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Aligning Local Conditions with Innovative Waste Solutions: A Study on Community Adoption in Indonesia

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Abstract

Residual waste management in communities faces technical, social, and economic challenges. While participatory approaches have been widely applied, their success is often hindered by varying engagement levels and complex social dynamics, particularly in Indonesian contexts. This study investigates the adoption of multilayer plastic waste processing solutions through a community-engaged design approach in Bekasi, Indonesia. Using action research, it examines how communities interact with proposed solutions, evaluating the technical, aesthetic, and sustainability aspects of processed products, as well as adoption rates. Findings indicate that adoption depends on sustained community involvement, alignment with local conditions, and technical feasibility for independent implementation. By analyzing social dynamics and influencing factors, this research underscores the value of flexible design strategies in enhancing the sustainability of community-based waste management. The study offers actionable insights to improve waste management practices, emphasizing adaptive, context-sensitive solutions tailored to diverse community needs.

Keywords: *Residual Waste Management, Community-Based Participatory Approach, Product Design, Community Adoption.*

Introduction

Waste management in communities involves complex social, cultural, and environmental factors, extending beyond mere physical infrastructure. A primary challenge lies in differing perceptions and sensitivities toward waste, which vary among individuals. Addressing this requires fostering public awareness and understanding community-specific behaviors and practices. Waste management is deeply tied to local resources, interests, and existing knowledge, making participatory approaches essential for designing contextually appropriate solutions. Through collaboration, designers can create sustainable systems that empower communities socially and economically, enhancing local ownership and long-term viability.

In Indonesia, waste management remains a pressing issue. According to the Ministry of Environment and Forestry (February, 2025), total waste generation from 264 regencies reached 25.9 million tons, with only 61.97% properly managed—falling short of the 70% target (Farahdiba et al., 2023). Plastic waste accounts for approximately 20% of the total. Globally, waste management aligns with Sustainable Development Goal (SDG) 12 (European Commission. Joint Research Centre. & United Nations Inter Agency Task Team., 2021),

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emphasizing sustainable consumption and production through integrated economic, environmental, and social strategies (Witoelar, 2021).

Communities have limited control over the types and amounts of waste generated from consumption (Pongrácz, 2002) and often encounter restricted waste management options (Nxumalo et al., 2020). Public knowledge of effective waste management remains inadequate (Brotosusilo & Handayani, 2020), typically focusing only on post-generation handling (Pongrácz, 2002). Despite these challenges, communities can actively contribute to waste collection, sorting, and small-scale processing (Cai et al., 2021). This participation is driven by enabling factors, with tangible social and economic benefits serving as key motivators (Farida et al., 2024; Jiang et al., 2021; Suryawan & Lee, 2023).

Skepticism toward community-based waste management often arises when initiatives fail to deliver significant impacts (Budihardjo et al., 2022). However, community-driven approaches can enhance awareness and ensure sustainability through social and economic benefits (Oyinlola et al., 2018). Bridging these aspects remains a critical challenge. I argue that targeted, adoptable solutions aligned with local conditions are essential to overcoming this gap. Yet, adoption challenges persist, such as lack of interest, negative attitudes, and inadequate training (Suleman et al., 2023). Thus, viable solutions must directly involve the community in their development and implementation.

This argument is based on the understanding that community involvement facilitates the exchange of collective knowledge, fostering awareness and shared learning (Luck, 2018). The effectiveness of such initiatives relies on productive interactions among stakeholders, which create an empowering environment (Fasoli & Tassinari, 2017; Manzini, 2015). Engaging the community is crucial to ensuring the adoption of solutions, even though participation levels may vary (Bosco et al., 2022; Hameem & Asaduzzaman, 2023). Moreover, maintaining flexibility to incorporate community-specific insights is essential for long-term success (Dayaratne, 2016; Lasage et al., 2017).

Collective waste management efforts can achieve greater impact when active participation is encouraged. Creative, inclusive approaches offer practical solutions to improve waste management and promote a healthier environment (Anjeli et al., 2024). Ideally, community-based initiatives can reduce government spending on waste collection, transportation, and disposal while extending landfill lifespans. However, their effectiveness depends on social conditions and infrastructure availability (Kurniawan et al., 2021). Community waste management practices are shaped by perceptions, behaviors, infrastructure adequacy, and public services (Cai et al., 2021; Jiang et al., 2021).

This study leverages local community knowledge to develop adoptable residual waste management solutions, utilizing existing driving factors within the community. Participatory methods foster shared understanding, helping identify community needs (Jokhu & Kutay, 2020) and uncover key challenges and opportunities (Jagtap, 2018). Community-based waste management through design rejects top-down approaches. While designers may propose solutions, decisions must align with the community's technical preferences and local context (Polyportis et al., 2022; Rahardiani et al., 2024).

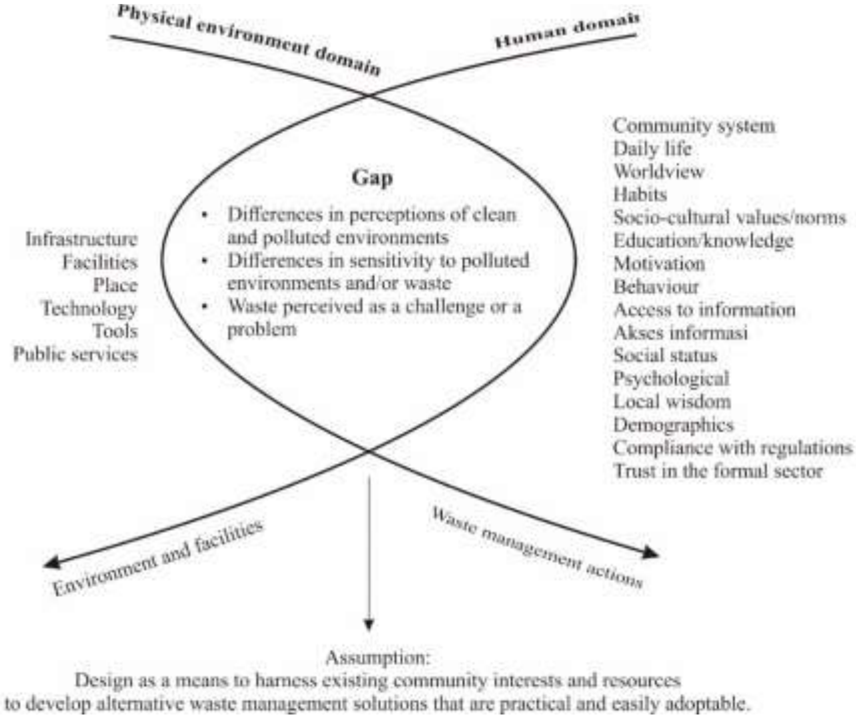


Figure 1. The Conceptual Framework of the Research.

Source: developed by Authors, 2023

Communities engage with waste issues in varied ways—some view waste as both a challenge and an opportunity, while others see it only as a problem. Fundamentally, no community desires a polluted environment, though perceptions of cleanliness, pollution, and tolerance differ. This study uses design to harness existing community interests and resources, developing practical and adoptable waste management solutions. The necessary knowledge already exists within the community, making them key partners in addressing the issue. Through an action research approach, the study examines how communities interact with proposed solutions, evaluating their technical, design, and sustainability aspects to assess adoption potential. The findings shed light on varying participation levels within Indonesian communities, contributing to broader discussions on participatory design paradigms.

Methods

This study adopts a qualitative approach, integrating design development through simple material studies. It employs an inductive methodology using participatory action research (PAR), deeply rooted in community engagement (Jokhu & Kutay, 2020; Müller, 2021). The PAR strategy is premised on the idea that communities inherently possess knowledge of societal issues and needs, making their active involvement crucial for effective problem identification (López-Sosa et al., 2019). However, limited community resources present significant challenges (Jokhu & Kutay, 2020), underscoring the importance of fostering knowledge exchange as a core component of this process (Müller, 2021).

The research is structured into three key phases: data collection, design study, and community response assessment. A preliminary study (2021–2023) was conducted across two villages, three hamlets, two waste banks, and one recycling center in Bekasi Regency, Indonesia. Insights from this phase informed the development of a participatory model, which underpins subsequent research activities carried out from 2024 to 2025 in Tanjungbaru Village, Bekasi. The data collection and analysis phase focuses on creating a structured mapping of the community's social and environmental conditions, identifying collective interests, and determining preferred waste management practices.

Multiple data collection methods were employed, including in-depth interviews with waste bank leaders and operators, community discussions, surveys, field observations, and visual documentation to analyze the living environment. Key informants played a vital role in facilitating access, ensuring locally relevant insights were captured. Collected data was categorized based on prevalent response patterns, guiding design development aligned with community preferences.

The material and technical study phase identifies the most suitable residual waste processing method based on trends observed during data collection. This research adopts a practice-based, iterative approach (Ulrich et al., 2020), where the creative process generates design outcomes while contributing to new knowledge on residual material processing.

The material study is guided by the tendencies of the target community, leading to several constraints:

1. Residual waste is defined as materials that cannot be monetized or repurposed as animal feed within the community.

2. Material processing avoids costly equipment investments to ensure economic feasibility.

3. Procedures are simplified to eliminate the need for complex techniques or specialized skills, ensuring ease of adoption and alignment with existing practices.

4. The solution must adapt to the operational conditions of waste banks in the target village.

Given these constraints, material processing excludes cleaning, shredding, sorting, or purification. Findings inform functional prototype development aligned with technical specifications. The phase involves design development and technical experimentation at a laboratory scale, focusing on optimal parameters like heating duration and pressure tonnage through iterative refinement. This process includes the following steps:

1. Identifying key technical and design challenges.

2. Conducting experiments to explore potential solutions.

3. Evaluating results to assess effectiveness and areas for improvement.

4. Refining the design or process based on prior analysis, iterating as needed to achieve optimal outcomes.

5. Producing a prototype ready for testing or implementation.

The next phase focuses on gathering community responses to identify the most suitable adoption model for the proposed solutions. This was conducted through group discussions with 13 participants, including waste managers and village residents. The discussions were guided by a series of open-ended questions designed to capture insights beyond those obtained through questionnaires. Key discussion areas included:

1. Design modifications and product innovation. Participants proposed ideas for new residue-based products and suggested design improvements to enhance functionality and appeal.

2. Division of labor. Discussions explored how production tasks could be distributed among community members to ensure efficiency and sustainability.

3. Economic planning. Participants provided input on marketing strategies, such as potential sales channels (e.g., local markets and other outlets). They also simulated market responses by introducing the product within their community to gauge spontaneous reactions.

4. Sustainability mapping. The process from residue collection to product commercialization was mapped, identifying key actors at each stage and fostering collaboration within the community.

The developed design was presented to the community to gather feedback, accompanied by an explanation of the product development process. To enhance analysis, feedback collection was supplemented with a Likert scale questionnaire (ranging from 1 to 5), where 1 indicates the most negative/disagreeing response and 5 represents the most positive/agreeing response.

Responses were categorized into three key areas, each broken down into 10 specific questions to comprehensively address technical feasibility, design preferences, and sustainability:

1. Technical feasibility. This section evaluates the community's confidence in producing the product using available resources and skills. Discussions focus on task allocation and integration with the existing waste management system.

2. Design preferences. Community members provide feedback on their likes, dislikes, and suggestions for alternative approaches to processing residual waste or improving the current design.

3. Sustainability potential. This section explores the community's perspectives on the economic viability of the design, including its marketability and potential to generate long-term value.

The collected responses undergo qualitative thematic analysis, complemented by basic quantitative analysis to ensure data validity. At this stage, the objective is to ensure that community engagement yields tangible benefits, making the proposed solutions both feasible and aligned with community needs.

Phases		**Aims**	**Methods**
Preliminary study	Nov. 2021	Formulating the problem	In-depth Interview with village development experts
	March 2022	Understanding the general profile of the target community	- In-depth Interview with Village Government and Recycling Center Management - Appointing a key person
	Sep. 2022 – March 2023	Approaching the community (round 1)	- Site visit (conducted in Sep. 2022) - In-depth Interview with Recycling Center Management (conducted in Nov. 2022)

			- Data collection on types of waste and their management (conducted in March 2023)
Data collection	April 2023	Approaching the community (round 2)	- Site visit - Interview with community representatives - Questionnaire survey - Foto & video documentation
	Oct. 2023	Approaching the community (round 3)	- Site visit - Interview with community representatives - Foto & video documentation
	Oct. 2023	Triangulation (Round 1): Reducing bias and enhancing the reliability of the research	Conducted with: - Village Development Expert, Bekasi - Design Thinking Practitioner at the Ministry of Education and Culture of the Republic of Indonesia Academic in the field of Product Design
	Nov. 2023	Triangulation (Round 2): Enhancing data validity	- Focus Group Discussion (FGD) with stakeholders
	May 2024	Approaching the community (round 4)	- Site visit - Interview with community representatives - Foto & video documentation
Design study	March-April 2024	Material and technical experimentation (Stage 1): Exploring alternative treatments for residual materials	prototyping iterative (Lab-scale testing)
	June-July 2024	Material and technical experimentation (Stage 2): Investigating the potential forms or processing of residuals	prototyping iterative (Lab-scale testing)
	Dec. 2024	Material and technical experimentation (Stage 3): Determining optimal technical parameters	prototyping iterative (Lab-scale testing)
	Dec. 2024	Designing pots to validate the success of the selected technical preferences	Comprehensive prototyping

Community response	Jan. 2025	Identifying the most appropriate adoption scenario	- FGD - Questionnaire survey

Table 1. Operational Research Conducted

Results and Analysis

Summary Insight from Preliminary Study

Bekasi City faces a growing waste management challenge that cannot rely solely on government intervention. Land availability for waste disposal and processing has significantly decreased due to urbanization and industrial development, leaving the Final Disposal Site (TPA) at full capacity. This necessitates the implementation of waste management programs at the village level. However, disparities in access to formal waste management services persist, leading to inappropriate practices such as dumping or burning waste in vacant lots near homes. Surprisingly, this issue has not garnered significant public concern. Fieldwork conducted from November 2022 to October 2023 revealed challenges in addressing residents' differing perceptions of environmental cleanliness and pollution tolerance.

Figure 2. Residual Waste in the Community Environment

Source: Authors, 2023

Society is divided into two main groups based on their views toward waste. The first group sees waste as a potential resource, utilizing it through recycling, composting, or repurposing items into new forms or functions. Open to innovation, this group values waste as a contributor to environmental sustainability by reducing disposal and increasing recycling. Their perspective fosters social inclusivity by providing economic opportunities for underprivileged groups, improving their quality of life and raising awareness about proper waste management.

In contrast, the second group views waste as a problem, focusing on its negative impacts, such as pollution, odor, and health risks. For this group, waste represents a threat to quality of life, disrupting comfort, cleanliness, and environmental aesthetics. It also symbolizes social disorder and governance failures, reinforcing perceptions of collective inability to address environmental issues and eroding community confidence and solidarity.

Understanding these differing perspectives is crucial for effective community engagement in waste management. A successful approach must balance both viewpoints, leveraging waste's economic potential while addressing its health and environmental challenges.

Results of the Data Collection

I have categorized the key challenges of waste management at the community level into six categories, as summarized in Table 2.

Categories	**Tendencies**	**Results**
Communication and awareness	Insights from various community stakeholders highlight the current waste conditions and ongoing waste management efforts.	The community perceives a lack of effective communication from local authorities regarding waste management practices. Information dissemination remains reliant on individuals, such as the head of the recycling center, particularly concerning waste segregation. Furthermore, residents often report neighbor complaints about smoke from waste burning in their vicinity.
Infrastructure and facilities	Community-based observations reveal daily waste management challenges, their environmental impact, and the initiatives local communities undertake to address them.	Local communities often find waste scattered in their yards, frequently improperly discarded by residents, including children. Although they acknowledge the role of waste pickers in managing trash, overall environmental cleanliness remains unsatisfactory. The predominant waste types in these areas are plastic and domestic refuse.
Community behavior and participation	Community actions and expressions reflect their participation in local waste management efforts.	The community advocates for establishing a waste bank as an alternative to waste burning, alongside a communal waste disposal system to enhance overall waste management.
Environmental and health impacts	Community perspectives and sentiments on the waste management initiatives implemented so far.	The community expresses satisfaction with the recycling center program and supports the retribution system, emphasizing the importance of proper waste management for public health.
Community aspirations and goals	The goals and aspirations the community aims to achieve through improved waste management practices.	The community desires waste management systems that generate economic benefits, believing that success should be measured by their income-generating potential.
Social conflicts and challenges	Negative sentiments toward the current waste management practices.	The community perceives a lack of effective communication from local officials on waste management. The absence of communal waste disposal bins, along with irresponsible disposal practices by some residents, has fueled dissatisfaction and sparked conflicts within the community.

Table 2. Summary Insight from Data Collection

As part of data triangulation efforts, discussions with relevant stakeholders were conducted to deepen understanding and inform strategies for the design study stage. These discussions revealed critical insights into waste management challenges and opportunities. A village development expert from Bekasi City's Village Community Empowerment and Development Program highlighted a significant gap between local governments and communities in waste management. While the government targets managing 30% of waste at the village level, the lack of processing facilities and ineffective communication has hindered progress, eroding public trust in government-led initiatives. This underscores the need for social mapping to assess program sustainability within participatory design frameworks, with economically driven programs offering viable solutions to avoid exacerbating existing challenges.

Engagement with a Design Thinking practitioner from Indonesia's Ministry of Education and Culture revealed a disconnect between waste management initiators and communities. As primary adopters, communities exhibit significant diversity, necessitating social mapping to identify key actors, relationships, and influences to tailor solutions effectively. Conversations with a product design academic emphasized that residual waste, perceived as valueless, remains a persistent challenge. Limited knowledge often leads to burning, an unsustainable practice. Solutions must map waste types considered residual by the community and provide guidance to foster adoption and refinement of interventions.

Finally, discussions with the Recycling Center chairman and Waste Bank manager in Bekasi revealed that economic and self-pride factors drive participation. Economic incentives reflect financial benefits, while self-pride highlights moral rewards tied to involvement. Both indicate that waste management initiatives must combine commercial value with collective achievement for long-term success.

Design Study

Based on stakeholder discussions and collected data, the community defines residual waste as materials that cannot yet be monetized. While official data on types and quantities remain unavailable, Waste Bank inflow data offers some categorization, though tonnage figures are lacking. The selected residual waste for processing includes materials not currently managed by the community, such as heavily damaged, burned, or oily plastic bottles and certain non-plastic waste, present in small amounts. Colored PET bottles can still be sold but at low prices, while food waste is processed into animal feed and compost. Thus, the focus shifts to plastic bags and multi-layered plastic packaging.

Material exploration was guided by the community's technical preferences and limited resources. To address constraints, activities requiring significant investment—such as shredding, sorting, cleaning, or purifying—were avoided, minimizing disruptions and ensuring adoptability. Simplicity in design prioritized learning and sustainability. This phase was divided into two parts: a technical and material study, followed by functional design application.

Technical Study:

The technical study represents an exploratory phase aimed at identifying the most suitable techniques for processing plastic bag residues and multilayer packaging, guided by the community's technical preferences. This phase focuses on exploring optimal forms and technical formulations through laboratory-scale experiments using an electric oven and hydraulic press. The initial stage involved heat treatment and pressing to determine the optimal heating duration and pressing pressure, with the temperature set at 250°C.

Experiment	Material		Heating		Press	Results	
	Type	Weight (g)	Temperature (°C)	Time (minutes)	Load (tons)	Weight (g)	Shape & Dimensions (cm)
I	Snack packaging and sachets	63	250°	90	1,5	52,5	Flat slab: 8 x 8 x 0,7
II	Snack packaging and sachets	64	250°	40	3	59	Flat slab: 10 x 10 x 0,7
III	Snack packaging and sachets	38,5	250°	60	3	77	Flat slab: 10,3 x 10,3 x 0,7
	Plastic bags	39,5					
IV	Snack packaging, sachets, and plastic bags	100	250°	40	4	78	Flat slab: 10 x 10 x 0,7

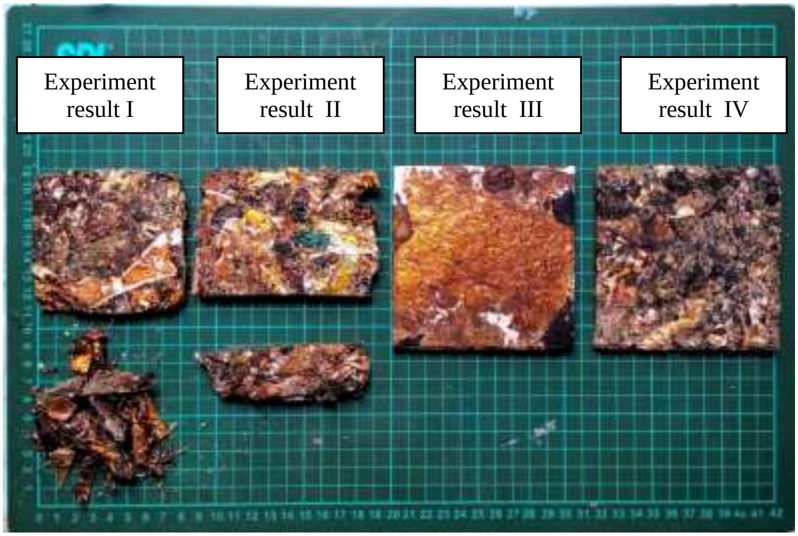


Figure 4. Comparison of Experimental Results for the First Stage.

Source: Authors, 2024

Notes from experimentation I:

1. Plastic bags served as a binding agent, but aluminum foil from snack packaging and sachets did not melt.

2. Aluminum foil bonded with plastic bags, but adhesion was poor when materials were shredded.

3. Post-processing weight varied due to shrinkage, likely caused by uncleaned residues (e.g., leftover contents or moisture) and material loss during transfer to the mold.

4. The best result, based on density and shape achievement, was obtained in Trial III: combining snack packaging, sachets, and plastic bags without shredding, with a heating time of 60 minutes and pressing force of 3 tons.

5. Color variations occurred due to differences in heating duration.

6. Texture and color could not be standardized, resulting in a generally brownish hue.

Improvements for subsequent experimentation:

1. Increase material volume by approximately 10% above the mold capacity to account for shrinkage.

2. Increase pressing load to 5 tons at 250°C for improved density and shape consistency.

Experiment	**Material**		**Heating**		**Press**	**Results**	
	Type	**Weight (g)**	**Temperature (°C)**	**Time (minutes)**	**Load (tons)**	**Weight (g)**	**Shape & Dimensions (cm)**
I	Unshredded and unsorted snack packaging, sachets, and plastic bags	220	250°	60	5	169,5	Ribbed block: 20x6,3x2
II						188,5	
III						174,5	
IV						191,5	
V						203	
VI						205,5	
VII						200,5	
VIII						193	

Table 4. Study Process and Results for the Second Stage

Figure 5. Experimental Results for the Second Stage

Source: Authors, 2024

Notes from experimentation II:

1. A processed weight of 200 grams yielded good density, consistent shaping, and sharp angles.
2. Trials involving cutting (Trials I and II) maintained good shape quality.
3. Aluminum foil adhered poorly to materials cut with a saw.
4. Each processing cycle took approximately 1.5 hours.

Improvements for subsequent experimentation:

1. Trim excess material post-heating using a saw or utility knife to refine shapes.
2. Reduce heating time to 45 minutes and pressing time to 15 minutes. Materials can be removed from the mold while warm, as they no longer deform.

Experimental Project: Creating Flower Pots

The design development for the flower pot was guided by three primary considerations: material properties, community resources, and economic sustainability. These factors were integrated into the design criteria to ensure feasibility and alignment with community needs.

The design focused on products that do not require structural strength, as the processed materials lack durability and cannot yet guarantee toxicity-free properties, even after heat treatment at 250°C (which eliminates bacteria and germs). The material retains a plastic-like odor post-processing, which dissipates after washing. Consequently, the material is unsuitable for construction or functional applications requiring high strength.

To align with the target community's resources, the technical processing methods prioritized simplicity. No specialized skills or significant tool investments are required. Processes such as cleaning, purification, sorting, shredding, and precision treatments were avoided to ensure ease of adoption. The product design accommodates non-uniformity and avoids assembly requirements. To minimize costs, the product dimensions were kept small, as larger tools would increase investment expenses.

From an economic perspective, the product must appeal visually and be accessible to the local community. Beyond production and sales, a strategic business system was proposed, leveraging the existing ecosystem of the Waste Bank and its partnerships with industries and communities. This approach positions the product as a reflection of local values rather than a mere commodity.

Among various potential designs, a flower pot was chosen as the experimental product due to its alignment with the established criteria. This activity aimed not only to design the flower pot but also to demonstrate its viability as a waste management solution adoptable at the Waste Bank or neighborhood (RT) level.

The flower pot design adhered to the established criteria, informing the technical production scenario. The process was divided into four sequential stages: ideation of the pot's shape, mold design, casting, and final product display. Feedback was gathered from the community during discussions.

Ex	**Material**	**Heating**	**Press**	**Results**

	Type	Weight (g)	Temperature (°C)	Time (minutes)	Load (tons)	Weight (g)	Shape & Dimensions (cm)
I	Unshredded and unsorted snack packaging, sachets, and plastic bags	129	250°	50	5	119,5	Pot with a basic cylindrical shape: 8 x ø 6 cm
II		145,5				116,5	
III		141				115	
IV		140				119	
V		130				115,5	
VI		134,5				118,5	
VII		149,5				118,5	
VIII		138				118	
IX		131				116	
X		152,5				127,5	

Table 5. Study Process and Results for the Third Stage

Figure 6. Experimental Results for the Third Stage

Source: Authors, 2024

Notes from the flower pot experiment:

1. The heated material volume should exceed the mold's capacity by approximately 10% to account for shrinkage.

2. The mold successfully shaped the pot, but removal was challenging. Coating the mold with petroleum jelly improved release.

3. Pliers and a lever were used to remove the pot.

4. Producing one pot required approximately one hour.

Design development:

1. The pot was displayed representatively using artificial succulent plants to ensure durability throughout the study period. Small pots proved visually appealing when placed on desks or window sills. A special tray was designed to enhance the pot's presentation.

2. The tray design emerged spontaneously during the pot-making process. A rough sketch was created to explore its basic configuration.

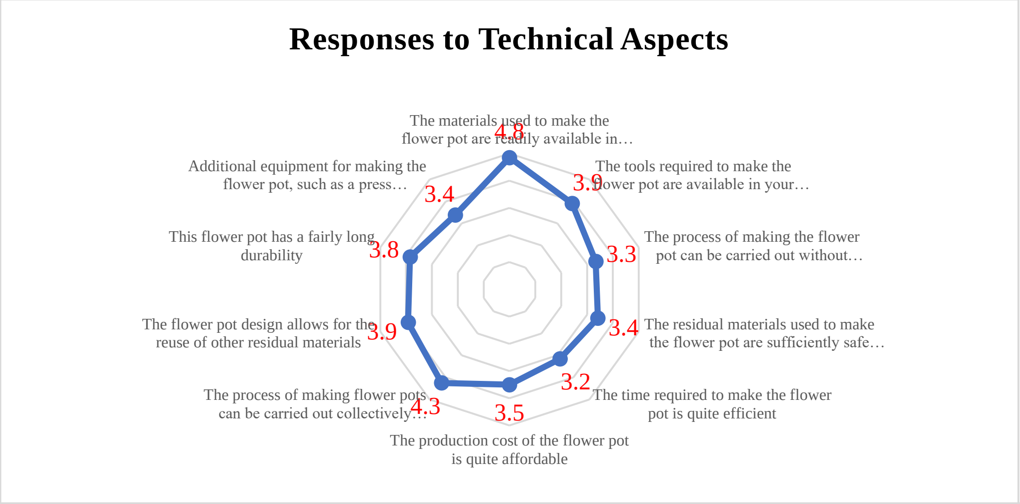
3. Sumatran pine wood was selected as the tray material.

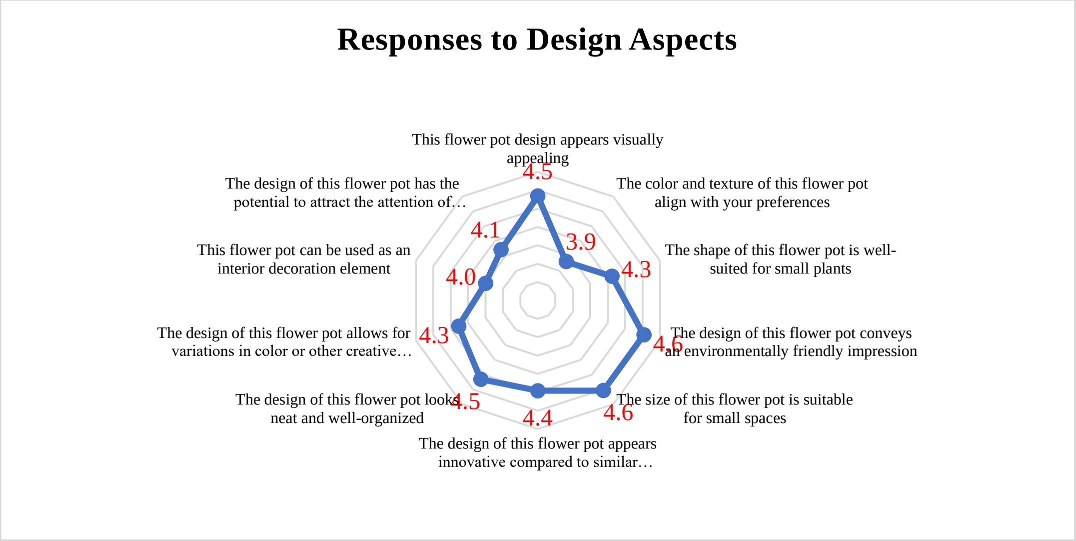
Figure 7. The Design Development Results

Source: Authors, 2024

Gathering Responses from the Target Community

Responses from group discussions and a January 2025 questionnaire revealed trends on the project's role in community-based waste management. Participants included six Waste Bank staff and seven Posyandu cadres from Tanjungbaru, Bekasi, key stakeholders in flower pot production. The final design and prototype were presented, along with an explanation of the production process, tool demonstrations, and a module detailing the steps. The questionnaire was completed collectively, guided by the researcher.


Responses to Technical Aspects
The materials used to make the flower pot are readily available in…
4.8
The tools required to make the flower pot are available in your…
3.9
The process of making the flower pot can be carried out without…
3.3
The residual materials used to make the flower pot are sufficiently safe…
3.4
The time required to make the flower pot is quite efficient
3.2
The production cost of the flower pot is quite affordable
3.5
The process of making flower pots can be carried out collectively…
4.3
The flower pot design allows for the reuse of other residual materials
3.9
This flower pot has a fairly long durability
3.8
Additional equipment for making the flower pot, such as a press…
3.4


Responses to Design Aspects
This flower pot design appears visually appealing
4.5
The color and texture of this flower pot align with your preferences
3.9
The shape of this flower pot is well-suited for small plants
4.3
The design of this flower pot conveys an environmentally friendly impression
4.6
The size of this flower pot is suitable for small spaces
4.6
The design of this flower pot appears innovative compared to similar…
4.4
The design of this flower pot looks neat and well-organized
4.5
The design of this flower pot allows for variations in color or other creative…
4.3
This flower pot can be used as an interior decoration element
4.0
The design of this flower pot has the potential to attract the attention of…
4.1

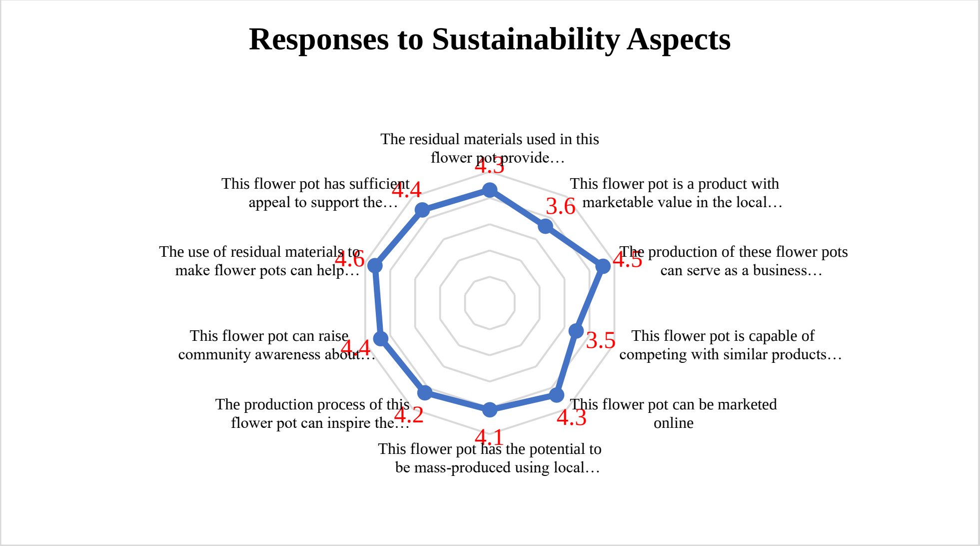


Figure 8. Spider Diagram of the Questionnaire Results Regarding Community Responses to the Flower Pot Project

Source: Authors, 2025

1. Technical aspects:

- Plastic packaging residue, an unresolved waste issue, is abundant in the community environment (92% of respondents confirmed its prevalence).
- Not all necessary equipment for making flower pots is currently available at the Waste Bank.
- About 58% of respondents indicated that no additional training is required to make the pots, though 62% doubted the efficiency of the one-hour production time.
- Half of the respondents expressed concerns about the safety of processing residual plastic materials.
- The total investment cost for tools (press machine, pliers, molds, etc.) is under ten million rupiah (~$600), leveraging existing community land and waste transportation systems.
- 58% agreed that production costs are low, while 33% expressed uncertainty.
- 83% agreed that flower pot production can be done collectively with residents, leveraging Posyandu cadres and existing waste management systems.
- 61% agreed that the design allows for the use of other residual materials.

Average technical aspect rating: 3.8 ("uncertain" to "agree").

Lowest score: Time efficiency (3.2).

Highest score: Material availability (4.8).

2. Design aspects:

- 93% agreed that the flower pot is visually appealing.

- 63% found the texture and color aligned with their preferences.
- 83% agreed it is suitable for small plants.
- 92% viewed the pot as environmentally friendly, well-suited for small spaces, neat, and innovative compared to market alternatives.
- All respondents agreed it allows for variations in color or creative shapes.
- 73% agreed it can serve as interior decoration, while 66% saw potential to attract buyers.

Average design aspect rating: 4.3 ("agree" to "strongly agree").

Lowest score: Color and texture (3.9).

Highest scores: Environmental friendliness and suitability for small spaces (4.6 each).

3. Sustainability aspects:

- Residual materials used had never been processed by the community before.
- 92% agreed these materials provide environmental benefits.
- While some doubted local sales potential (38% uncertain, 28% disagreed), 92% strongly agreed the pots represent a business opportunity.
- Respondents noted glossy pots might be more appealing.
- 69% were uncertain about market competitiveness.
- 83% agreed the pots could be marketed online.
- 69% believed mass production using local resources is feasible.
- 84% agreed the pots inspire processing of other residues, and 85% stated they raise awareness about waste management.
- All respondents agreed using residual waste to create products reduces waste generation.
- 85% found the pots appealing enough to support community recycling programs.

Average sustainability rating: 4.2 ("agree" to "strongly agree").

Lowest score: Market competitiveness (3.5).

Highest score: Using residual waste to reduce waste generation (4.6).

Figure 9. Group discussions and questionnaire surveys to gather responses from the community

Source: Authors, 2025

The responses were further analyzed through interviews with the chairman of the Waste Bank. Overall, the data highlights the community's emphasis on three key factors: ease of production, aesthetic design, and economic value. These insights reveal potential areas for improvement and further development:

1. Work efficiency and waste reduction. The flower pot design reduces multi-layered plastic waste and offers economic benefits. Its simple, learnable production process supports community adoption. In a lab setting, eight pots can be made daily, scaling to 40 weekly in a five-day Waste Bank operation, using 4.72 kg of waste. By skipping sorting, washing, or shredding, it minimizes time and labor, making direct material processing a key advantage.

2. Product absorption and investment schemes. Producing flower pots requires no factory-scale equipment, enabling village-level implementation. Residents can collect multi-layered plastic waste at home for the Waste Bank to purchase, promoting household waste sorting. Though not for mass-market sale due to limited scale, collaborations with nearby industries, such as packaged goods producers, can boost market absorption. Processed products may support industries' PROPER initiatives, attracting CSR funds to aid the Waste Bank's development and fostering community-industry partnerships.

3. Community involvement and division of labor. Households contribute by collecting plastic waste and exchanging it for money at the Waste Bank. Officers transport waste, Posyandu cadres prepare materials, and staff operate the pressing machine, ensuring efficient division of labor.

4. Product realism. Not all residual plastic products are practical for market or sustainability. The flower pot, with low investment costs, is feasible for Waste Bank production and personal use. Though not for mass sale, it serves as a branding tool for environmental advocacy.

Discussion

This research encountered several challenges, including limited waste processing facilities and weak investment capacity. The design solution addresses these constraints by leveraging existing community resources, avoiding costly investments or additional workspace, and minimizing tasks such as sorting, shredding, washing, or purifying materials. This approach reflects an understanding of local conditions and mitigates barriers associated with overly complex or expensive solutions (Aulia et al., 2023). However, this strategy also presents limitations, particularly regarding scalability and long-term sustainability, as existing equipment may become obsolete over time.

Design Criteria in the Context of Waste Management

The following design criteria have been effectively applied to address waste management challenges within this context:

1. Social criteria:

a. The design allows individuals to contribute based on their capacity without requiring uniform technical skills.

b. The design accommodates existing social structures, such as role-based division of labor within the community.

c. Mechanisms like waste sorting fee waivers incentivize community participation.

2. Technical criteria:

a. The production process is simple, utilizing technology that requires minimal training.

b. Abundant residual materials are used without the need for complex purification or processing.

c. Existing tools, such as waste incineration furnaces or gas ovens owned by the Waste Bank, are utilized to avoid burdening the community.

3. Economic criteria:

a. The product must have economic value and clear market absorption channels.

b. The design attracts external funding sources, such as CSR initiatives, to support community programs.

c. Income generated through the Waste Bank is reinvested into the community.

4. Environmental criteria:

a. Products extend the lifecycle of residual materials by creating new utility.

b. The production process avoids generating additional waste that is difficult to manage.

c. For example, flower pots can support household greening initiatives.

Key Factors for the Sustainability of Waste Management

Two critical indicators emerged from this research: economic viability and community pride.

1. Income generation.

Repurposing waste into products like flower pots creates income streams and reduces waste. In Tanjungbaru, it hasn't created jobs but enables industry collaborations for CSR funding, boosts Waste Bank capacity, and offers residents sorting incentives, enhancing skills and outputs.

2. Pride.

Community members feel responsibility and ownership, fostering pride and collective identity. Tangible outcomes enhance social cohesion, mutual support, and trust, extending to training and knowledge-sharing with other communities.

Practical Implications

To ensure local adoptability, the design leverages community potential while addressing technical, sustainability, and environmental aspects. Empowering the community provides long-term benefits and enhances participation. This foundational approach offers measurable guidance, serving as a diagnostic tool for similar community-based waste management projects. An example of this framework is presented in the following table:

Measurability	Diagnostic Checklist
Integration with the community	1. Does the design align with the community's social structure and interaction patterns? 2. Is the solution economically relevant to the community's potential? 3. Does the community have the necessary time to implement the solution? 4. Is the community receptive to or resistant to specific innovations?
Appropriateness	1. Is the technology simple enough for the community to operate and manage effectively? 2. Are the required materials and tools readily available and accessible locally? 3. Can the solution be easily adapted to fit the community's specific conditions? 4. Do the community's existing skills align with the implemented technology or methods?
Contextual relevance to the community	1. How well does the design align with the values, norms, and customs of the local community? 2. Can the solution be implemented in the long term with active community participation? 3. Does the design support and enhance existing local practices? 4. Can the solution be integrated into the systems already in place within the community?
Community empowerment	1. Does the solution foster a sense of ownership and pride within the community? 2. Do community members recognize the benefits of the solution and voluntarily wish to participate? 3. Does the solution enhance the community's economic capacity without imposing financial or labor burdens? 4. Can the community sustain the solution's implementation without excessive reliance on external parties?

Table 6. Diagnostic Table for Measuring the Level of Community Adoption of Community-Based Waste Management Alternatives

Limitations and Suggestions for Future Research

This study faced limitations related to implementation time, long-term observation, and sustainability measurement. Short-term research is insufficient to capture dynamic changes, particularly in altering community behavior and habits. Limited time also hindered the ability to assess the sustainability of solutions or establish trust, which is crucial for project success. Without long-term observation, determining the endurance and lasting benefits of initiatives remains challenging.

To address these gaps, future research could adopt longitudinal studies to evaluate sustainability over time, identifying factors that support or hinder success. Comparative studies between communities viewing waste as a resource versus a problem could reveal differences in attitudes, motivations, and participation outcomes. Such insights would deepen understanding of effective waste management strategies, offering valuable guidance for designing inclusive, sustainable solutions tailored to diverse community contexts. This approach emphasizes the importance of time and trust in achieving meaningful, long-term impact.

Conclusion

The study findings highlight that communities are more likely to engage in initiatives directly linked to fulfilling their basic needs. Economic incentives, such as increased income or job opportunities, act as powerful motivators for participation. Projects fostering solidarity and collective benefit further encourage involvement, especially when perceived as advantageous for the entire community. Social recognition, which enhances individuals' status, also drives participation. When individuals feel a personal stake, they are more likely to contribute actively. A sense of ownership fosters responsibility and strengthens commitment to project outcomes, while successful engagement boosts self-confidence and self-esteem, reinforcing continued involvement.

Design solutions should prioritize minimal, gradual interventions to improve outcomes over time. While resistance to change is inevitable, it should not hinder progress; gradual training can ease adoption without overwhelming the community. The participatory process must leverage available resources while encouraging innovative ideas for long-term sustainability. Although initial investments may be modest, sustained planning and capacity building are crucial for enduring success. Participatory design projects in waste management should be viewed as ongoing initiatives rather than short-term fixes. Designers must remain adaptive, recognizing these efforts as long-term commitments requiring continuous collaboration, refinement, and responsiveness to community needs. This approach ensures sustainable, impactful solutions tailored to local contexts.

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