the waste management system. Furthermore, the model also accommodates the separation of organic and inorganic waste, enabling the analysis of the utilisation rates for each type of waste whether through recycling, reuse, or composting as well as their potential economic value over a 10-year simulation period. This approach aligns with the concept of the circular economy, in which waste is not merely viewed as a by-product, but as a resource with economic value.

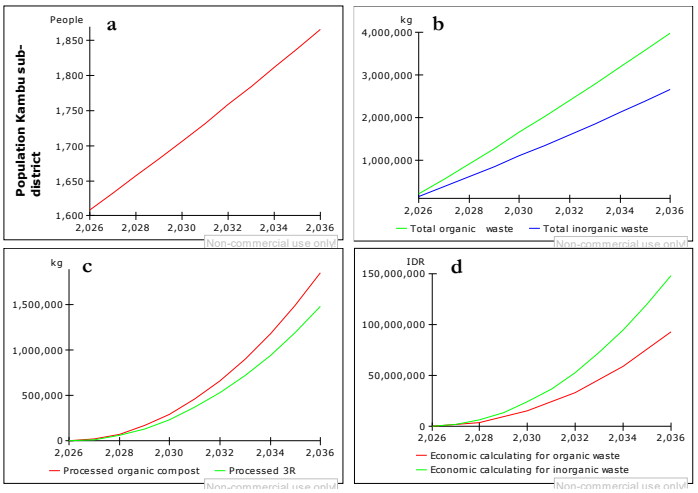

Figure 5. System dynamics approach simulation (a) population growth, (b) waste generation from Kambu sub-district, (c) waste utilization, and (d) Economy feasibility from waste generation

The model in Figure 5 shows that, with an initial population of 1,608 in Kambu Sub-district, a population growth rate of 1.8% per year and a mortality rate of 0.3%, the population increases by approximately 25 people per year (Figure 5a). This population growth contributes to an increase in domestic waste generation, assuming an average waste production of 1 kg/person/day or equivalent to 365 kg/person/year. Furthermore, with a waste composition of 40% inorganic and 60% organic (Figure 5b), a simulation of utilisation through a sorting system was conducted. In the initial scenario, the utilisation rate for organic waste was assumed to be 10% and 12% for inorganic waste (Figure 5c), which could subsequently increase alongside improvements to the 3R system and greater community participation. From an economic perspective, assuming a selling price of Rp50/kg for organic waste and Rp100/kg for inorganic waste, the simulation indicates that potential income for the community or waste bank operators ranges from approximately Rp3–7 million per year (Figure 5d), depending on the level of participation and management efficiency. This cycle demonstrates that 3R-based waste management not only reduces the environmental burden but also has the potential to generate sustainable local economic value, as has been widely implemented in waste bank systems and community-based management across various urban areas.

Conclusion

Household waste management based on the 3R principles in Kambu Village has not yet been implemented optimally. This is evident from the low level of community participation in waste sorting, reuse, and processing, as well as the limited availability of supporting facilities and infrastructure such as segregated waste bins, waste banks, 3R transfer stations, and waste collection services in residential areas. This situation indicates a gap between the concept of 3R-based waste management and its implementation on the ground. Additionally, community participation and support remain relatively low, despite a general awareness of the environmental impacts of waste management. The main challenges identified stem from community behavior and infrastructure limitations, which have hindered the effectiveness of the 3R-based waste management system. Therefore, there is a need to enhance public education, strengthen waste management institutions, and provide more adequate facilities and infrastructure to support the sustainable implementation of the 3R system.

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