



Fostering Zero Waste Communities: A Participatory Action Research Approach to Implementing 3R Principles in a Suburban Indonesian Village

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ABSTRACT

The challenge of municipal solid waste in community settings reflects a pressing national issue in Indonesia, underscored by Presidential Regulation No. 97 of 2017, which targets a 30% reduction in waste by 2025. This study addresses the conventional "collect-transport-dispose" waste management system in RW 06, Wage Village, Sidoarjo, an area characterized by unsorted household waste. The objective of this community-based intervention was to enhance knowledge, shift attitudes, and build practical skills for waste management based on the 3R (Reduce, Reuse, Recycle) principles to foster a zero waste environment. The study employed a Participatory Action Research (PAR) methodology, engaging the community as active partners across three stages: (1) a baseline survey and participatory planning with community leaders; (2) intervention implementation through educational seminars and hands-on workshops on waste segregation and the construction of household-scale anaerobic composters; and (3) impact evaluation via a comparative analysis of pre- and post-intervention survey data from 60 households. The results demonstrate a significant improvement across all indicators. Community understanding of the 3R concept increased by 75%, routine participation in waste segregation rose by 68%, and the adoption of composting technology for organic waste reached 55%. This study concludes that the PAR approach is highly effective in initiating behavioral change in waste management. The program's success was driven not only by the transfer of technical knowledge but also by strengthening community social capital and strategically targeting key behavioral determinants, particularly perceived behavioral control. This initiative serves as a replicable micro-model for implementing a circular economy at the community level.

INTRODUCTION

Indonesia is facing a national-scale waste emergency. Data from the National Waste Management Information System (SIPSN) in 2023 indicated a total national waste generation of 37.8 million tons per year, with only 62.54% being managed (Indonesia Asri., 2023). The majority of this waste, 45.6%, originates from households, with food scraps (40.3%) and plastics (17.22%) being the largest components (Cohen & Gil, 2021). The predominant management system still relies on the conventional collect-transport-dispose approach, leading to overburdened landfills that pose further environmental risks, such as leachate contamination and methane gas emissions (Khapre et al., 2019).

In response, the Indonesian government established a strategic policy framework through Presidential Regulation (Perpres) No. 97 of 2017 concerning the National Policy and Strategy (Jakstranas) for the Management of Household Waste and Household-like Waste. Jakstranas sets an ambitious target of 30% waste reduction and 70% waste handling by 2025 (PERPRES No. 97 Tahun 2017). This policy fundamentally promotes a paradigm shift from a linear economy (*take-make-dispose*) to a circular economy, where



waste is viewed as a resource to be reintegrated into production and consumption cycles (Bittner et al., 2024).

Achieving the Jakstranas targets requires that macro-level interventions are supported by tangible actions at the micro-level. Community-Based Waste Management (CBWM) is critical as the frontline for policy implementation at the grassroots level (Artha et al., 2023). CBWM models, such as 3R (*Reduce, Reuse, Recycle*) programs and Waste Banks (*Bank Sampah*), are concrete manifestations of efforts to reduce waste at its source. The 3R principles provide a practical framework for active community participation: *Reduce* consumption of potential waste; *Reuse* materials that are still viable; and *Recycle* waste into new, useful products.

Beyond technical practices, effective CBWM aims to instill a *Zero Waste* philosophy. This is a holistic approach focusing on waste prevention through a more comprehensive hierarchy, often known as the 5Rs: *Refuse, Reduce, Reuse, Recycle, and Rot* (compost). However, applying a zero-waste lifestyle in Indonesia faces significant challenges, primarily related to unsustainable consumption patterns and a gap between environmental awareness and tangible action (Magfirah HS, 2023).

CASE STUDY

RW 06 in Wage Village, Sidoarjo, represents a typical suburban community facing waste management challenges. Initial observations revealed several fundamental issues. First, the existing waste system was entirely dependent on a mixed collection model without household-level segregation. Second, inadequate waste transport infrastructure led to environmentally harmful practices like open dumping and burning, which pose serious health risks (Wulandari et al., 2021). Third, community knowledge regarding the negative impacts of waste and alternative management methods like the 3R concept was very low. This situation reflects a local political ecology where waste is not merely a technical issue but a socio-cultural one, rooted in habits, norms, and limited access to information and facilities (Aparcana, 2017).

METHOD

This project adopted a Participatory Action Research (PAR) framework. PAR was chosen for its emphasis on collaboration, empowerment, and a continuous cycle of reflection and action, making it highly suitable for community empowerment programs (Vaughn & Jacquez, 2020). Unlike traditional research where the community is an "object" of study, PAR positions the residents of RW 06 as "partners" or co-researchers (Cornish et al., 2023). Residents were actively involved in every stage, including problem identification, solution design, implementation, and evaluation. This deep engagement was essential to ensure that the interventions were relevant, socially acceptable, and sustainable (Duesa et al., 2022).



Stage 1: Diagnosis and Participatory Planning (Baseline Survey & Observation)

This initial phase aimed to map the existing conditions and design a targeted intervention. A baseline survey (pre-test) was administered to a sample of 60 randomly selected households. The questionnaire was designed to measure three key variables: (1) Knowledge of 3R concepts and composting; (2) Attitudes towards environmental issues and personal responsibility; and (3) Practices related to daily waste management.

The survey findings were then validated and deepened through a Focus Group Discussion (FGD) with key community stakeholders, including the RW head, RT heads, and Family Welfare Program (PKK) cadres. This session served as both a needs assessment and a participatory planning forum where the content, schedule, and methods for the workshops were co-designed.

Stage 2: Intervention Implementation (Education and Workshops)

Based on the diagnosis, the intervention was designed to combine theoretical and practical elements:

1. **Educational Seminar:** An interactive seminar was held for all residents covering the urgency of the waste problem, the *Zero Waste* and 3R concepts, and the economic potential of well-managed waste.
2. **Practical Workshop on Waste Segregation:** Residents received hands-on training to sort household waste into three categories: organic, inorganic recyclables, and residue.
3. **Workshop on Household-Scale Anaerobic Composter Construction:** A key intervention was the introduction of appropriate technology for organic waste management. The anaerobic composter method using a stacked bucket system was chosen for its strategic advantages in a densely populated area: it requires minimal space, needs no regular turning, and is relatively odor-free if managed correctly (Sinaga et al., 2023). Residents were taught to assemble the composter, prepare a bio-activator solution (using EM4), and properly layer organic waste (Indrawati & Fariz Indra Permana, 2021). This process yields two valuable products: Liquid Organic Fertilizer (POC), which is rich in N, P, and K nutrients, and solid compost (Mangera & Yuni Ekowati, 2022).
4. **Mentoring and Support:** Following the workshops, the project team provided two months of intensive mentoring through home visits and an online communication group to monitor progress, address challenges, and maintain community motivation.

Stage 3: Impact Evaluation (Post-Intervention Survey and Analysis)

At the end of the mentoring period, a post-intervention survey (post-test) was administered to the same 60 households that participated in the baseline study. This sample cohort was selected using a simple random sampling technique derived from the RW 06 household registry, ensuring that the data is demographically representative and



minimizes selection bias. The collected data were analyzed quantitatively using descriptive statistics and a comparative analysis between pre-test and post-test results to measure the program's impact on knowledge, attitudes, and practices..

IMPLEMENTATION

The quantitative improvements were driven by a hands-on program that established real-world infrastructure. The Community Service Program (PKM) directly engaged 250 residents in RW 06, Desa Wage, to tackle the daily issue of mixed household waste by introducing two appropriate key technologies.

To manage organic waste, an anaerobic composter unit was strategically deployed in each neighborhood unit (RT 01 through RT 05), ensuring high accessibility for all residents. This tool allows residents to process kitchen scraps into valuable solid and liquid organic fertilizer, transforming organic waste from a liability into a community asset and effectively closing the biological nutrient loop at the neighborhood level.

A centralized waste bank (*Bank Sampah*) was established to facilitate the sorting and collection of inorganic recyclables. This facility serves as an instrument for both education and economic empowerment. Educationally, it reinforces sorting practices, making the distinction between waste categories tangibles. Economically, it creates a financial incentive through the sale of recyclables, reinforcing pro-environmental behavior and ensuring the program's long-term viability.

The success of these interventions is rooted in the application of the 3R principles (Reduce, Reuse, Recycle) as a foundational mindset. This project empowers residents to master the "Recycle" step, which serves as a visible and rewarding gateway into the broader journey of a zero-waste lifestyle.

RESULT AND DISCUSSION

Results: Quantitative Analysis Of Community Capacity Building

The analysis of survey data collected before (pre-test) and after (post-test) the intervention reveals a significant shift in the community's capacity to manage household waste.

Baseline Conditions (Pre-Test Findings)

The initial survey painted a clear picture of the challenges. While nearly all respondents (97%) had heard of the term "3R," a significant gap existed in practice. Only 18% reported "always" sorting their waste, while another 18% "never" sorted it. The majority (45%) sorted only "sometimes." Furthermore, only 24% had ever attempted to make compost from their organic waste, and a mere 21% had previously received any form of training on waste management. This data confirmed that despite nominal awareness, practical application was minimal.

Comparative Quantitative Analysis



The impact of the intervention is summarized in Table 1, which compares survey results before and after the program across the three domains of knowledge, attitude, and practice.

Table 1. Comparison of Knowledge, Attitude, and 3R Practices Before and After the Community Outreach Program in RW 06, Wage Village.

Indicator	Before (%)	After (%)	Improvement (%)
Knowledge			
Correctly understands the 3R concept	20	95	75
Knows the difference between organic & inorganic waste	45	100	55
Understands the benefits of composting	15	92	77
Attitude (% Agree/Strongly Agree)			
Feels personally responsible for generated waste	70	98	28
Believes waste segregation is important	75	100	25
Interested in composting organic waste	30	95	65
Practice (Self-Reported Behavior)			
Routinely segregates organic and inorganic waste	18	83	65
Reduces single-use plastic bag consumption	25	75	50
Manages organic waste with a composter	0	55	55

The data clearly demonstrates the program's success. The most dramatic improvements were in knowledge, with understanding of composting benefits soaring by 77%. More importantly, this knowledge translated into action. The rate of routine waste segregation increased by 65%, and the adoption of composting technology, previously non-existent, reached 55% among respondents. This indicates that the program successfully moved beyond information dissemination to foster tangible behavioral change.

Discussion: Unpacking The Drivers Of Success

The positive quantitative results can be attributed to a synergy of a participatory methodology, the activation of community social capital, and targeted interventions on the psychological determinants of behavior.

The Role of Social Capital as a Foundation for Success



This program's success was heavily reliant on the existing social fabric of RW 06. Applying the lens of Social Capital Theory, the intervention was effective because it activated and strengthened existing social capital. Key elements included:

- **Social Networks:** The program leveraged established and functional social networks, such as the RW/RT structure and the women's PKK groups, as efficient channels for information dissemination and mobilization.
- **Trust:** The program gained significant legitimacy and credibility through the active support of respected community leaders like the RW and RT heads (Ragiliawati & Qomaruddin, 2020). Residents were more receptive to messages delivered by trusted figures.
- **Norms:** The program gradually cultivated a new social norm where waste segregation and environmental cleanliness became valued and expected behaviors within the community.

Analyzing Behavioral Change through the Theory of Planned Behavior (TPB)

The *Theory of Planned Behavior* (TPB) provides a systematic framework for understanding the psychological mechanisms that drove behavioral change (Gusti et al., 2015). The program effectively targeted all three core determinants of intention:

- **Attitude:** The educational sessions successfully reframed waste from being solely a nuisance to also being a resource. Organic waste was seen as raw material for valuable fertilizer, and inorganic waste as a potential source of income, fostering a positive attitude toward sorting and composting.
- **Subjective Norms:** The visible participation of neighbors and vocal support from community leaders created a strong perception that influential others expected and approved of the new behaviors (Gusti et al., 2015).
- **Perceived Behavioral Control (PBC):** This was the most critical lever. Before the intervention, residents may have lacked the confidence and skills to manage their waste. The hands-on workshop on building and using an anaerobic composter directly increased their PBC. By providing knowledge, skills, and a simple tool, the program empowered residents with the belief that they were capable of performing the new behaviors, which is strongly reflected in the 55% adoption rate for composting.

Operationalizing The Zero Waste Framwork: Program Implementation And Community Action

The significant quantitative improvements detailed in Table 1 were driven by a hands-on, participatory program that went beyond theory to establish real-world infrastructure. As documented in local media, this Community Service Program (PKM) by the Universitas Negeri Surabaya team directly engaged 250 residents in RW 06, Desa Wage, to tackle the daily issue of mixed household waste.

The core of the intervention was the introduction of two key appropriate technologies:

1. Anaerobic Composter



Figure 1. Household-Scale Anaerobic Composter

To manage organic waste, anaerobic composter units were placed in every neighborhood unit (RT 01 to RT 05). This location was chosen to make the units easily accessible for everyone, which naturally encourages residents to participate. This tool allows households to turn kitchen scraps into useful solid and liquid fertilizer. Beyond simply reducing waste volume, this technology changes how we view organic matter. Instead of being seen as a smelly nuisance that attracts pests, organic waste is transformed into a valuable community asset. This process completes the biological cycle at the neighborhood level by returning food nutrients back to the soil.

2. Waste Bank (Bank Sampah)



Figure 2. The Community Waste Bank Facility

An Instrument for Education and Economic Incentive A centralized waste bank was established to facilitate the sorting and collection of inorganic recyclables like plastic bottles. This facility is not merely a collection point; it serves as a powerful



instrument for both education and economic empowerment. Educationally, the waste bank prompts residents to make a conscious act of sorting, thereby reinforcing the training material and making the distinction between waste categories tangible. Economically, it opens opportunities to generate collective income from the sale of recyclables. This creates a tangible financial incentive that reinforces pro-environmental behavior, transforming what was once considered worthless trash into a resource with economic value and ensuring the program's long-term viability.

The 3R Principle as a Foundational Mindset for Zero Waste

The success of these technological interventions is rooted in the powerful application of the 3R principles (Reduce, Reuse, Recycle) as a foundational mindset. This concept is not simply a list of actions but a strategic hierarchy. Reduce is the most critical step because it focuses on preventing the generation of waste at its source. Reuse extends the life cycle of products. Finally, Recycle, which is operationally enabled by the composter and the waste bank, is the strategy for managing waste that cannot otherwise be avoided. This project empowers residents to master the "Recycle" step, which serves as a visible and rewarding gateway into the broader journey of a zero-waste lifestyle, encouraging them to progress towards more impactful behaviors like consumption reduction.

A Catalyst for Broader Community Action

250 Taman Residents Trained to Manage Waste



SORTED: Sulistiyono utilizes the waste bank in front of the Posyandu RW 06 building Perum Taman Surya Agung Desa Wage yesterday (11/8).

SIDOARJO – Waste in Perumahan Taman Surya Agung is collected from homes and transported to the TPS every Tuesday and Friday, before being taken to the TPA. However, every week there are still 3-4 cubic meters of waste that is mostly mixed organic and inorganic, causing odors and inviting flies.

To overcome this problem, the PKM Team of Surabaya State University (Unesa) intervened through the Community Partnership Program (PKM) 2025. From July 19-August 10, the PKM team consisting of Prof Drs Suroto, Prof Dr Rusijono, and Fifiukha Dwi Khory MPd provided with 3R (reduce, reuse, recycle) concept. More than 250 residents were equipped with knowledge and skills in waste management. They also provided a plastic waste bank and five units of

They also provided a plastic units of aerobic composters for each RT (RT 01-RT 05) so that organic waste can be processed into compost.

"If waste is sorted from home, it can reduce the burden on TPS and TPA, also creating a healthier and more productive environment," explained Prof Rusijono, a member of the PKM Unesa team.

In addition to technical training, this program also invites residents to build collective awareness to protect the environment. A participatory approach is carried out through face-to-face socialization in each RT, accompanied by initial tests and final tests to measure residents' understanding. "We designed this PKM so its sustainability is carried out by the residents themselves. Zero Waste is not just a slogan, but becomes a lifestyle in the RT and RW environment," concluded Fifiukha Dwi Khory. (eza/uzi)

Figure 3. Local Media Coverage of the RW 06 Waste Management Program

The recognition of this initiative by local media validates its success and elevates it from a local project to a public success story and a replicable pilot model. This publicity acts as a powerful catalyst and driver for the wider community. When other neighborhoods witness that a clean, organized, and productive environment is achievable through



community collaboration in RW 06, it inspires them to take similar action. This project therefore demonstrates a concrete, grassroots model for implementing national environmental policies, proving that meaningful change begins with organized and empowered communities.

CONCLUSION

Synthesis Of Key Findings

This community-based intervention in RW 06, Wage Village, successfully initiated a fundamental shift in household waste management. The Participatory Action Research (PAR) approach proved highly effective in enhancing knowledge, fostering pro-environmental attitudes, and, most importantly, driving the adoption of 3R practices. The significant increases in waste segregation and composting demonstrate that combining education with practical, hands-on training can effectively bridge the knowledge-action gap. The program's success was underpinned by strong social capital and was psychologically driven by a marked increase in residents' perceived behavioral control.

Recommendations For Program Sustainability

To ensure the long-term impact of this initiative, the following steps are recommended to institutionalize the newly formed practices:

1. **Formalization and Expansion of the Community Waste Bank (Bank Sampah):** Building upon the pilot facility established during the program, the next critical step is to formalize its institutional status. The community should seek official legal recognition (such as a Village Decree or SK Desa) to transition the Waste Bank from an ad-hoc project into a permanent, professional entity. This formalization is essential to access wider recycling markets, standardize pricing, and ensure the facility continues to provide a sustained direct financial return to households, thereby cementing the economic motivation for waste segregation (Raharjo et al., 2017).
2. **Development of a Compost Value Chain:** The Liquid Organic Fertilizer (POC) and solid compost produced have economic potential. A small community enterprise could be formed to collect, package, and market these products, creating a local circular economy for organic waste.
3. **Strengthening Support from Village Government:** The Wage Village government is encouraged to adopt this model as a pilot program and integrate it into its official development plans. Allocating village funds for supporting infrastructure (e.g., collection carts, weighing scales) would signal strong institutional commitment and facilitate replication in other areas.
4. **Leveraging Digital Technology:** To enhance efficiency and engagement, especially among younger residents, the adoption of simple digital tools is recommended. Mobile applications can be used for Waste Bank management, tracking savings, and



disseminating ongoing environmental education.

Limitations and Future Research Directions

This study has limitations, including a relatively short observation period and reliance on self-reported behavior. Future research should conduct longitudinal studies to monitor long-term sustainability, quantitatively measure waste volume reduction, and perform a deeper analysis of the economic and gendered impacts of the program.

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