

GREEN WASTE MANAGEMENT BASED ON A CIRCULAR ECONOMY TOWARDS A ZERO WASTE COMMUNITY IN GAMPOENG LANCANG GARAM, LHOKSEUMAWE

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Abstract

Household waste management at the village level requires behavioral changes, institutional support, and the utilization of waste as a resource. This Community Service activity aims to increase the knowledge, awareness, and skills of the Lancang Garam Village community, Lhokseumawe City, through a circular economy-based Green Waste Management approach towards a zero-waste community. The program was implemented from July to November 2025 with the core activity on November 3, 2025. Methods included initial surveys, interviews and FGDs, outreach, training on waste sorting, organic waste processing, inorganic waste utilization, participatory approaches, education, appropriate technology, and collaboration with officials and community groups. The report results show an increase in understanding and awareness, the implementation of waste sorting from source and processing of organic waste into compost, and the formation of the embryo of a waste management group at the village level. Program achievements also include accepted journal articles, Copyright IPR, online media publications, and an increase in the level of application readiness from the range of 4-6 to 7-8. The findings confirm that participatory education supported by local governance can be the foundation for sustainable, circular economy-based waste management.

Keywords: circular economy; community empowerment; green waste management; household waste; zero waste

INTRODUCTION

Household waste management is a crucial issue because the initial point of waste generation is at the household level. When households do not separate their waste at the source, organic waste, plastic, paper, glass, metal, and residuals mix together in a single stream. This reduces the opportunity for reuse, increases the volume that must be transported, and increases the burden on final processing facilities. Management that relies solely on collection, transportation, and disposal is insufficient to build a sustainable system. Waste reduction, sorting, recycling, composting, and resource recovery need to be integrated into people's daily practices (Rahim, 2020; Noor et al., 2020). This context is evident in Lancang Garam Village, Lhokseumawe City. The final report of the activity shows that much household waste is still disposed of without sorting and processing. Organic waste is mixed with plastic and other residues. Some residents also lack the technical knowledge to process waste into compost, recyclable materials, or other usable products. The practice of burning various types of waste is also still seen as a practical way to reduce waste, even though burning plastic, rubber, Styrofoam, and similar materials has the potential to produce emissions that are detrimental to health and the environment. This situation shows that the waste problem goes beyond the availability of vehicles, but also relates to local knowledge, habits, facilities, and governance.

The PKM report highlights the pressure on Lhokseumawe City's waste management as a key reason to strengthen source-level management. Data used in the report indicate that waste production is approximately 105 tons per day, potentially increasing during periods of higher economic activity. The report also notes the limited availability of suitable collection vehicles. While city data does not directly reflect the volume of waste generated in Gampoeng Lancang Garam, it does illustrate why household waste reduction strategies are relevant. The greater the proportion of waste that is sorted, composted, reused, or channeled into the recycling chain, the less burden the city's collection and disposal systems must handle (Ramdani, 2024). Green Waste Management in this activity is understood as a management approach that minimizes environmental impact while maintaining material value for as

long as possible. Waste is not simply viewed as residual material. Waste is positioned as a resource that can be sorted, processed, reused, or returned to the economic cycle. This view aligns with the principles of a circular economy that seek to reduce waste and pollution, maintain products and materials in use, and encourage the regeneration of natural systems. At the community level, this approach needs to be translated into simple practices that can be implemented by households, such as sorting, composting, reusing, selling recyclable materials, and strengthening waste banks or community management units (Ellen MacArthur Foundation, 2019). The implementation of a circular economy at the village level cannot rely solely on technology. Household decisions to sort waste are influenced by attitudes, social norms, accessibility of facilities, past habits, knowledge, and environmental support. Ajzen (1991) explains that behavioral intentions are shaped by attitudes toward the behavior, subjective norms, and perceived behavioral control. In the context of waste management, this framework helps explain why education must go hand in hand with social support and facilities. Residents who understand the benefits of sorting may not practice it if facilities are unavailable, environmental norms are unfavorable, or waste collection continues to mix sorted materials. Therefore, community interventions need to build both knowledge and the social conditions that make new behaviors easier to adopt.

Lancang Garam Village also has a significant institutional context. Community Service Program (PKM) activities are designed in collaboration with village officials and involve village leaders, Tuha Peut (Village Leader), youth leaders, women's leaders, and the community. The involvement of local actors offers two advantages. First, the program can tailor its content to the issues truly felt by residents. Second, the opportunity for sustainability increases because waste management can be integrated into the village's institutional agenda, rather than remaining a one-day activity. This approach aligns with the notion that urban waste management requires simultaneous consideration of technical, environmental, social, economic, and legal aspects (Khosravani et al., 2023).

From a local policy perspective, the final report positions this activity as supporting the direction of Lhokseumawe City's waste management, including the "Broh Jeut Keu Peng" program. The framework emphasizes that waste can have value when managed appropriately. The activity is also linked to the Sustainable Development Goals, specifically SDG 11 on sustainable cities and human settlements, SDG 12 on responsible consumption and production, and the opportunity to contribute to SDG 8 through material-based economic activities. This connection is important because changes at the household level can yield broader benefits when connected to city policies, community education, and local economic opportunities.

The partner issues mapped in the report encompass five key issues. First, education on sorting, processing, and recycling is still limited. Second, the habit of sorting waste at the household level has not yet been established. Third, community-based management systems such as waste banks or collective composting are not yet operational. Fourth, the economic potential of waste has not been fully utilized. Fifth, technical facilities and training are still limited. The report also highlights the suboptimal nature of local institutions and the lack of strong village regulatory support. This mapping demonstrates that the solutions needed are multidimensional and require a combination of education, practice, organization, simple technology, and policy support.

The Community Service Program (PKM) is therefore not designed solely for outreach. Activities include initial surveys, interviews and focus group discussions (FGDs), outreach, training on organic and inorganic waste management, an introduction to composting and recycling, and institutional mentoring. The community is positioned as the subject of the activities. Village officials play a role in mobilization and strengthening legitimacy. Academics and students play a role in material development, facilitation, documentation, and follow-up. This work pattern is crucial because behavioral changes are more likely to be sustained when residents participate in defining problems and selecting solutions appropriate to the local context.

The purpose of this article is to describe the implementation and achievements of the circular economy-based Green Waste Management program in Gampoeng Lancang Garam and to discuss its contribution to the establishment of a zero-waste community. The article also analyzes the relationship between education, community participation, appropriate technology, and institutional strengthening as elements that shape the program's sustainability. The analysis uses data and information available in the final PKM report. Because the report does not present quantitative pre-test and post-test scores, the article does not calculate the magnitude of the intervention effect. Achievements are discussed descriptively based on initial conditions, implementation processes, reported changes, outcomes, and sustainability indicators.

Table 1. Mapping of partner problems and direction of program intervention

Initial problems	Impact on waste management	Direction of intervention
Waste management education is still limited	Residents do not yet understand sorting, composting and recycling practically.	Socialization, educational media, discussions, and contextual training
Sorting at source is not yet a habit	Organic, inorganic and residual waste are mixed so that the material value decreases.	Sorting training and management practices from the household level
Community-based systems have not yet been established	Management depends on transportation services and does not yet have a collective mechanism.	Strengthening management groups, waste banks, and support from village officials
The economic potential of waste has not been utilized	Materials that are still valuable are wasted and income opportunities are lost	Introduction to the principles of circular economy, reuse, composting, and recycled products
Limited technical resources and skills	New behavior is difficult to maintain because facilities and capabilities are inadequate.	Introduction to composters, simple tools, media, and assistance
Local institutional and regulatory support is not optimal	The program is at risk of stopping after the activity is completed.	Integration into village planning, budget support, and network strengthening

LITERATURE REVIEW

2.1 Household Waste Management

Household waste management is part of the urban waste system, but it differs in that the initial decisions occur in the private space of the household. Residents determine whether materials are mixed, separated, reused, composted, sold, or disposed of. These choices affect the quality of the materials at subsequent stages. Mixed and contaminated waste is more difficult to recycle. Conversely, sorting at source increases the chances of material recovery and can reduce transportation and processing costs. Therefore, effective urban waste management cannot rely solely on downstream infrastructure. The system needs to intervene in behaviors and facilities at the point of generation (Noor et al., 2020).

Public health aspects are also important. Unmanaged waste can produce odors, disrupt aesthetics, clog drainage, create breeding grounds for vectors, and encourage open burning. Narethong (2020) positions waste management as part of an integrated effort to control the impact of waste on public health. In the village context, this relationship is closely tied to residents' daily experiences. Residents directly experience the impact of waste on neighborhood roads, waterways, public spaces, and the quality of their homes. Therefore, education that connects waste management to local health and hygiene is more easily understood than messages that are merely normative.

Waste management also requires institutional capacity. Households can sort independently, but the flow of materials still requires a collection, storage, processing, and marketing system. Without clear channels, community motivation can decrease because sorted waste is re-mixed. Khosravani et al. (2023) emphasize the importance of technical, environmental, social, economic, and legal dimensions. The technical dimension encompasses facilities and procedures. The social dimension relates to participation and norms. The economic dimension concerns costs, incentives, and material values. The legal dimension relates to rules, responsibilities, and institutional support. The integration of these five dimensions is relevant at the village level.

In the PKM report, the situation in Gampoeng Lancang Garam demonstrates a gap between general awareness of cleanliness and systematic management practices. Residents may consider cleanliness important, but sorting, composting, and recycling have not become routine. This gap needs to be addressed through practical learning. Knowledge needs to be translated into simple steps, such as differentiating organic and inorganic waste, determining containers, understanding marketable materials, and learning how to process food scraps or leaves into compost. When technical steps are made clear, perceived behavioral control can increase because residents feel these actions are feasible with available resources.

The literature on community-based waste management also emphasizes the importance of social ownership. Azwar (2017) views community-based management as a strategy that places citizens in the planning and implementation process. This approach does not eliminate government responsibility. Instead, it more clearly divides roles. The government and local officials can provide regulations, facilities, and support. Communities carry out daily sorting and management. Academics can support education and evaluation. Businesses can become partners in material absorption. This combination is more in line with a circular economy than a model that simply moves waste from homes to landfills.



Image 1. Sustainable waste management flow used as a reference in the PKM report

2.2 Circular Economy in Waste Management

A circular economy offers a shift in perspective on materials. Linear systems follow a pattern of taking resources, producing, using, and then discarding. This pattern results in the loss of material value and increases pressure on natural resources. A circular economy seeks to extend the lifespan of products and materials through design, maintenance, reuse, repair, repurposing, and recycling. In household waste management, this principle means separating materials as early as possible to ensure their potential for reuse remains high. Organic waste can enter the biological cycle through composting. Certain inorganic materials can re-enter the technical cycle through reuse or recycling (Ellen MacArthur Foundation, 2019).

The concept of a circular economy is relevant for community programs because it connects environmental goals with economic benefits. Residents often view waste as a burden because it requires space, time, and money to dispose of. When materials have a path to reuse, this perception can change. Paper, plastic, metal, and certain materials have value if their quality is maintained. Organic waste can produce compost for plants or productive activities. Creative products from used materials can also have utility. However, programs need to avoid the narrow understanding that all waste has a market value. Residues still need to be managed safely, while the primary priority remains waste reduction and prevention.

At the household level, implementing a circular economy requires a clear sequence of actions. Reducing single-use consumption can be done before waste is even created. Reusing maintains product functionality without additional processing. Sorting maintains material quality. Composting transforms organic fractions into useful materials. Recycling becomes an option for materials that cannot be reused directly. This sequence is crucial so that the circular economy is not simply understood as the activity of selling waste. The Community Service Program (PKM) utilizes education to introduce the relationship between these steps so that the community understands that economic value is one benefit, not the sole objective.

The report also links the circular economy to the potential for strengthening local economies. This idea makes sense when there is sufficient scale of materials, markets, and institutions. Incentive-based waste banks can serve as aggregation mechanisms. Management groups can record volumes, separate materials, and establish relationships with collectors or MSMEs. Compost can be used for local needs. Crafts or product reuse can be additional activities. While the final report does not yet present a financial feasibility analysis, this direction suggests

that the program could be developed from basic education to a social enterprise or community economic unit model at a later stage. The shift towards a circular economy also requires a shift in mindset. Citizens need to understand that consumption and disposal decisions have consequences. Education helps build understanding, but new habits require repetition, social support, and facilities. Therefore, a circular economy at the village level is not simply an economic concept. It is a material governance framework involving the behavior of households, community organizations, local governments, businesses, and city service systems. Its success is determined by the ability of these actors to prevent material flows from re-mixing and being wasted.

2.3 Zero Waste Community and the Role of the Community

Zero waste describes a management approach that seeks to prevent waste and conserve resources through production, consumption, reuse, and material recovery. The Zero Waste International Alliance (2021) emphasizes resource conservation and the prevention of waste that harms land, water, air, or health. At the community level, zero waste is best understood as a process toward systematically reducing waste. The goal of approaching zero waste is not achieved through a single activity. It requires gradual changes in consumption, sorting, processing, policies, and infrastructure.

The zero-waste community concept places the community as the primary actor. Households serve as the upstream point, while community groups can serve as organizing nodes. The group's role includes educating fellow residents, collecting sorted materials, managing compost, recording, coordinating with officials, and connecting with recycling markets. This structure helps transform individual behavior into collective practice. Without a social structure, programs easily become dependent on active individuals and struggle to sustain themselves when external facilitators cease their support.

Community participation also enhances the suitability of solutions. Communities are aware of activity patterns, collection times, problematic locations, dominant waste types, and daily challenges. Focus group discussions (FGDs) and deliberations can be used to combine local knowledge with technical know-how. The Community Empowerment Program (PKM) has used this approach from the outset. This approach prevents entirely top-down solutions and allows communities to express their needs, capabilities, and limitations. In empowerment, the participatory process is as important as the output, as it builds ownership of the program.

The role of village officials is crucial in transforming community practices into more permanent systems. Officials can incorporate waste management into planning, establish or recognize management units, allocate support, facilitate facilities, and develop local regulations. The PKM report highlights the suboptimal institutional framework and the need for policy support. These findings suggest that a zero-waste community requires a link between household actions and village governance. If the two are separate, it is difficult to support community behavior with a consistent system.

Communities also need ongoing learning mechanisms. New members, changes in management, and shifts in consumption patterns can reduce program consistency. Therefore, educational media, local cadres, routine activities, and evaluations need to be designed as part of the system. The sustainability indicators compiled in the report divide targets into short-, medium-, and long-term. This division demonstrates that increasing knowledge is the initial stage, while integration into village development programs and improving environmental quality are longer-term goals.

2.4 Behavioral Change and the Theory of Planned Behavior

The Theory of Planned Behavior (TPB) provides a framework for understanding why someone intends to perform a behavior. Ajzen (1991) describes three main constructs that shape intention: attitude toward the behavior, subjective norms, and perceived behavioral control. Attitudes reflect positive or negative assessments of the action. Subjective norms reflect perceptions of social support or pressure. Perceived behavioral control reflects the perceived ease or difficulty of performing the action. In waste management practices, these three can be translated into perceptions of the benefits of sorting, family and neighbor support, and the availability of containers, time, information, and collection routes.

Education primarily influences the basis for attitude formation. When residents understand the impact of mixing waste and the benefits of sorting, behavioral assessments can become more positive. However, knowledge alone does not automatically produce behavior. Social norms need to be supportive. The involvement of village leaders, women's leaders, and youth can shape the message that waste management is an expected practice in the community. Behavioral control also needs to be reinforced through practical examples, simple tools, and easy procedures. Therefore, the design of Community Empowerment Programs (PKM) that combines education and

participation is logically linked to the SDG mechanism. The report also touches on Heikal's development of the SDGs through past behavioral variables. This idea is relevant because the habit of throwing away waste without sorting can become a long-lasting pattern. Changing habits requires repeated new experiences. Initial training and practice can be the first step, but sustainability requires reinforcement after the program is complete. Therefore, mid-term evaluation is more important than simply responding positively during outreach. The program needs to assess whether sorting is still being carried out, whether the management unit is functioning, and whether the sorted materials have a clear path.

A behavioral framework helps avoid overly simplistic assessments of residents. Non-compliance with sorting doesn't necessarily indicate a lack of concern. Residents may have positive attitudes but face barriers related to facilities, space, collection schedules, or uncertainty about benefits. A participatory approach allows these barriers to emerge in discussions. Solutions can then be tailored to local capabilities. From this perspective, a zero-waste community is the result of the interaction between individual intentions, habits, community norms, behavioral control, and institutional support.



Image 2. Theory of Planned Behavior which is used as the basis for behavioral change in the PKM report

2.5 Appropriate Technology, Education, and Asset-Based Community Development

Appropriate technology in community programs must meet several criteria. The technology must be easy to understand, appropriate for local waste types, low cost, maintainable, and replicable. The Community Service Program (PKM) report cites household composters, incentive-based waste bank systems, eco-enzymes, and recycling crafts as examples of solutions that could be introduced. The primary value of these technologies lies not in their complexity, but in their ability to transform previously discarded materials into functional products or materials. Technology also serves as a learning tool because residents can see the direct connection between sorting and processing results.

Composting plays a crucial role because reports indicate organic waste is the dominant component of waste generation. At the household level, composting can reduce the volume of waste that must be transported. The resulting compost can be used for plant growth. Nasution and Hidayat (2018) identified household composting as a strategy for managing organic waste. However, successful composting requires proper sorting. Contamination with plastic or other materials can reduce quality. Therefore, composting training should be preceded by an understanding of waste categories and sorting procedures.

Waste banks operate on inorganic fractions that have economic value. This model combines environmental benefits with economic incentives. Residents collect sorted materials, the management unit weighs and records them, and then distributes the materials to partners. Permana and Sari (2021) position waste banks as a community model that can strengthen participation. In the context of Lancang Garam, waste banks are still more appropriately viewed as a development direction because the final report emphasizes the formation of a fledgling management group, not a fully-fledged waste bank system. Further stages need to ensure recording mechanisms, pricing, storage, and absorption partners.

The asset-based community development approach complements technology with a focus on local assets. The program not only identifies deficiencies but also maps existing capabilities, networks, leaders, organizations, spaces, and resources. The involvement of officials, youth leaders, women's leaders, students, and community groups constitutes a social asset that can be leveraged to sustain the program. The asset approach also helps reduce dependence on external assistance because solutions build on local capabilities and can be developed incrementally.

Transformational education bridges the gap between technology and social assets. Material needs to be presented in accessible language, with relevant examples, and hands-on practice. Leaflets, infographics, short videos, discussions, and demonstrations can be used to cater to different learning styles. Community Service Program (PKM) activities combine media and direct interaction. This approach is crucial because technical information about waste can often feel abstract. When participants can see the types of materials, the sorting process, and the results of composting or recycling, understanding becomes more operational.

2.6 Program Integrative Framework

Based on this description, the Green Waste Management program can be understood as an integrative intervention with five layers. The first layer is knowledge, namely understanding the impacts of waste, sorting, composting, reuse, and recycling. The second layer is behavior, namely the practice of sorting and processing at home. The third layer is simple technology that enables the behavior to be implemented in practice. The fourth layer is community organizations that manage collective activities. The fifth layer is village governance that provides legitimacy, support, and program integration. All five layers are interdependent.

If a program only increases knowledge, the impact may stop at awareness. If a program provides tools without education, the tools may go unused. If households sort but there is no collection organization, materials re-mix. If community groups are active but lack support from officials, sustainability can be weak. Therefore, the model developed through Community Service Program (PKM) prioritizes participation and collaboration as connecting mechanisms. A zero-waste community is a long-term goal built through stages of change in knowledge, practice, institutions, and policy integration.

Table 2. Key concepts and their relevance to the Green Waste Management program

Draft	Main focus	Relevance of the program
Household waste management	Reduction, sorting, processing, transportation and disposal	Placing households as the starting point for changing waste flows
Circular economy	Maintaining material value and reducing waste	Promote composting, reuse, recycling and valuable uses
Zero waste community	Reduction of residues through system and behavioral changes	Be a long-term direction, not a one-time activity target
Theory of Planned Behavior	Attitudes, subjective norms, behavioral control, and intentions	Explaining educational needs, social support, and ease of facilities
Appropriate technology	Simple, inexpensive, easy to use, and replicable solution	Supporting composters, waste banks, educational media, and simple processing
Participatory approach	The community becomes the subject of planning and implementation	Increase solution fit and sense of ownership
Asset-based community development	Utilization of local assets, capacities, networks and institutions	Strengthening sustainability through officials, figures, groups, academics and students

METHOD

3.1 Design and Location of Activities

This article is compiled from the final report of the Community Service activity entitled Green Waste Management: Education and Innovation of Household Waste Management Based on Circular Economy Towards Zero Waste Community in Gampoeng Lancang Garam, Lhokseumawe. The program implementation period is recorded from July to November 2025, while the main socialization activity was carried out on November 3, 2025. The location of the activity is Gampoeng Lancang Garam, Banda Sakti District, Lhokseumawe City. The main targets consist of households as waste producers, with the involvement of village officials, Tuha Peut, youth leaders, women

leaders, and other community elements. The program's design is community empowerment-oriented, using a participatory and educational approach. The program does not employ an experimental design. The stages are designed to identify problems, build knowledge, introduce practices, encourage early implementation, and strengthen institutions. The results are derived from the initial survey, interviews and focus group discussions (FGDs), field observations, socialization processes, discussions, documentation, program evaluation, and outcomes recorded in the final report. The report does not present numerical data from pre- and post-tests, therefore, this article does not conduct statistical testing and does not state suggested improvements in percentage terms.

3.2 Targets and Stakeholders

The program's targets are defined inclusively. Households are the primary group because most sorting decisions occur at the source. Housewives are seen as crucial due to their close ties to domestic activities and food waste management. Youth and local organizations are seen as strategic in supporting the campaign, creativity, and sustainability of activities. Village officials play a legitimizing and coordinating role. Academics and students act as knowledge facilitators, mentors, and liaisons between concepts and practice.

Multi-actor involvement is used to build shared responsibility. The program does not position waste management as solely the responsibility of sanitation workers. Each actor has a distinct but complementary function. This division of roles also forms the basis for post-activity institutional strengthening, as routine activities require administrators, village support, household participation, and access to parties who can receive or utilize the sorted materials.

Table 3. Stakeholders and functions in program implementation

Stakeholders	Role in the program	Contribution to sustainability
Household	Participate in education, carry out sorting and processing practices	Be a source of behavioral change and waste reduction from upstream
Gampong officials and Tuha Peut	Coordination, legitimacy, participant mobilization, and institutional support	Integrating waste management into village agendas and policies
Youth figures and women figures	Mobilizing participation and expanding social communication	Forming community norms and driving cadres
Lecturer team	Designing materials, facilitating socialization, training, evaluation, and follow-up	Maintaining the quality of knowledge and providing mentoring
Student	Supporting field, documentation, education, marketing, and mentoring	Expanding implementation capacity and campus-community relations

3.3 Preparation and Problem Identification Stage

The initial phase involved observing waste management conditions and communicating with partners. The survey focused on the dominant types of household waste, disposal habits, sorting practices, community perceptions, utilization potential, and institutional barriers. Interviews and focus group discussions (FGDs) with community leaders, village officials, housewives, and youth were used to explore the issue from a local perspective. This information was compiled into a map of problems and potentials, which served as the basis for determining the materials and format of activities.

Initial mapping revealed intervention needs in knowledge, behavior, facilities, economics, and organization. These findings prevented the program from focusing on a single aspect. For example, introducing composters is insufficient if residents haven't separated organic waste. A waste bank struggles to operate without administrators and sales channels. Education is insufficient without follow-up. Therefore, the identification results were translated into a package of interconnected activities.

3.4 Education, Socialization, and Training

The educational phase includes material on the impact of waste on the environment and health, an introduction to Green Waste Management, the principles of a circular economy, organic and inorganic separation, reuse, recycling, and composting on a household and communal scale. Educational media in the program design include leaflets, infographics, and short videos. The material is delivered interactively so participants can connect the concepts to the types of waste they encounter every day.

Training focuses on skills that can be immediately implemented. Sorting is a fundamental skill because it determines the quality of the material flow. Organic waste is introduced as a material that can be processed into compost. Inorganic waste is discussed based on the possibilities for reuse, collection, and recycling. Technologies introduced in the draft include household composters, incentive-based waste banks, eco-enzymes, and recycling crafts. The article distinguishes between technologies introduced as options and practices explicitly reported to have begun to be implemented, namely, sorting at source and processing organic waste into compost.

3.5 Participatory, Educational, Asset-Based, and Collaborative Approach

The participatory approach positions the community as the subject. Communities are involved from the needs identification stage through evaluation. Focused Group Discussions (FGDs) and village deliberations (musyawarah) are used to explore problems and potential. An educational approach is used to increase knowledge and awareness through contextual materials. Asset-based community development is used to leverage local capacity, including village leadership, social groups, youth leaders, women's leaders, and campus networks.

An appropriate technology approach is used to ensure solutions are within the community's capabilities. A circular economy approach is used to explain material value and utilization opportunities. A collaborative approach connects village officials, the community, academics, students, and potential business partners. This combination forms a design that not only seeks knowledge transfer but also changes practices and strengthens the social systems that support them.



Image 3. Stages of community service implementation as outlined in the final PKM report

3.6 Partner Participation

Partners were involved from the planning stage. Surveys and interviews were conducted before the main implementation to assess conditions and needs. Village officials played a role in communication, scheduling, mobilizing participants, and program acceptance. The community was involved in outreach, discussions, practices, and evaluation. This involvement was crucial because waste issues touch on daily habits that cannot be changed through external decisions alone.

Partner participation is also linked to sustainability. After the activity, the roles of officials and community groups are expected to shift from participants to managers. This role shift forms the basis for the formation of the initial waste management group. The report does not yet provide a final organizational structure and detailed operational mechanisms. Therefore, this institution is discussed as an initial achievement that requires further strengthening.

3.7 Monitoring, Evaluation, and Data Analysis

Monitoring and evaluation were designed through implementation observations, program reflections, reporting, and achievement assessments. The method design mentioned the use of questionnaires or surveys after the training to assess the effectiveness of the materials. However, the final report from which this article is based does not present questionnaire scores, response distributions, evaluation sample sizes, or statistical results. Therefore, this article only uses available evidence and does not construct undocumented quantitative data.

The analysis was conducted descriptively by comparing initial conditions, implemented activities, reported changes, outcomes, and sustainability indicators. Evidence of change consisted of reported statements regarding increased understanding and awareness, the implementation of sorting, the start of household composting, the involvement of various community elements, the formation of the initial management group, output achievements, and the TKT assessment. The results were then discussed using the concepts of waste management, circular economy, zero waste, community participation, and the SDGs.

Table 4. Implementation stages, main activities, and process indicators

Stage	Main activities	Process indicators used
1. Preparation and identification	Initial survey, interviews, FGD, mapping of problems and potential	Key issues, local potential, actors, and program needs identified
2. Education and socialization	Green Waste Management material, impact of waste, circular economy, and zero waste	Participants are involved in the delivery of material and discussions
3. Practical training	Sorting, organic processing, reuse and recycling options	Participants get examples of practical steps that can be applied.
4. Institutional assistance	Strengthening the role of civil servants and community groups	The emergence of local management and support groups
5. Monitoring and evaluation	Observation, reflection, reporting, achievement assessment and follow-up plans	Documented achievements, constraints, outputs and sustainability needs

RESULTS AND DISCUSSION

4.1 Initial Conditions and Need for Intervention

Initial conditions indicate that household waste management is still dominated by a collect-transport-dispose pattern. Organic and inorganic waste are not consistently separated. This situation reduces utilization opportunities because materials that could be composted or recycled are mixed with residue. The report also indicates that public knowledge about the circular economy, composting, ecobricks, and waste banks remains limited. As a result, the potential utility and economic value of household waste have not been systematically utilized.

Limitations extend beyond the individual level. The report highlights the lack of community-based management systems, suboptimal formal institutions, a lack of small-scale sorting and recycling facilities, and weak village regulatory support. These conditions explain why technical interventions need to be followed by institutional interventions. Residents can be encouraged to sort, but without ongoing management pathways, this behavior is difficult to sustain. Conversely, establishing management units without household participation also fails to result in a stream of sorted materials.

From a TPB perspective, the initial conditions can be interpreted as a combination of attitudes, norms, and behavioral control. Limited knowledge can hinder the formation of positive attitudes. The absence of collective habits indicates that social norms of discrimination are not yet strong. Limited resources and organization reduce perceived behavioral control. The program design addresses these three aspects through education, involvement of key figures, practice, and group strengthening. This relationship demonstrates that the program goes beyond simply conveying information, but also seeks to change the social environment that influences household decisions.

4.2 Implementation of Education and Socialization

The main activity on November 3, 2025, involved village leaders and Tuha Peut, youth leaders, women's leaders, and the community. The composition of participants demonstrated a cross-group approach. The presence of officials provided legitimacy, while the involvement of community leaders expanded opportunities for message dissemination after the activity. The outreach process utilized explanations and discussions so that the community could connect the material to the conditions they faced.

Educational materials covered the importance of source sorting, organic waste management, inorganic waste utilization, and a circular economy. The report states that this process increased public understanding and awareness. Because pre- and post-test scores were not available, these improvements should be interpreted as descriptive findings from implementation and observation, rather than quantitative estimates of effects. Nevertheless, cognitive change remains important, as knowledge is a prerequisite for sorting and processing practices.

The use of local context strengthens the relevance of the material. Communities not only accept the definition of a circular economy but are also introduced to the possibility of converting waste into resources. This approach has the potential to foster positive attitudes because the benefits become more concrete. Discussions also provide a space for participants to address challenges. Two-way communication is more conducive to empowerment than one-way lectures, as communities can assess the feasibility of practices based on their household and environmental conditions.



Image 4. Initial meeting with Geusyik Gampoeng Lancang Garam to discuss the activity implementation plan

4.3 Changes in Knowledge, Awareness, and Initial Practices

The final report noted positive changes in cognitive and behavioral aspects. People began to understand the importance of sorting household waste and its impact on the environment. At the practical level, sorting at source and processing organic waste into compost began at the household level. This finding is important because it demonstrates the shift from knowledge to initial action. In behavior change programs, this transition is a critical stage. Knowledge without action has limited impact, while initial practice provides experience that can strengthen perceptions of capability.

Sorting is a key lever. When organics are separated, composting becomes possible. When inorganics are separated and kept clean, reuse and recycling opportunities increase. Thus, one simple behavior can change the entire management flow. This finding aligns with the principles of a circular economy that preserves the value of materials. If sorting is continued, villages can develop a more structured collection system. If not maintained, the program's benefits will be further diminished due to the mixing of materials.

Household composting also has direct implications for reducing the amount of waste that needs to be transported. The report does not provide data on waste weight before and after the program. Therefore, the article does not calculate volume reduction. However, mechanically, any organic waste successfully processed at home does not enter the waste stream. The actual impact at the village scale will depend on the consistent number of households, the volume of organic waste processed, the quality of the process, and the use of the compost. These measurements should be part of the agenda for further evaluation.

4.4 Participation and Institutional Strengthening

One important achievement is the formation of the embryonic waste management group at the village level. The term "empire" indicates that the institution is still in its infancy. While not yet a fully-fledged operational unit, the group's emergence demonstrates an initial commitment to collective waste management. This achievement is crucial because many management practices require coordination beyond the household, particularly inorganic waste collection, recording, storage, marketing, and regular educational activities.

The involvement of village officials strengthens waste management as a governance issue, not just an individual matter. Official support can develop into regulations, budgeting, location designation, facility facilitation, or the formation of units. Youth and women leaders can play a role in social mobilization. This structure aligns with the asset-based community development approach because the program leverages existing social assets. Sustainability is greater if groups have clear tasks, schedules, coordination mechanisms, and targets.

From a subjective norm perspective, the participation of various figures can shape the social message that waste sorting and management are valued community behaviors. Changing norms is crucial to maintaining this behavior. If only a few households sort, the practice can be perceived as a personal burden. If officials, groups, and neighbors support it, the behavior can become the new standard. Therefore, institutional achievement has both psychological and operational functions.



Image 5. PKM education and socialization attended by representatives of various elements of the Gampoeng Lancang Garam community

4.5 Circular Economy and Potential Added Value

The circular economy approach broadens the program's objectives from cleanliness to resource utilization. The public is introduced to the idea that organic and inorganic waste have different management pathways. Organic waste can be processed into compost. Inorganic waste can be sorted for reuse, recycling, or distribution to a waste bank system. This shift in perspective is crucial because the value of materials is lost when all waste is mixed together.

Economic potential needs to be managed realistically. Not all materials have stable prices. Storage and transportation costs can reduce profits. Craft products require a market. Compost requires quality and users. Because the final report does not yet present calculations of costs, revenues, material volumes, or market analysis, the economic benefits in this article are positioned as potential development outcomes, not measurable financial outcomes. This clarification is important to ensure the program's claims remain consistent with available evidence.

The next step could be developing material and value records. Management units could weigh composted organic matter, collected inorganic matter, sales revenue, operational costs, the number of participating households, and compost usage. This data will enable the circular economy to be evaluated economically, not just conceptually. Record keeping also helps village officials determine appropriate support and assess the model's replication potential.

4.6 Improving Program Readiness and Output

The final report recorded an initial readiness level of 4-6 and an outcome level of 7-8. This assessment reflects a shift from existing technologies, systems, and approaches that have not yet been implemented locally to education, training, local adaptation, piloting, evaluation, and actual implementation by the target community. In the context of PKM, this improvement can be read as an indicator that the concept has not stopped at design but has been tested in a community setting.

The assessment of the TKT in social programs should be read in conjunction with evidence of implementation. The report mentions that sorting and composting practices have begun, and that management groups have begun to form. This evidence supports the claim of early implementation. However, readiness for implementation is not the same as sustainability. A system ready for implementation still requires consistency, resources, management, and monitoring. Therefore, the TKT results are more appropriate as a basis for the next stage rather than being considered the end of the process. Program outputs also demonstrate dissemination and documentation achievements. The report notes an accepted journal article on community service, IPR copyright for the Green Waste Management Model, and online news regarding the empowerment of assisted villages in waste

management. These outputs broaden the impact because program experiences can be documented, protected, and disseminated. However, the quality of social impact still needs to be assessed based on changes in practices and institutions, not just the number of academic outputs.

Table 5. Outcome and status achievements as recorded in the final report

Type of output	Title/output object	Status
Mandatory output - service journal	Waste management for education/socialization of household waste management based on a circular economy	Accepted
Mandatory output - Copyright IPR	Green Waste Management Model for education/socialization of household waste management based on a circular economy	Already
Additional output - online news	Empowerment of campus-based villages in waste management to support the Mayor of Lhokseumawe's program	Already

4.7 Program Achievement Matrix Based on Available Evidence

To maintain consistency between claims and evidence, program achievements can be grouped into outputs, initial outcomes, and impact direction. Outputs include outreach, materials, training, documentation, articles, intellectual property rights, and news. Initial outcomes include reported increases in understanding, sorting practices, composting, and the establishment of new groups. Long-term impacts, such as reduced waste going to landfill, increased income, improved environmental quality, or changes in well-being, cannot yet be expressed as measurable outcomes because the report does not provide longitudinal data.

This distinction between levels of achievement is crucial for community service articles. Outputs can often be achieved quickly, while outcomes require behavioral and organizational change. Impacts require longer timeframes and more robust measurement. With this framework, programs can be positively assessed without overstating the evidence. Programs successfully build a foundation for change, but sustainability must be demonstrated through follow-up.

Table 6. Matrix of results and interpretation based on the final PKM report

Dimensions	Available evidence	Interpretation
Knowledge and awareness	The report states that public understanding and awareness is increasing.	Positive cognitive outcomes descriptively; quantitative scores not yet available
Sorting from source	Sorting practices are starting to be carried out at the household level.	Demonstrates early adoption of behaviors that support separate material flows.
Organic processing	Processing of organic waste into compost has begun	Demonstrates early application of the principles of the circular economy biological cycle
Institutional	The embryo of a waste management group was formed	Demonstrates initial collective commitment; operational structures still need strengthening
Participation	The activity involved officials, Tuha Peut, youth, women and the community.	Supporting social norms and legitimacy of community-based management
Applicability Readiness	Initial TKT 4-6 and final TKT 7-8	Depicting the shift from conceptual readiness to local implementation
Dissemination	Article accepted, HKI already, online news already	Demonstrate academic output, intellectual property, and public publication achievements
Environmental and economic impacts	No quantitative measures of waste reduction or revenue are available.	Cannot be calculated yet; further monitoring with measurable indicators is needed.

4.8 Program Sustainability

Sustainability is a key focus in the final report. Indicators are divided into short-, medium-, and long-term indicators. In the short term, the focus is on knowledge, awareness, and positive attitudes. In the medium term, the focus shifts to sorting practices, group formation, and support from officials. In the long term, waste management is expected to be integrated into village development programs, institutions will function sustainably, and environmental quality and well-being will improve.

The indicator structure demonstrates a logical sequence of change. Knowledge serves as the foundation, but not the ultimate goal. Practices and organizations serve as bridges to systemic change. Integration into village planning is necessary for the program to have resources and legitimacy. This framework also aligns with the SDGs because attitudes and intentions need to be supported by behavioral controls and stable norms. When facilities, rules, and organizations are in place, communities are more likely to maintain behavior.

Policy and budgeting support at the village level is a crucial recommendation. Budgeting can be used for sorting containers, composters, storage space, scales, educational media, or mentoring activities. Policies can regulate the roles of households and management units. However, the formulation of regulations should be based on implementation capacity. Regulations without facilities and mentoring can result in low compliance. Therefore, institutional strengthening needs to be implemented in stages according to community readiness.

Table 7. Program sustainability indicators across three time horizons

Horizon	Key indicators	Follow-up needs
Short-term	Increasing knowledge, awareness and positive attitudes towards waste sorting and management	Repetition of education, simple practices, communication media, and household support
Medium term	Sorting began to become routine, management groups were formed, and officials supported the activities.	Management structure, schedule, facilities, recording, collector/UMKM network, and monitoring
Long-term	Circular economic management is integrated into village development and environmental quality is improved.	Policy, budgeting, permanent institutions, impact indicators, and periodic evaluation

4.9 Implications for the Zero Waste Community Model

The program's results demonstrate that zero-waste communities need to be built through small but connected units of change. Households sort. Organic fractions are processed. Inorganic fractions are collected. Groups coordinate. Officials provide support. Academics provide assistance and evaluation. When this chain is functioning, waste destined for landfill can be gradually reduced. The model doesn't require complex technology in the initial stages. What's more important is consistency of flow and role allocation.

The model also positions education as an ongoing process. Generations of households, administrators, and participants can change. Therefore, knowledge needs to be institutionalized through media, cadres, routine activities, and regulations. One-off activities can foster understanding, but zero waste requires repetition. Emerging management groups can become local learning centers if given the mandate and resources.

From a circular economy perspective, the model needs to maintain material quality. Proper sorting increases the likelihood of reuse. Composting needs to avoid contamination. Inorganic materials need to be separated based on market-acceptable types. Material data needs to be recorded to determine priorities. With this information, villages can identify the largest waste categories and choose the most effective interventions. A data-driven approach also helps avoid activities that are symbolically appealing but have little impact.

From a governance perspective, the model needs to connect community initiatives with city programs. Village-based waste management does not replace municipal waste services, but rather reduces the burden and improves the quality of material flows. Residues still require safe transportation and disposal. This connection makes zero-waste communities more realistic because it focuses on reduction and utilization, rather than claiming that all waste can be managed by the community itself.

4.10 Limitations and Agenda for Further Evaluation

This article has limitations stemming from the source data. The final report does not provide detailed participant numbers, pre- and post-test scores, questionnaire results, volume of sorted waste, compost weight,

number of households maintaining the practice, or data on income from waste utilization. Therefore, the results cannot be used to calculate effect sizes or quantitative changes. Statements of increased understanding and behavioral changes are maintained at the descriptive level as reported. The follow-up period is also insufficient to assess long-term sustainability. Practices initiated after socialization may change when initial support wanes. Newly formed management groups require strengthening of structures and procedures. Subsequent research or community service should include measurements at multiple time points, such as one month, three months, and six months after the intervention. Measurements could include knowledge, attitudes, norms, behavioral control, sorting frequency, number of active households, and material volume.

Environmental evaluations should utilize mass data. Households can be provided with simple weighing guidelines, or management units can weigh incoming materials. Data on organic, inorganic, and residue values can be compared. The most important indicator is the reduction in residue sent to disposal services. Economic evaluations can record equipment costs, operational costs, material sales, compost value, and other benefits. Social evaluations can assess participation, satisfaction, division of labor, and institutional capacity. The next agenda item could also be a more formal test of the TPB framework. Questionnaires could measure attitudes toward sorting, subjective norms, perceived behavioral control, intentions, past habits, and actual behavior. Analysis could reveal the factors most strongly influencing adoption. This information could help the team design more appropriate interventions. If behavioral control is low, priority can be given to facilities. If norms are weak, social campaigns and the role of community leaders need to be strengthened. If attitudes are weak, education on benefits needs to be improved.

CONCLUSION

The circular economy-based Green Waste Management program in Lancang Garam Village demonstrated that household waste management can be strengthened through a combination of education, participation, technical practice, and institutional support. The program was implemented in a participatory manner, involving village officials, Tuha Peut (village head), youth leaders, women's leaders, community members, lecturers, and students. The materials focused on sorting, organic management, inorganic utilization, the circular economy, and zero waste. The final report descriptively demonstrates an increase in community understanding and awareness. The practice of sorting organic waste from source to compost and processing it into compost has begun. The beginnings of a waste management group have also been formed. These achievements demonstrate that the program has moved from knowledge transfer to initial implementation and organizational strengthening. The TKT score, which increased from a range of 4-6 to 7-8, supports the concept's adaptation and application to the local context. The circular economy approach provides a broader framework than environmental cleanliness. Waste is viewed as a material flow that needs to maintain its value. Sorting is a key step because it opens the path to composting, reuse, and recycling. However, the economic benefits cannot yet be quantified because the report does not provide volume, cost, or revenue data. Therefore, economic benefits should be viewed as potential development that requires measurement at a later stage.

The program's sustainability depends on the village's ability to transform initial practices into routine systems. Officials need to strengthen management groups, provide policy and budget support, develop networks with collectors or MSMEs, and implement monitoring. Households need feedback to maintain consistent sorting behavior. Academics can support data-driven measurement and mentoring. When these elements are connected, the program has a greater chance of progressing toward a zero-waste community. The article recommends a longitudinal evaluation using both quantitative and qualitative indicators. Measurements should include the number of active households, the volume of organic waste composted, the volume of inorganic waste recovered, the residue disposed of, the economic value of materials, and institutional functions. This data will strengthen the evidence of impact, inform decision-making, and determine whether the Green Waste Management model can be replicated in other villages with similar characteristics.

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