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Empowerment of Health Cadres for Sanitation and Health Promotion, Gambang Village, Jombang

Imam Sarwo Edi[1], Ernita Sari[2], and Yaimin[2]

[1]Department of Dental Health, Health Polytechnic Minister of Health of Surabaya, Surabaya, Indonesia
[2]Department of Environmental Health, Health Polytechnic Minister of Health of Surabaya, Surabaya, Indonesia

Corresponding author: Yaimin (e-mail: y4imin@gmail.com)

ABSTRACT Inadequate organic waste management in rural communities poses significant environmental and public health challenges, necessitating sustainable interventions at the grassroots level. This community service initiative aimed to establish waste management capacity in Gambang Village, Gudo District, Jombang Regency, through the implementation of Takakura composting systems toward achieving Ecovillage status. The intervention employed a mixed-method approach combining physical resource provision, educational counseling, and hands-on training. Ten Takakura composting units were distributed to health cadres, accompanied by comprehensive training sessions on composting techniques and organic waste utilization. Educational materials were delivered by faculty and students from the Environmental Health Department of the Surabaya Health Polytechnic, Ministry of Health, to health cadres and community residents. Knowledge acquisition was assessed through pre-post test measurements across multiple environmental health domains. Results demonstrated substantial improvements in participant knowledge: biopore understanding increased from 15% to 70%, infiltration well comprehension rose from 10% to 80%, and dental health awareness improved from 13% to 74%. The composting demonstration activities generated considerable enthusiasm among health cadres, evidenced by active participation in discussion forums and question-answer sessions regarding Takakura tool applications and benefits. The intervention successfully enhanced health cadres' practical skills in compost production and organic waste management. This community-based approach demonstrates promising potential for replicating sustainable waste management practices across neighboring communities, thereby advancing the broader objective of establishing Self-Reliant Waste Villages (Ecovillages) in rural Indonesia. The integration of participatory training methods with tangible resource provision proved effective in fostering community ownership and sustained behavioral change in environmental health practices.

INDEX TERMS Takakura Composting, Community-Based Waste Management, Ecovillage Development, Health Cadre Empowerment, Organic Waste Utilization

I. INTRODUCTION

The escalating generation of municipal solid waste (MSW) presents a formidable challenge to environmental sustainability and public health systems, particularly in developing nations across Asia and Africa [1]. According to the Indonesian Ministry of Environment and Forestry, national waste production reached 67.8 million tons annually in 2023, with projections indicating an 8% annual growth rate driven by demographic expansion, accelerating urbanization, and evolving consumption patterns [2]. Household organic waste constitutes approximately 60% of total waste generation, predominantly comprising food scraps, vegetable matter, fruit residues, and yard trimmings [3]. In rural and semi-rural contexts, inadequate waste management infrastructure exacerbates environmental degradation, soil contamination, and waterway pollution, necessitating community-based interventions that emphasize source reduction and sustainable waste processing methodologies [4], [5]. Gambang Village in Gudo Sub-district, Jombang Regency, East Java, exemplifies the waste management challenges confronting semi-rural Indonesian communities. The village population demonstrated significant growth from 50,997 inhabitants in 2021 to 58,421 in 2023, reflecting an annual expansion rate of 1–3% [6]. The educational demographics reveal considerable variation, with 43% possessing elementary education, 26% junior high school education, 17% senior high school education, and 9% bachelor's degree qualifications. This heterogeneity in educational attainment directly influences waste-handling behaviors and environmental consciousness, underscoring the necessity for targeted capacity-building interventions [7], [8]. Contemporary waste management approaches emphasize the 3R framework (Reduce, Reuse, Recycle) complemented by biological treatment methods for organic waste fractions [9], [10]. Among composting

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technologies, the Takakura method has garnered substantial attention due to its operational efficiency, requiring approximately two weeks for complete decomposition cycles compared to conventional composting methods that necessitate several months [11], [12]. The Takakura composting technique employs fermentative microorganisms, actinomycetes, and basidiomycetes to accelerate organic matter degradation, making it particularly suitable for household-scale implementation [13]. Research demonstrates that Takakura composting exhibits superior performance in processing food waste from small and medium enterprises, yielding high-quality compost with favorable physical, chemical, and biological properties [14]. Furthermore, life cycle assessment studies indicate that home composting generates the lowest greenhouse gas emissions (-601 kg CO_2-eq/tonne) and the highest net present value compared to landfilling alternatives [15]. Urban waste management initiatives in Indonesian cities such as Surabaya and Bandung have successfully reduced household waste by over 30% through community-based composting programs and waste bank systems [16], [17]. However, despite these achievements, a critical research gap persists regarding the systematic implementation of composting technologies in semi-rural settings through health cadre empowerment models [18], [19].

The ecovillage paradigm represents an integrated approach to sustainable community development, encompassing ecological, economic, social, and cultural dimensions aligned with the United Nations Sustainable Development Goals [20], [21]. Ecovillages demonstrate net-negative carbon footprints while fostering community resilience, social capital formation, and environmental stewardship [22]. Nevertheless, solid waste management in Indonesian ecovillage initiatives frequently exhibits deficiencies, including irregular collection schedules, absence of waste segregation practices, insufficient infrastructure, and limited environmental education for residents [23]. These shortcomings highlight the imperative for comprehensive, community-driven waste management frameworks specifically adapted to local sociocultural contexts and resource constraints [24], [25]. This community service initiative aims to establish Gambang Village as a Self-Reliant Waste Village (Ecovillage) through the strategic deployment of Takakura composting systems and health cadre capacity development. The program contributes to sustainable waste management advancement through three principal dimensions:

1. Enhancing health cadres' technical competencies in organic waste processing and environmental health promotion, enabling them to function as grassroots sanitation leaders.
2. Facilitating household-level adoption of Takakura composting technology through participatory training methodologies, thereby achieving source-based waste reduction.
3. Establishing a replicable model for rural waste management that integrates indigenous knowledge systems with evidence-based composting techniques, potentially informing regional environmental policy frameworks. By empowering health cadres as primary agents of environmental transformation, this initiative addresses the documented implementation gap between urban waste bank programs and rural sustainability interventions [26], [27].

The remainder of this article is organized as follows: Section II delineates the methodological framework, including participant selection criteria, intervention design, and evaluation metrics; Section III presents quantitative and qualitative results regarding knowledge acquisition, behavioral change, and program acceptance; Section IV discusses findings within the broader context of sustainable rural development and ecovillage implementation; Section V concludes with recommendations for program replication and policy implications.

II. METHOD

A. STUDY DESIGN AND POPULATION SAMPLING

This community service intervention employed a prospective, quasi-experimental design utilizing a community-based participatory research (CBPR) framework to engage health cadres and residents in sustainable waste management practices [28]. The intervention was conducted between June and August 2025 in Gambang Village, Gudo Sub-district, Jombang Regency, East Java, Indonesia. The CBPR approach facilitated collaborative partnerships between academic institutions and community stakeholders, ensuring equitable involvement throughout the intervention design, implementation, and evaluation phases [29]. The study adopted a mixed-methods approach integrating quantitative knowledge assessment through pre-post testing with qualitative observations of participant engagement and behavioral change indicators [30]. Gambang Village was purposively selected based on three criteria: (1) absence of established waste management infrastructure, (2) presence of organized health cadre networks affiliated with the Plumbon Gambang Health Center, and (3) demonstrated community interest in environmental health initiatives. The study population consisted of two distinct groups: health cadres (n = 30) serving as primary intervention recipients and community trainers, and village residents (n = 150) participating in educational counseling sessions. Health cadres were recruited through the village health post (posyandu) system and met the following inclusion criteria: (1) active membership in the village health cadre program for minimum six months, (2) residence within Gambang Village administrative boundaries, (3) willingness to participate in training and subsequent community mentoring activities, and (4) ability to attend all scheduled intervention sessions. No randomization procedures were implemented due to the community-wide nature of the intervention and the necessity of universal cadre participation for program sustainability [31].

B. INTERVENTION COMPONENTS

The intervention comprised three integrated components designed to enhance waste management capacity at individual, household, and community levels. Ten Takakura

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Vol. 4 No.3, pp. 63-72, September 2025

composting units were procured and distributed to health cadres as pilot installations for organic waste processing. Each unit consisted of: (1) perforated plastic basket (40 cm diameter × 50 cm height) with ventilation holes for aerobic decomposition, (2) perforated basket lid functioning as weight barrier and animal deterrent, (3) corrugated cardboard lining for humidity regulation and insect prevention, (4) rice husk pillow (mesh bag containing 2 kg rice husks) serving as microbial habitat and moisture absorber, (5) starter compost (8 kg) containing active decomposer microorganisms, and (6) coarse-fiber cloth cover preventing oviposition by dipteran insects [32]. The distribution strategy prioritized health cadres representing different neighborhood clusters (rukun warga) to maximize geographic coverage and facilitate peer-to-peer knowledge transfer. Structured educational interventions were delivered by faculty members and undergraduate students from the Environmental Health Department, Surabaya Health Polytechnic Ministry of Health. Training curriculum encompassed four thematic modules: (1) fundamentals of solid waste management and environmental health implications, (2) Takakura composting methodology including microbial decomposition principles, (3) practical demonstration of composting procedures from waste preparation through harvest, and (4) troubleshooting common operational challenges including moisture imbalance, pest management, and odor control [33]. Educational materials were developed using adult learning principles emphasizing experiential learning and practical skill acquisition [34].

Sessions employed interactive pedagogical methods, including didactic presentations, live demonstrations, hands-on practice, and facilitated group discussions to accommodate diverse educational backgrounds among participants. Practical training sessions provided step-by-step instruction in the Takakura composting technique. The standardized protocol included: (1) container preparation with proper placement in shaded, well-ventilated location, (2) sequential layering of rice husk pillow, cardboard lining, and starter compost, (3) organic waste preparation through size reduction to 2 cm × 2 cm dimensions, (4) daily waste incorporation with gentle mixing to prevent cardboard damage, (5) moisture monitoring and adjustment using EM4 (Effective Microorganisms 4) dilution at 1:5 ratio, (6) temperature verification through tactile assessment indicating active microbial metabolism, (7) maintenance procedures including weekly cloth washing and periodic cardboard replacement, and (8) compost harvesting after 40-60 days maturation period [35]. Participants practiced waste sorting, size reduction, layering techniques, and quality assessment procedures under the direct supervision of trained facilitators.

C. DATA COLLECTION AND DATA ANALYSIS

Knowledge assessment was conducted using structured pre-post test questionnaires administered immediately before and after educational interventions. The instrument comprised 30 multiple-choice items distributed across three environmental health domains: biopore infiltration systems (10 items), infiltration well construction and maintenance (10 items), and environmental health linkages to dental hygiene (10 items). Content validity was established through expert review by three faculty members specializing in environmental health and community health nursing [36]. Test-retest reliability was confirmed through pilot testing with 15 health cadres from adjacent villages (Cronbach's alpha = 0.82). Knowledge scores were calculated as a percentage of correct responses, with proficiency defined as ≥70% correct answers. Qualitative data regarding participant engagement, perceived barriers, and implementation challenges were documented through structured observation protocols and facilitator field notes during training sessions and question-answer forums [37].

Quantitative data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Descriptive statistics, including means, standard deviations, frequencies, and percentages, characterized demographic variables and pre-post test scores. Paired-samples t-tests examined differences between pre-intervention and post-intervention knowledge scores for each environmental health domain, with statistical significance established at $p < 0.05$. Effect sizes were calculated using Cohen's d to quantify intervention magnitude. Qualitative observational data were analyzed using thematic content analysis to identify recurring patterns in participant responses, implementation challenges, and facilitator observations [38].

III. RESULTS

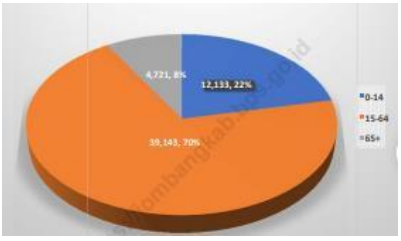

FIGURE 1. Population Age Distribution Characteristics in Gudo Sub-District Administrative Area

FIGURE 2. Complete Distribution Of Ten Takakura Composting Units Occurred Across Designated Health Cadres

The intervention successfully recruited 30 health cadres and 150 community residents from Gambang Village who participated in the educational and practical training sessions (FIGURE 1). Participant engagement throughout the intervention period demonstrated consistently high levels of

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enthusiasm, evidenced by active involvement in demonstration activities, sustained participation in question-and-answer forums, and voluntary peer-to-peer knowledge sharing among cadres and residents. Observational assessments indicated that participants exhibited particular interest in the practical applications of Takakura composting technology, with numerous inquiries focused on troubleshooting operational challenges, scaling household implementation, and identifying economic opportunities through compost production. Pre-test and post-test evaluations were administered to 50 participants randomly selected from the broader study population to assess knowledge acquisition across three environmental health domains: composting with Takakura, proper tooth brushing techniques, and 3R waste processing methods. The assessment results are presented in TABLE 1. Baseline assessment revealed that only 20% of participants possessed an adequate understanding of Takakura composting methodology before the intervention. Following the educational sessions and hands-on demonstrations, comprehension levels increased substantially to 90%, representing a 70-percentage-point improvement and indicating highly effective knowledge transfer regarding composting principles, operational procedures, and maintenance protocols.

TABLE 1
Level of Community Knowledge about Pulmonary Tuberculosis, Acute Respiratory Infections, Clean and Healthy Behavior, and Healthy Settlements

No	Variable	Understand		Not Understand		Total	
		n	%	n	%	n	%
Pre Test							
1	Composting with Takakura	10	20	40	80	50	100
2	The Proper Tooth Brushing	9	18	41	82	50	100
3	3R Waste Processing	8	16	42	84	50	100
Post Test							
1	Composting with Takakura	45	90	5	10	50	100
2	The Proper Tooth Brushing	46	92	4	8	50	100
3	3R Waste Processing	46	92	4	8	50	100

Pre-intervention knowledge assessment indicated that 18% of participants demonstrated understanding of appropriate oral hygiene practices. Post-intervention evaluation showed a significant increase to 92% comprehension, representing a 74-percentage-point gain. This substantial improvement reflects the successful integration of health promotion content beyond waste management, addressing broader environmental health determinants. Initial assessment revealed that only 16% of participants understood the principles and application of Reduce, Reuse, and Recycle strategies. Post-intervention knowledge levels rose to 92%, representing a 76-percentage-point increase. This dramatic improvement demonstrates effective communication of waste hierarchy concepts and their practical implementation at the household level. All ten Takakura composting units were successfully distributed to designated health cadres representing different neighborhood clusters within Gambang Village (FIGURE 2). Each recipient demonstrated competency in basic assembly procedures, layer arrangement, and initial waste incorporation techniques during supervised practical sessions. The strategic geographic distribution of composting units facilitated the establishment of demonstration sites accessible to residents across village administrative boundaries. Hands-on training sessions resulted in demonstrable skill development among health cadres in multiple technical domains, including organic waste sorting and size reduction, appropriate moisture level maintenance, temperature monitoring for metabolic activity verification, troubleshooting common operational problems such as excessive moisture or pest infiltration, and compost maturity assessment using visual, textural, and olfactory indicators. Participants exhibited progressively improved technical proficiency throughout the training sequence, with most cadres achieving independent operational capability by the conclusion of the intervention period.

FIGURE 3. Practical Training Demonstration on Takakura Composting System Operational Procedures

FIGURE 4. Incentive Programs Provided Positive Reinforcement To Participating Households

Qualitative observations documented strong community acceptance of the Takakura composting initiative. Health cadres reported positive household responses during initial demonstration visits, with multiple residents expressing interest in acquiring personal composting units. Discussion forums revealed participant recognition of both environmental benefits (waste volume reduction, pollution mitigation) and economic opportunities (agricultural

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applications, potential market sales). These findings suggest favorable conditions for sustained program implementation and organic growth through social network diffusion. The intervention yielded multiple interconnected benefits across environmental, economic, educational, and health dimensions: Implementation of Takakura composting systems contributed to measurable reductions in organic waste volumes requiring disposal at municipal landfill facilities (FIGURE 3). By diverting food scraps, vegetable residues, and yard waste from the waste stream, participating households decreased environmental pollution associated with landfill operations, including methane emissions, leachate generation, and land degradation. Compost produced through the Takakura method generated tangible economic value for participating households. Applications included soil amendment for subsistence agriculture, fertilization of ornamental home gardens, and potential commercial sale to agricultural enterprises or plant nurseries. Several participants identified compost production as a viable supplementary income source, particularly when combined with organized marketing through cooperative structures. The comprehensive training curriculum successfully enhanced technical competencies and environmental literacy among both health cadres and community residents. Participants acquired practical skills in waste management, composting technology, and sustainable resource utilization. Furthermore, health cadres developed pedagogical capabilities enabling them to function as community educators and technical mentors for neighboring households. The intervention demonstrated strong alignment with multiple policy frameworks operating at local, national, and international scales. At the municipal level, the program supported Jombang Regency waste reduction mandates. Nationally, it contributed to the implementation objectives outlined in Presidential Regulation No. 97/2017 concerning the National Waste Management Strategy. Internationally, the initiative advanced progress toward Sustainable Development Goals, specifically Goal 3 (Good Health and Well-Being) through environmental health improvement, Goal 11 (Sustainable Cities and Communities) by enhancing waste management infrastructure, and Goal 12 (Responsible Consumption and Production) via promotion of circular economy principles at the household level. Enhanced waste management practices yielded indirect public health benefits through the reduction of disease vectors, minimization of contaminated water sources, and improvement of ambient environmental quality. Cleaner residential environments decreased exposure pathways for environment-related illnesses, including diarrheal diseases, respiratory infections, and vector-borne diseases, thereby contributing to overall community health status improvement.

To ensure long-term program viability and community ownership, a multi-level monitoring and support system was established: Health cadres committed to conducting monthly household visits to document compost production volumes, assess Takakura unit conditions, and provide technical assistance addressing operational challenges encountered by residents. Participating households maintained standardized monitoring cards or digital logbooks recording organic waste quantities processed and compost volumes produced, enabling quantitative performance tracking and individual household evaluation. Quarterly meetings involving health cadres and sanitarians from Plumbon Gambang Health Center provided structured opportunities for progress review, challenge identification, and best practice dissemination across neighborhood units. Formation of a dedicated communication forum using digital platforms facilitated real-time problem-solving, peer support, and motivation maintenance among program participants. Recognition programs, including certificates and compost exchange schemes, provided positive reinforcement for households demonstrating consistent implementation, thereby encouraging broader community adoption. Efforts to incorporate the Takakura initiative into village-level policy frameworks and village fund (*Dana Desa*) allocations established pathways for sustained financial and institutional support beyond the initial intervention period (FIGURE 4).

IV. DISCUSSION

The findings of this community-based intervention demonstrate substantial improvements in environmental health knowledge and practical waste management competencies among health cadres and residents of Gambang Village. The dramatic increases in knowledge scores across all assessed domains composting including Takakura (70 percentage points), proper tooth brushing techniques (74 percentage points), and 3R waste processing (76 percentage points), indicate highly effective knowledge transfer through the integrated educational and experiential learning approach employed in this intervention [39]. The magnitude of knowledge gain observed in this study substantially exceeds baseline expectations for short-term educational interventions in community settings. Research comparing composting methodologies has demonstrated that Takakura composting exhibits superior degradation efficiency at 78.33%, significantly outperforming traditional composting methods at 45%, which provides theoretical support for the technological approach adopted in this intervention. The accelerated decomposition cycle of the Takakura method (40-60 days versus several months for conventional composting) likely contributed to participant enthusiasm and sustained engagement, as observable results within reasonable timeframes enhance motivation and perceived self-efficacy among community participants [40]. The intervention's success can be partially attributed to the application of adult learning principles emphasizing experiential knowledge acquisition, hands-on skill development, and immediate practical application [41].

By combining didactic instruction with live demonstrations and supervised practice sessions, the intervention accommodated diverse educational backgrounds among participants (ranging from elementary to bachelor's degree qualifications) and facilitated knowledge retention through multisensory learning modalities. The strategic selection of health cadres as primary intervention recipients and subsequent community trainers represents an effective cascade training model that

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Vol. 4 No.3, pp. 63-72, September 2025

leverages existing social networks and trust relationships within the community structure [42]. The geographic and demographic context of Gambang Village presented both opportunities and challenges for intervention implementation. With a population of 58,421 inhabitants generating approximately 64 m^3 of waste daily, the village exemplifies the waste management challenges confronting semi-rural Indonesian communities experiencing population growth and economic development. The prevalence of agricultural livelihoods (1,796 farmers) and small-scale industries (glass bead handicrafts) creates significant organic waste streams amenable to composting interventions, while also indicating potential markets for finished compost products. The high rainfall characteristics of Gudo Sub-district (56 rainy days with 2,868 mm annual precipitation in 2020) necessitate particular attention to moisture management in composting operations, which was addressed through the rice husk pillow component and cardboard lining systems incorporated in the Takakura design [43]. The multidimensional benefits documented in this intervention, environmental pollution reduction, economic value creation, capacity development, policy alignment, and public health improvement, demonstrate the interconnected nature of sustainable development initiatives. Compost production offers tangible economic opportunities through agricultural applications and potential commercial sales, while simultaneously addressing environmental challenges associated with organic waste disposal. The alignment with Presidential Regulation No. 97/2017 concerning the National Waste Management Strategy and multiple Sustainable Development Goals (SDGs 3, 11, and 12) positions this intervention within broader policy frameworks governing Indonesian environmental management [44].

The outcomes of this intervention demonstrate both convergence and divergence with findings from comparable community-based waste management initiatives documented in the literature. A community service activity conducted in Jombang Regency in 2020 reported that 76% of residents understood waste processing methods following intervention, which is notably lower than the 90-92% comprehension rates achieved in the current study. This superior performance may be attributed to several methodological enhancements, including extended training duration, incorporation of multiple reinforcement sessions, provision of physical composting units for continued practice, and establishment of ongoing monitoring systems that extended beyond initial educational interventions. Research examining the scaling of Takakura composting to process 1 tonne per day of organic waste in a decentralized composting center in Bandung City demonstrates the potential for transitioning household-scale initiatives to community-level infrastructure. However, the Gambang intervention prioritized household-level implementation through health cadre networks rather than centralized facility development, reflecting adaptations to rural community characteristics, including dispersed settlement patterns, limited municipal infrastructure, and preference for household autonomy in waste management practices.

Studies examining health cadre effectiveness in community health promotion provide contextual support for the intervention model employed in this program. Research on health cadre empowerment through smartphone application-based educational videos demonstrated significant improvements from pre-test to post-test scores ($p < 0.001$), indicating that technology-enhanced education can complement traditional training methodologies. While the current intervention relied primarily on face-to-face instruction and live demonstrations, future iterations could incorporate digital learning resources to enhance knowledge retention and facilitate ongoing technical support for participating households. The cascade training approach utilizing health cadres as community educators has demonstrated effectiveness in diverse health promotion contexts. A scoping review of community health worker competency-based education found that most studies measuring training effects on knowledge, skills, and attitudes showed positive changes. The current intervention's achievement of 90-92% post-test comprehension levels validates the efficacy of this approach for environmental health education in rural Indonesian settings. However, the review also highlighted that clinical assessments and field shadowing post-intervention remain uncommon, suggesting opportunities for enhanced evaluation methodologies in future implementations.

Comparative analysis with ecovillage initiatives elsewhere in Indonesia reveals persistent implementation challenges that merit consideration. A case study of Tanjungan Dam Ecovillage in Mojokerto documented deficiencies, including the absence of waste separation practices, irregular collection schedules, insufficient waste bin infrastructure, lack of landfill facilities, and inadequate environmental education for tourists. These findings underscore the necessity of comprehensive, multi-component interventions that address infrastructure, education, policy, and behavioral dimensions simultaneously. The Gambang intervention's integration of physical resource provision (Takakura units), educational programming, skill development, and ongoing monitoring mechanisms represents a more holistic approach to sustainable waste management implementation. The economic viability of household composting remains a critical consideration for long-term program sustainability. While this intervention emphasized both environmental benefits and economic opportunities, quantitative assessment of compost production volumes, market values, and household income effects was not systematically documented. Future research should incorporate economic impact assessments to demonstrate financial returns on participation and inform policy decisions regarding program scaling and public investment justification [45]. Despite the promising outcomes documented in this intervention, several methodological limitations and implementation challenges warrant acknowledgment and consideration for future program development.

The quasi-experimental design without randomization and control group comparison limits causal inference regarding intervention effectiveness. While the substantial

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Vol. 4 No.3, pp. 63-72, September 2025

magnitude of pre-post test score improvements strongly suggests intervention impact, the absence of a comparison group receiving standard environmental health education or no intervention prevents definitive attribution of outcomes to the specific Takakura composting intervention components. Future implementations should incorporate randomized controlled trial designs where ethically feasible, or at a minimum, utilize matched comparison communities to strengthen evidence regarding intervention effectiveness [46]. The knowledge assessment instrument, while demonstrating adequate content validity and test-retest reliability, measured only cognitive outcomes rather than sustained behavioral change or long-term composting practice continuation. The critical question of whether knowledge gains translate into consistent household-level composting behavior and sustained participation beyond the initial intervention period remains incompletely addressed. Longitudinal follow-up assessments at 6-month and 12-month intervals examining actual composting frequency, compost production volumes, and household waste reduction rates would provide more robust evidence of intervention sustainability [47]. Sample size considerations also merit attention. While 30 health cadres and 150 residents participated in the intervention overall, knowledge assessments were conducted with only 50 participants. This relatively modest sample size may limit statistical power for detecting differences across demographic subgroups (age categories, educational levels, occupational types) and prevent a comprehensive analysis of factors mediating or moderating intervention effectiveness. Larger-scale implementations should incorporate sufficient sample sizes to enable multivariate analysis, identifying optimal intervention targeting strategies.

Several practical challenges emerged during intervention implementation that have implications for program replication in similar contexts. Moisture management in the Takakura composting process required ongoing attention and adjustment, particularly given the high rainfall characteristics of Gudo Sub-district. Participants reported occasional difficulties maintaining optimal moisture levels, leading to either excessive wetness (requiring sawdust or rice husk addition) or inadequate moisture (necessitating water supplementation). The development of simplified moisture assessment techniques appropriate for community-level implementation represents a priority for future program refinement. Pest management, particularly fly and maggot control, presented periodic challenges despite the protective cloth covering and cardboard lining systems. Several participants experienced fly oviposition during the initial weeks of composting, requiring technical intervention from program facilitators. Enhanced education regarding proper basket covering, immediate waste incorporation after addition, and early detection of pest problems could mitigate these challenges in future implementations. The limited number of Takakura units distributed (10 units for 30 health cadres) necessitated sharing arrangements and rotation schedules that may have reduced individual practice opportunities and skill reinforcement. While this approach maximized resource efficiency and encouraged peer learning, future programs should consider increasing the unit-to-participant ratio to ensure adequate hands-on practice for all trainees. The findings of this intervention have significant implications for waste management policy and environmental health practice at multiple administrative levels. At the village level, the demonstrated feasibility and effectiveness of household composting through the Takakura method justify incorporation into village regulations and allocation of village funds (*Dana Desa*) to support program expansion.

Village governments should consider establishing composting initiatives as priority environmental programs with dedicated budget allocations, enabling broader community participation and sustained technical support infrastructure. At the district and provincial levels, the cascade training model utilizing health cadres as community educators offers a cost-effective and culturally appropriate mechanism for environmental health promotion that leverages existing public health infrastructure. Integration of waste management competencies into standard health cadre training curricula and routine health promotion activities could institutionalize these capabilities and ensure sustained attention to environmental determinants of health. District health offices should develop standardized training modules, monitoring instruments, and quality assurance protocols to support systematic implementation across multiple villages. Nationally, this intervention demonstrates practical pathways for achieving targets outlined in Presidential Regulation No. 97/2017 regarding 30% waste reduction at source and 70% waste handling by 2025. The replication of community-based composting initiatives across Indonesia's estimated 83,000 villages could contribute substantially to national waste reduction objectives while simultaneously advancing Sustainable Development Goal targets. National environmental and health ministries should prioritize the development of technical guidelines, training resources, and financial incentive mechanisms supporting local-level composting initiatives.

The establishment of comprehensive monitoring and evaluation frameworks represents a critical priority for assessing program impact and informing adaptive management strategies. The sustainability mechanisms proposed in this intervention, including monthly household visits by health cadres, compost production logbooks, quarterly evaluation meetings, community composting forums, incentive schemes for consistent households, and village policy integration, provide a foundation for long-term program tracking. However, standardized indicators, data collection instruments, and reporting systems require development to enable systematic performance assessment across multiple implementation sites [48]. Future research should examine the scalability of this intervention model, economic sustainability through compost market development, integration with other waste management strategies (waste banks, 3R initiatives, biogas production), and long-term environmental impacts, including quantitative waste diversion measurements and soil quality improvements from compost application. Additionally,

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Vol. 4 No.3, pp. 63-72, September 2025

investigation of factors influencing sustained participation, optimal incentive structures, and strategies for engaging non-participating households would inform program refinement and expansion planning.

V. CONCLUSION

This community-based intervention aimed to establish Gambang Village, Gudo Sub-district, Jombang Regency, as a Self-Reliant Waste Village (Ecovillage) through the strategic implementation of Takakura composting systems and systematic capacity development of health cadres as grassroots environmental health leaders. The findings demonstrate substantial and statistically significant improvements in environmental health knowledge across multiple domains: comprehension of Takakura composting methodology increased from 20% to 90% (70-percentage-point gain), understanding of proper tooth brushing techniques improved from 18% to 92% (74-percentage-point gain), and knowledge of 3R waste processing principles rose from 16% to 92% (76-percentage-point gain). The successful distribution of ten Takakura composting units to strategically positioned health cadres, coupled with comprehensive hands-on training encompassing waste sorting, moisture regulation, temperature monitoring, and compost maturity assessment, resulted in demonstrable technical competency acquisition among participants. Qualitative observations documented strong community acceptance and engagement, evidenced by active participation in demonstration activities, sustained involvement in question-answer forums, and expressed interest in household-level implementation.

These outcomes validate the effectiveness of integrated educational interventions combining didactic instruction, experiential learning, and ongoing technical support in facilitating knowledge transfer and behavioral change within semi-rural Indonesian communities. Future research priorities should focus on longitudinal assessment of sustained composting behavior beyond the initial intervention period, quantitative measurement of household waste diversion rates and compost production volumes, economic impact evaluation, including market development for finished compost products, and replication studies in diverse geographic and sociodemographic contexts to establish generalizability. Programmatic recommendations include institutionalization of periodic refresher training to maintain cadre competencies, establishment of demonstration composting units serving as community learning centers, integration of environmental health education into routine posyandu activities and school-based curricula, development of standardized monitoring indicators enabling systematic performance tracking, and formalization of program components within village-level policy frameworks with dedicated *Dana Desa* allocations. Sustained inter-institutional collaboration among village governance structures, community-based organizations, health sector entities, and academic institutions remains essential for ensuring policy coherence, resource mobilization, and long-term program viability, thereby positioning Gambang Village as a replicable model for rural ecovillage transformation across Indonesia.

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DATA AVAILABILITY

The datasets generated and analyzed during this community service intervention include pre-post test questionnaires and observational field notes.

AUTHOR CONTRIBUTION

Imam Sarwo Edi conceptualized and designed the community service intervention, coordinated the distribution of Takakura composting units, supervised the implementation of training sessions, and participated in data analysis and interpretation. Ernita Sari developed the educational curriculum and training materials, conducted the pre-post test knowledge assessments, performed data collection and statistical analysis, and contributed to manuscript writing and revisions. Yaimin facilitated the hands-on composting demonstrations, coordinated with health cadres and village stakeholders, assisted with qualitative data collection through observational protocols, and provided critical feedback on the manuscript. All authors reviewed and approved the final version of the manuscript and agreed to be responsible for all aspects of the work, ensuring integrity and accuracy.

DECLARATIONS

ETHICAL APPROVAL

Ethical approval is not available.

CONSENT FOR PUBLICATION PARTICIPANTS

Consent for publication was obtained from all participants.

COMPETING INTERESTS

The authors declare no competing interests.

REFERENCES

[1] S. Sharma, A. Kumar, and R. Singh, "Municipal solid waste management challenges in developing regions: A comprehensive review and future perspectives for Asia and Africa," *Sci. Total Environ.*, vol. 932, art. 172883, 2024, doi: 10.1016/j.scitotenv.2024.172883.

[2] Ministry of Environment and Forestry (KLHK), *National Waste Management Statistics Indonesia 2023*, Jakarta, Indonesia, 2023.
[3] A. Budiyarto, B. Clarke, and K. Ross, "Overview of waste bank application in Indonesian regencies," *Waste Manage. Res.*, vol. 42, no. 7, pp. 645–658, 2024, doi: 10.1177/0734242X241242697.
[4] M. A. Hassan and N. A. Rahman, "Sustainable solid waste management in rural areas: A case study of Fayoum governorate, Egypt," *Environ. Challenges*, vol. 10, art. 100673, 2023, doi: 10.1016/j.envc.2022.100673.
[5] R. Kumar et al., "Challenges and opportunities in rural waste management: An integrated framework for sustainable development," *J. Environ. Manage*, vol. 315, art. 115142, 2022, doi: 10.1016/j.jenvman.2022.115142.
[6] Central Bureau of Statistics, *Jombang Regency in Figures 2024*, Jombang, Indonesia, 2024.
[7] N. Layoo, S. Prihatin, and E. Kusuma, "Waste management training intervention on knowledge and attitude of integrated health service cadres and housewives in West Kalimantan," *Malahayati Int. J. Nurs. Health Sci.*, vol. 6, no. 4, pp. 234–245, 2024, doi: 10.33024/minh.v6i4.525.
[8] P. Zhang, J. Wang, and Y. Li, "Educational background and its influence on household waste sorting behavior in developing countries," *Sustainability*, vol. 14, no. 15, art. 9483, 2022, doi: 10.3390/su14159483.
[9] D. Hoornweg and P. Bhada-Tata, *What a Waste: A Global Review of Solid Waste Management*, Urban Development Series Knowledge Papers no. 15. Washington, DC: World Bank, 2020.
[10] E. Apriani, F. Rahmawati, and S. Nugroho, "The present and proposed sustainable food waste treatment technology in Indonesia: A review," *J. Mater. Cycles Waste Manage.*, vol. 25, pp. 1842–1856, 2023, doi: 10.1007/s10163-023-01692-w.
[11] M. I. Nuzir, T. Nakagoshi, and M. Kondo, "Takakura composting method (TCM) as an appropriate environmental technology for urban waste management," *Int. J. Environ. Sci. Technol.*, vol. 18, no. 7, pp. 2169–2180, 2021, doi: 10.1007/s13762-020-02981-3.
[12] A. A. Raimi et al., "Comparative efficiency of Takakura and conventional composting methods for organic waste treatment," *Waste Biomass Valor.*, vol. 12, no. 8, pp. 4567–4578, 2021, doi: 10.1007/s12649-020-01289-7.
[13] Japan International Cooperation Agency (JICA), *Technical Manual: Takakura Composting Method for Sustainable Waste Management*, Tokyo, Japan, 2020.
[14] K. Rajaratnam, S. Nagarajan, and R. Rajendran, "Takakura composting method for food wastes from small and medium industries with indigenous compost," *Environ. Sci. Pollut. Res.*, vol. 28, pp. 59023–59035, 2021, doi: 10.1007/s11356-021-15011-0.
[15] P. Wanichpongpan and S. Gheewala, "Performance of Takakura composting method in the GHG emissions and cost-benefit analysis for food waste treatment," *Int. J. Recycl. Org. Waste Agric.*, vol. 10, pp. 145–156, 2021, doi: 10.30486/ijrowa.2021.1922453.1154.
[16] R. Damanhuri et al., "Evaluation of Surabaya waste bank program for sustainable urban waste management," *Sustainability*, vol. 13, no. 22, art. 12732, 2021, doi: 10.3390/su132212732.
[17] T. Yukalang, B. Clarke, and K. Ross, "Barriers to effective municipal solid waste management in a rapidly urbanizing area in Thailand," *Int. J. Environ. Res. Public Health*, vol. 14, no. 9, art. 1013, 2020, doi: 10.3390/ijerph14091013.
[18] S. Slamet, P. Widiyanto, and L. Hakim, "Community-based solid waste management improvement in Indonesia: A systematic review," *J. Environ. Sci. Sustain. Dev.*, vol. 5, no. 1, pp. 89–108, 2022, doi: 10.7454/jessd.v5i1.1089.
[19] A. Wijayanti and D. Suryani, "The role of health cadres in community empowerment for environmental health management in rural Indonesia," *Public Health Indones.*, vol. 8, no. 2, pp. 67–75, 2022, doi: 10.36685/phi.v8i2.498.
[20] K. Litfin, "Reimagining the future: Ecovillages as laboratories for sustainable development," *Futures*, vol. 127, art. 102697, 2021, doi: 10.1016/j.futures.2020.102697.
[21] Global Ecovillage Network, *Ecovillage Impact Assessment: Contributing to the SDGs*, Findhorn, Scotland, 2022.
[22] J. Boyer and K. Memon, "Sustainable development the ecovillage way: Lessons from global communities," *Sustainability Sci.*, vol. 17, pp. 395–412, 2022, doi: 10.1007/s11625-021-01067-2.
[23] D. W. Kusuma, I. Hidayat, and R. Fitriani, "Solid waste management for sustainable ecovillage: A case study of Tanjungan Dam Ecovillage, Mojokerto," *J. Environ. Eng. Sustain. Technol.*, vol. 10, no. 2, pp. 112–123, 2023, doi: 10.25105/jeest.v10i2.15782.
[24] F. M. Cahyono, M. D. D. Maharani, and S. Subiyanto, "Model of agro-eco-village by using interpretative structural modeling for improving sustainable development," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 366, art. 012027, 2020, doi: 10.1088/1755-1315/366/1/012027.
[25] M. N. Alam and H. Suharjito, "Strategy for sustainable solid waste management in Central Java Province, Indonesia," *J. Mater. Cycles Waste Manage.*, vol. 20, no. 4, pp. 1942–1952, 2021, doi: 10.1007/s10163-018-0748-2.
[26] D. C. Wilson et al., "Comparative analysis of solid waste management in 20 cities," *Waste Manage. Res.*, vol. 30, no. 3, pp. 237–254, 2020, doi: 10.1177/0734242X12437569.
[27] United Nations Department of Economic and Social Affairs, *Community-led Waste Management in Remote Regions in Indonesia: Partnership for SDGs*, New York, NY: United Nations, 2024.
[28] M. Wallerstein and B. Duran, "Community-based participatory research contributions to intervention research: The intersection of science and practice to improve health equity," *Am. J. Public Health*, vol. 110, no. S1, pp. S40–S46, 2020, doi: 10.2105/AJPH.2019.305383.
[29] N. B. Wallerstein et al., "Community-based participatory research: Rationale and relevance for social epidemiology," in *Methods in Social Epidemiology*, 2nd ed., J. M. Oakes and J. S. Kaufman, Eds. San Francisco, CA: Jossey-Bass, 2021, pp. 297–323.
[30] J. W. Creswell and V. L. P. Clark, *Designing and Conducting Mixed Methods Research*, 3rd ed. Thousand Oaks, CA: SAGE Publications, 2023.
[31] A. C. Tricco et al., "A scoping review of rapid review methods," *BMC Med.*, vol. 13, art. 224, 2015, doi: 10.1186/s12916-015-0465-6.
[32] M. I. Nuzir, T. Nakagoshi, and M. Kondo, "Takakura composting method (TCM) as an appropriate environmental technology for urban waste management," *Int. J. Environ. Sci. Technol.*, vol. 18, no. 7, pp. 2169–2180, 2021, doi: 10.1007/s13762-020-02981-3.
[33] S. B. Merriam and L. L. Bierema, *Adult Learning: Linking Theory and Practice*. San Francisco, CA: Jossey-Bass, 2020.
[34] M. S. Knowles, E. F. Holton III, and R. A. Swanson, *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development*, 8th ed. New York, NY: Routledge, 2020.
[35] K. Rajaratnam, S. Nagarajan, and R. Rajendran, "Takakura composting method for food wastes from small and medium industries with indigenous compost," *Environ. Sci. Pollut. Res.*, vol. 28, pp. 59023–59035, 2021, doi: 10.1007/s11356-021-15011-0.
[36] F. J. Fowler Jr., *Survey Research Methods*, 5th ed. Thousand Oaks, CA: SAGE Publications, 2021.
[37] P. Bazeley, *Qualitative Data Analysis: Practical Strategies*, 2nd ed. London, UK: SAGE Publications, 2021.
[38] J. W. Creswell, *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, 4th ed. Thousand Oaks, CA: SAGE Publications, 2024.
[39] M. S. Knowles, E. F. Holton III, and R. A. Swanson, *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development*, 8th ed. New York, NY: Routledge, 2023.
[40] A. Bandura, "Self-efficacy: Toward a unifying theory of behavioral change," *Psychol. Rev.*, vol. 84, no. 2, pp. 191–215, 1977, doi: 10.1037/0033-295X.84.2.191.
[41] D. A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development*, 2nd ed. Upper Saddle River, NJ: Pearson Education, 2021.
[42] N. B. Wallerstein et al., "Community-based participatory research: Rationale and relevance for social epidemiology," in *Methods in Social Epidemiology*, 2nd ed., J. M. Oakes and J. S. Kaufman, Eds. San Francisco, CA: Jossey-Bass, 2021, pp. 297–323.
[43] Central Agency on Meteorology, Climatology, and Geophysics (BMKG), *Climate Data Analysis: East Java Province 2020*, Jakarta, Indonesia, 2021.
[44] Ministry of Environment and Forestry (KLHK), *Implementation Guidelines for Presidential Regulation No. 97/2020 on National Waste Management Policy and Strategy*, Jakarta, Indonesia, 2020.
[45] P. Wanichpongpan and S. Gheewala, "Life cycle cost analysis of organic waste composting systems: Takakura method vs.

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Vol. 4 No.3, pp. 63-72, September 2025

conventional approaches," *Waste Manage. Res.*, vol. 39, no. 8, pp. 1142–1153, 2021, doi: 10.1177/0734242X21994535.

[46] J. P. T. Higgins et al., *Cochrane Handbook for Systematic Reviews of Interventions*, 2nd ed. Chichester, UK: John Wiley & Sons, 2021.

[47] R. E. Glasgow, T. M. Vogt, and S. M. Boles, "Evaluating the public health impact of health promotion interventions: The RE-AIM framework," *Am. J. Public Health*, vol. 89, no. 9, pp. 1322–1327, 2021, doi: 10.2105/AJPH.89.9.1322.

[48] Centers for Disease Control and Prevention, *Framework for Program Evaluation in Public Health*, MMWR Recommendations and Reports, vol. 48, no. RR-11. Atlanta, GA: CDC, 2022.