Vol. 2 No. 1 Edisi Januari 2026 E.ISSN. 3089-8579

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APPLYING THE 3R PRINCIPLES FOR SUSTAINABLE WASTE MANAGEMENT IN CIBODAS TOURISM VILLAGE

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DOI: https://doi.org/10.62567/jpi.v2i1.1216

Abstract

The community service program implemented in Cibodas Tourism Village, Pasirjambu District, Bandung Regency, aimed at improving local waste management practices, reducing environmental impacts of tourism, and creating livelihood opportunities through circular-economy activities. The program combines participatory methods and workshops on waste management by applying the 3R principles (Reduce, Reuse, and Recycle). Measurable outcomes included improved source segregation accuracy, an operational community composting facility, and income streams from recyclable materials. The initiative, aligned with Sustainable Development Goals (SDG), demonstrates that integrated education and infrastructure interventions can produce environmental and socio-economic co-benefits in rural tourism settings.
Keywords: *community service, waste management, 3R, composting, SDGs*

Abstrak

Program layanan masyarakat yang dilaksanakan di Desa Wisata Cibodas, Kecamatan Pasirjambu, Kabupaten Bandung, bertujuan untuk meningkatkan praktik pengelolaan sampah lokal, mengurangi dampak lingkungan dari pariwisata, dan menciptakan peluang mata pencaharian melalui kegiatan ekonomi sirkular. Program ini menggabungkan metode partisipatif dan lokakarya pengelolaan sampah dengan menerapkan prinsip 3R (Reduce, Reuse, dan Recycle). Hasil yang dapat diukur meliputi peningkatan akurasi pemisahan sampah di sumber, fasilitas kompos komunitas yang beroperasi, dan aliran pendapatan dari bahan daur ulang. Inisiatif ini, yang selaras dengan Tujuan Pembangunan Berkelanjutan (SDG), menunjukkan bahwa intervensi pendidikan dan infrastruktur yang terintegrasi dapat menghasilkan manfaat lingkungan dan sosial-ekonomi di lingkungan pariwisata pedesaan.
Kata Kunci: pelayanan masyarakat, pengelolaan limbah, 3R, pengomposan, Tujuan Pembangunan Berkelanjutan (SDGs)

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1. INTRODUCTION

Indonesia faces a mounting waste crisis. National estimates indicate annual municipal solid waste generation in the tens of millions of tons, with substantial shares ending in unmanaged disposal sites and the marine environment (Jambeck et al., 2015; World Bank, 2021; Perwitasari et al., 2025). This systemic issue is compounded in areas experiencing rapid tourism growth, where visitor-related waste streams (often dominated by single-use plastics) strain local collection capacities (UNEP, 2018; Tan et al., 2025; Chango-Cañaveral et al., 2025).

Rural tourism villages—such as Cibodas in Pasirjambu District, Bandung Regency—are particularly vulnerable (Holladay et al., 2025). Cibodas was established as a budding tourism village in 2022 and offers agrotourism and ecotourism experiences. However, the rise in visitors has increased the volume and heterogeneity of waste, from food residues to packaging and electronic waste (Musasa et al., 2025; Tirado-Ballestas et al., 2025). Local stakeholders voiced concerns that inadequate waste handling undermines the village's environmental quality and tourism potential (Baygut & Bilici, 2025; Sales-Contini et al., 2025).

Evidence shows that community-based strategies—especially those combining the Reduce, Reuse, Recycle (3R) hierarchy with practical infrastructure (waste banks and composting units)—are effective in low-resource contexts (Heruman & Asteria, 2016; Linda, 2016; Dewanti et al., 2020; Leestma et al., 2025; Ashraf et al., 2025). Waste banks can convert sorted recyclables into financial returns for households or women's groups and serve as local aggregation points that feed into formal recycling channels (Rani et al., 2025; Wardany et al., 2020). The Cibodas program built on these documented approaches and adapted them to local cultural and logistical conditions (Tirado-Ballestas et al., 2025).

Beyond economic benefits, proper organic waste processing (composting) reduces methane emissions (Wang et al., 2025). It improves soil quality for local agriculture, an essential co-benefit for agrarian-based tourist activities (Ghisellini et al., 2016; Zhang et al., 2025). Practical, low-cost compost systems using pallet-based bins and community-managed turning schedules have been widely promoted in Indonesia and were recommended in the Cibodas training modules (Chen et al., 2025).

This paper documents the design, implementation, and outcomes of the Cibodas community service program. It aims to provide a replicable model for integrating environmental stewardship and local economic development in tourism villages. The specific objectives were: (1) to increase community knowledge and practice of waste segregation; (2) to operationalize the 3R approach at household and village levels; (3) to establish community composting and linkages with a local waste bank; and (4) to generate local income streams from recyclables (Hong et al., 2025; Onsongo et al., 2025; Sribanasarn et al., 2025).

Scholars and practitioners increasingly frame municipal waste management as a socio-technical challenge requiring behavioural change, appropriate technologies, and enabling institutions (Wilson et al., 2012; Baldé et al., 2017; Musasa et al., 2025). The 3R hierarchy, reduce, reuse, recycle, remains central to policy and grassroots strategies (UNEP, 2018; Rani

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et al., 2025). In Indonesia, localized interventions such as waste banks and community composting have succeeded in multiple case studies (Heruman & Asteria, 2016; Dobiki, 2018; Dewanti et al., 2020; Perwitasari et al., 2025).

Economic valuation of recyclable streams (e.g., PET, HDPE, aluminum) provides crucial incentives for households to sort at source (Linda, 2016; Suni et al., 2025). Local studies report that revenues from collected recyclables can be reinvested into community programs, women's empowerment activities (PKK groups), and maintenance of waste sorting infrastructure (Wardany et al., 2020; Baygut & Bilici, 2025). The Cibodas program explicitly targeted PKK and BUMDes as primary partners to embed revenue flows into local institutions (Sribanasarn et al., 2025).

Composting organic waste reduces landfill mass and greenhouse gas emissions while producing a usable soil amendment for local crops, supporting circular economy principles (Lal, 2015; Ghisellini et al., 2016; Ismail & Zokm, 2025). Indonesian educational materials emphasize household and communal composting as accessible strategies; the program's training materials echo these recommendations and provide step-by-step guidance for palleted compost bins and C: N ratio management (Li et al., 2025; Tan et al., 2025).

Behavioral change literature points to the effectiveness of multi-modal engagement for sustained adoption (Ajzen, 1991; Rogers, 2003; Suni et al., 2025). The participatory model used in Cibodas co-designing modules with village actors follows best practices for community ownership and long-term sustainability (Maphanga et al., 2025; Soacha-Godoy et al., 2025)

2. RESEACRH METHOD

Study area and participants: The program was implemented in Desa Cibodas (Pasirjambu District), a rural tourism village at approximately 1,000–1,200 meters above sea level, characterized by agroforestry, smallholder farms, and growing visitor numbers. The target population included village managers, BUMDes executives, PKK members, Pokdarwis volunteers, and representative households (n=30 participants directly engaged). Socio-demographic baseline data and site mapping were collected during initial field visits .

Program design and phases: The intervention had four interlinked phases: (a) preliminary assessment and Focus Group Discussion (FGD) to identify waste streams, collection points, and local actors; (b) capacity-building workshops covering source segregation, 3R principles, composting design, handling of B3/hazardous waste, and simple bookkeeping for waste bank operations; (c) hands-on mentoring including construction of pallet compost bins, setup of color-coded bins at public facilities, and piloting household segregation with weekly collection; and (d) monitoring and evaluation using waste audits, participant surveys, and economic tracking of recycled material sales (Manimaran et al., 2025; Maphanga et al., 2025; Mhaddolkar et al., 2025). The program timeline and budget were aligned with the project proposal. The team provided educational modules on composting bays from reclaimed pallets, following low-cost designs promoted in local training packs (step-by-step guidance included in program module), and community facilitators were trained to lead residents(Gamaralalage

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et al., 2025; Zuffi et al., 2025).

3. RESULT AND DISCUSSION

a. Result

Participation levels were high: of the 30 primary participants invited, 25 attended workshops, as seen in Figure 1. Participants reported improved understanding of waste categories (organic, recyclable, B3) and composting basics. Anecdotal feedback emphasized appreciation for practical demonstrations and the economic framing of recycling (selling to a waste bank).

Figure 1. Group Photo Session Activities

Baseline waste audits indicated low levels of source separation with mixed-waste bins and ad-hoc disposal. Separation accuracy improved substantially after introducing colour-coded bins (green = organic, blue = recyclable, grey = residual). This mirrors evidence from other programs that infrastructure, coupled with education, as seen in Figure 2, can shift household sorting behaviour rapidly (Wilson et al., 2012; Gussgard & Jokstad, 2025).

Figure 2. Material Presentation to Participants

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The pallet-based communal composting system accepted kitchen scraps, garden trimmings, and agricultural residues (Chen et al., 2025). Compost trials showed improved soil moisture retention and seedling vigor in small agricultural plots where the product was applied, aligning with documented agronomic benefits (Gomez et al., 2025; Tryhuba et al., 2025; Zhang et al., 2025). Training emphasized C:N management, moisture control, and turning schedules to avoid anaerobic odors (practices taken from program training materials) (Chango-Cañaveral et al., 2025; Poyyamozhi et al., 2025).

A formal link was established between the community group (PKK) and a nearby waste bank. Sorted recyclables (PET, HDPE, paper, glass, metals) were aggregated (Klasen et al., 2025; Mhretu et al., 2025). The economic incentive proved critical for sustaining participation and parallels other Indonesian case studies where waste bank operations supported community empowerment (Dewanti et al., 2020; Wardany et al., 2020; Suni et al., 2025).

b. Discussion

The 3R principles (Reduce, Reuse, and Recycle) are foundational strategies for sustainable waste management and are widely applied to manage various waste streams, including food, plastic, and construction waste (Ashraf et al., 2025; Baygut & Bilici, 2025; Kahvecioğlu & Selçuk, 2025). Implementing these principles in community programs not only enhances waste management efficiency but also fosters a culture of environmental stewardship among residents (Rani et al., 2025; Sales-Contini et al., 2025). The findings from the Cibodas program underscore the importance of community engagement and education in promoting sustainable waste management practices, as evidenced in similar initiatives across Indonesia (Melnyk et al., 2025; Mhretu et al., 2025).

Reduction focuses on minimizing waste generation at the source and is considered the most preferred approach in the waste hierarchy (Poyyamozhi et al., 2025). This strategy emphasizes lowering raw material and energy consumption to prevent waste creation (Foreman, 2024; Kahvecioğlu & Selçuk, 2025). However, challenges in reduction practices include the need for clear definitions of waste types and standardized monitoring methods (Manimaran et al., 2025; Shinde et al., 2025).

Reuse involves extending the life cycle of materials by using items multiple times before disposal (Xiao et al., 2025; Zu et al., 2025). Applications range from repurposing organic waste into fertilizers to transforming inorganic waste into handicrafts (Dalimunthe et al., 2024; Dhiman et al., 2025; Li et al., 2025). Reuse practices conserve resources, reduce the demand for new products, and deliver both economic and environmental benefits (El-Mahallawi et al., 2025; Munshi & Kulkarni, 2025; Soliman et al., 2025).

Recycling refers to the processing of waste to recover valuable resources (Bhandari, 2024; Baygut & Bilici, 2025). For example, plastic waste can be converted into new products for household appliances in factories, paving blocks can be independently produced by communities, and more recently, it can be converted into fuel oil through thermal cracking or pyrolysis, thus addressing the challenges of waste management and energy supply (Kang et al., 2025; Naik et al., 2025). Similarly, recycling construction and demolition waste reduces

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reliance on landfills and mitigates environmental impacts (Shinde et al., 2025). However, successful recycling requires effective waste segregation at source, as well as the development of infrastructure and markets for recycled materials (Balogun et al., 2025; Devos et al., 2025).

The program's success rested on four elements: (1) co-design with local stakeholders to ensure cultural fit and ownership, (2) hands-on practical training that translated knowledge into skills, (3) simple, low-cost infrastructure (bins and pallet compost bays) that removed logistical barriers, and (4) economic incentives via waste bank linkages that reinforced behavior change (Chango-Cañaveral et al., 2025; Cheng et al., 2025; Musasa et al., 2025; Tan et al., 2025).

These elements collectively fostered a sustainable waste management culture in Cibodas, demonstrating that community engagement and practical solutions can effectively address local environmental challenges (Shinde et al., 2025). The findings suggest that community-based approaches like those implemented in Cibodas can significantly enhance waste management practices and environmental sustainability in rural tourism areas (Holladay et al., 2025). Moreover, integrating local knowledge and community involvement is crucial for the long-term success of such initiatives, as evidenced by similar programs in rural tourism contexts (Liang et al., 2025; Suni et al., 2025).

Integrating community-led initiatives with economic incentives can significantly enhance waste management practices and empower local economies, particularly in rural tourism contexts (Chango-Cañaveral et al., 2025; Cheng et al., 2025). The results indicate community engagement is crucial for effective waste management, fostering environmental sustainability and economic resilience in rural tourism areas (Liang et al., 2025; Onsongo et al., 2025). The Cibodas program exemplifies how localized, participatory approaches can effectively address waste management challenges, enhancing environmental quality and community livelihoods in rural tourism settings (Seboka et al., 2025; Tirado-Ballestas et al., 2025).

Challenges included maintaining momentum during low-tourism seasons, ensuring correct separation of contaminated recyclables (e.g., food-soiled plastics), and building capacity to manage B3 hazardous streams (batteries, bulbs, e-waste) that require specialized handling (Elwan et al., 2025; Raj et al., 2025). The proposal and training materials flagged B3 as requiring institutional support from local authorities and designated drop-off services (Manimaran et al., 2025; Musasa et al., 2025). Given the program's success, ongoing support and adaptation will be essential to address emerging challenges and ensure the sustainability of waste management practices in Cibodas (Gussgard & Jokstad, 2025; Rani et al., 2025; Tryhuba et al., 2025).

Future initiatives should focus on sustaining community engagement and addressing hazardous waste management challenges to enhance waste management programs' long-term effectiveness in rural tourism areas (Holladay et al., 2025; Sales-Contini et al., 2025). The Cibodas program's outcomes highlight the potential for community-driven waste management solutions to foster sustainable tourism and improve local livelihoods (Hong et al., 2025;

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Maneen et al., 2025). Future should explore the Cibodas program's scalability across different tourism villages to evaluate its adaptability and effectiveness in diverse socio-economic contexts (Andom et al., 2025; Perwitasari et al., 2025).

To scale the model, the village needs stronger market linkages for recyclables (bulk buyers), municipal coordination for hazardous waste collection, and a modest expansion of composting capacity to handle peak-season organic surges (Baygut & Bilici, 2025; Zyoud et al., 2025). Formal integration of waste management into the village tourism roadmap would institutionalize responsibilities and budget lines for maintenance (Seboka et al., 2025; Tirado-Ballestas et al., 2025). Establishing these frameworks will ensure the long-term viability of waste management initiatives in Cibodas and similar rural tourism villages across Indonesia (Chango-Cañaveral et al., 2025; Hong et al., 2025; Klasen et al., 2025; Musasa et al., 2025).

4. RECOMMENDATION

The lessons learned from the Cibodas program can serve as a blueprint for other rural tourism villages in Indonesia, promoting sustainable practices and enhancing community resilience. By fostering community participation and integrating local knowledge, similar programs can effectively address waste management challenges, ensuring environmental sustainability and economic growth in rural tourism areas. Suggestions for program improvements in Cibodas Village include:

- Institutionalize weekly separation and collection schedules with clear responsibilities assigned to BUMDes or PKK.
- Invest in medium-scale composting infrastructure (e.g., aerated static piles or larger bays) to increase throughput during high-season periods.
- Establish periodic training refreshers and a community stewardship group to monitor contamination and compliance.
- Negotiate long-term buy-in agreements with regional recyclers and explore value-added processing (e.g., crafting recycled-material souvenirs for sale to tourists).
- Coordinate with municipal authorities for B3 handling and safe disposal channel.
- Strengthening partnerships with local governments and NGOs can enhance resource availability and support for sustainable waste management initiatives.

5. CONCLUSION

This community service program in Cibodas Village demonstrates that a combined approach of education, practical mentoring, and light infrastructure can effectively reduce landfill-bound waste, produce usable compost, and generate local income from recyclables. The initiative aligns SDG targets for sustainable communities and responsible consumption and provides a viable model for other tourism villages. Long-term success will depend on institutionalization, market linkages, and municipal-level support for hazardous waste streams.

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