

Transforming Households Toward a Circular Economy: Community-Based Waste Management in Merdeka Urban Village, Bandung City

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Abstract	Article Info
Restrictions on waste disposal at the Sarimukti Landfill under the City of Bandung's 2025 daily quota, together with the policy on self-managed waste treatment, call for a shift from a "collect-transport-dispose" system to a source-based circular economy approach. This study analyzed the generation, composition, and characteristics of household waste in RW 05, Merdeka Urban Village, and developed recommendations for waste management based on circular economy principles. Waste sampling was conducted over three days (June 28–30, 2026) at 20 households in accordance with SNI 3964:2025. Average daily waste generation at the sampling sites was 30.656 kg/day. Organic food waste (53.45%) and wood/yard waste (0.35%) made up 53.8% of the total, followed by recyclable inorganic waste (plastic, paper/cardboard, metal; 22.12%), diapers (6.0%), hazardous waste (0.9%), and other residues (15.0%). By integrating biological treatment (black soldier fly [BSF] maggot bioconversion and composting of the organic fraction), delivery of inorganic waste to the Semut Merah Waste Bank, and transport of residues to the Patrakomala 3R site, the potential reduction in waste sent directly to the landfill at the sampling scale was 98.29% (from 30.656 kg/day to 0.523 kg/day). Based on an IPCC 2006 Tier 1 calculation, processing 5,981.01 metric tons of food waste per year through maggot farming could reduce methane (CH₄) emissions by 0.24%. Using BSF larvae as catfish feed and maggot residue (frass) as fertilizer for urban farming (<i>buruan sae</i>) demonstrates a community-based circular economy value chain that reduces the burden on the landfill and carbon emissions at the local level.	Article History Received : January 11, 2026 Revised : March 25, 2026 Accepted: August 10, 2026 Keywords: Circular Economy, BSF Maggots, Merdeka Urban Village, Urban Farming, Greenhouse Gas Emissions
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INTRODUCTION

Bandung, the capital of West Java Province, is known for its natural beauty and cultural heritage sites, which make it one of the top domestic tourist destinations in Indonesia. As a rapidly developing city, Bandung generates a steadily growing volume of waste (Mariane et al., 2025). According to the National Waste Management Information System (SIPSN), the city generates 1,496 metric tons of waste per day, or 546,151 metric tons per year (SIPSN, 2024).

Bandung currently faces serious challenges in waste management. Effective September 1, 2025, the West Java Provincial Government restricted waste disposal at the Sarimukti Landfill through a circular letter from the West Java Provincial Secretary. The circular changed the disposal system from a per-trip basis to a tonnage-based system and set Bandung's daily quota at 981.31 metric tons out of the total quota allocated to the four regions of Greater Bandung, a reduction of 220 metric tons per day (DLH Jawa Barat, 2026).

In addition, the old waste management paradigm, which treats the landfill (*Tempat Pembuangan Akhir*, TPA) as a “final disposal site” rather than a “final processing site,” persists among Bandung residents. As a result, most household waste ends up in the landfill as residue, even though the landfill can no longer accommodate the large volume of waste generated by the city. The old paradigm therefore needs to shift from a “collect–transport–dispose” system to an approach that focuses on waste reduction and treatment and regards waste as something with use value (M. Puspita, 2023; Yushman et al., 2023).

Food scraps are the most dominant waste type in Bandung, accounting for 44.52% of total waste (SIPSN, 2024; Irmawartini et al., 2023). Food waste is organic and holds value if properly processed. Various organic waste processing technologies are already in use at waste collection sites (*tempat penampungan sementara*, TPS) and can reduce the amount of waste sent to landfills (Chaerul & Susangka, 2011; Chaerul & Mardiyah, 2019; Chaerul, 2020). The Bandung City Government has also promoted innovations such as Kang Empos (*Karung Ember Pengomposan*, a sack-and-bucket composting system), Loseda (*Lodong Sesa Dapur*, a kitchen-waste container), and black soldier fly (BSF) maggot technology (locally known as *maggotisasi*). BSF processing breaks down organic waste while yielding valuable products, namely maggots for animal feed and residue for organic fertilizer, and thus supports a sustainable waste management system (Chaerul et al., 2025).

RW 05 in Merdeka Urban Village is one of the areas that has adopted maggot-based waste processing. RW (*rukun warga*) 05 has 313 households (*kepala keluarga*, KK) and 838 residents. Residents of Merdeka, particularly those in RT (*rukun tetangga*) 01 who contribute their waste, separate it into two categories: food scraps and non-organic waste. RT 01 voluntarily provides containers to collect recyclable waste, meaning waste that still has economic value, which is deposited at the Merdeka waste bank, Semut Merah (“Red Ant”). Part of the remaining waste (residue) is transported to the 3R Waste Processing Facility of Patrakomala and processed in an incinerator, and the rest is taken to the landfill. On average, waste is hauled to the landfill one to two times per week.

Three maggot houses are currently active, in Tongkeng, Patrakomala, and Gudang Utara. The Gudang Utara (Gudut) maggot house was built through a collaboration between the Merdeka Community Based Organization (CBO) and the ITB community service team, on a 4 × 6 m plot owned by the City Government. Initially, the village’s maggot cages stood next to the village office without proper roofing. Maggot-based processing is not yet fully effective because organic waste is still mixed with other waste, and the products of maggot processing have not yet been distributed as goods with economic value. This study therefore aims to provide recommendations for using BSF maggot-based waste processing to advance circular economy practices. Accordingly, the objectives are to identify the types of waste generated by residents, to identify the methods used in circular waste management, to identify strategies for reducing waste generation, and to estimate the potential carbon emissions resulting from waste generation in Merdeka.

METHOD

This community service activity consisted of four stages: preparation, problem identification, implementation, and report preparation. In the preparation stage, the team was formed and initial coordination with the community was carried out. The team coordinated with residents and the local CBO to ensure the segregation of dry and wet waste into separate plastic bags in preparation for the waste sampling process. In the problem identification stage, the team conducted direct observations of existing waste management conditions and interviewed the CBO to identify waste management issues in Merdeka Urban Village, specifically in RW 05.

The implementation stage involved waste sampling aimed at gathering data on current waste generation and composition, which served as the basis for analyzing the waste management system to be planned for Merdeka Urban Village. The collected sampling data was processed in accordance with the SNI 3964:2025 standard. After the waste sampling data was

collected, it was processed to calculate the waste generation, composition, and projected reduction in gas emissions resulting from the organic waste treatment process carried out by BSF (Black Soldier Fly). In the final stage, a report is prepared based on the results of the community service activities and the analysis of waste management in Merdeka Urban Village.

RESULT AND DISCUSSION

Waste Generation, Composition, and Characteristics

Waste sampling was conducted over three days, June 28–30, 2026. Waste in RW 05 is collected every Monday and Friday. The waste collected on June 28 represented two days of accumulation, whereas the waste collected on June 29 and 30 represented a single day's accumulation each. Based on the sampling, average daily waste generation was 30.656 kg/day for the 20 households registered as waste generators.

Waste was sorted into 13 categories: food scraps or yard waste, rigid plastics, plastic film, paper/cartons/cardboard, metal, fabric or textile products, hazardous waste (B3), rubber or leather, glass, diapers, and other waste (residue). Food scraps and leaves are processed further, taking into account the ability of maggots to break down certain types of organic waste, because some of the food scraps are still mixed with other inorganic waste. Waste generation by composition during the sampling period is presented in Table 1, and the percentage composition is shown in Figure 1.

Table 1. Waste composition by sampling day (mass in kg)

Composition		Day 1	Day 2	Day 3
Organic	Food waste	18.919	13.8	16.44
	Garde waste	0	0	0.30
	Wood	0.05	0.22	0.05
Plastic	film	1.975	3.39	2.705
	Rigid	1.13	1.79	0.665
Paper, cartons, and cardboard		2.56	4.56	1.125
Metal		0.135	0.2	0.115
Fabric and textile products		0.195	0	0
Rubber and leather		0	0.8	0.005
Glass		0.3	0.29	0.12
Hazardous waste (B3)		0.6	0.26	0
Diapers		3.96	1.31	0.205
Residue		8.275	3.38	2.135
TOTAL		38.099	30.00	23.87

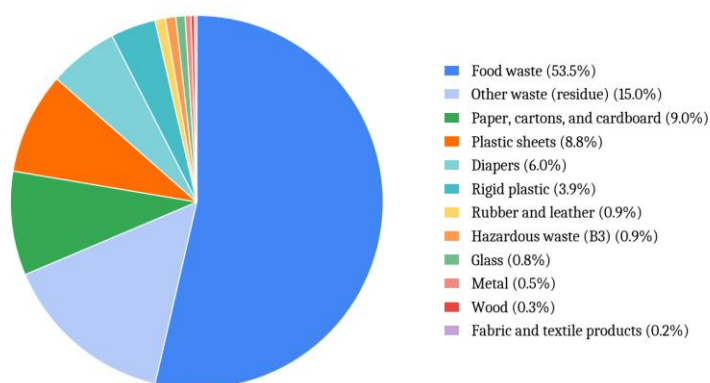


Figure 1. Percentage composition of waste

The percentage data show that organic waste dominates at 53.8%, consisting of food waste (53.45%). The food waste fraction has high potential as feed for BSF maggots, whereas other organic waste, such as leaves (0.35%), can be composted. Among recyclable inorganic waste categories, wood, fabric and textile products, rubber and leather, residues, and diapers will be transported to the Patrakomala 3R site. Plastic sheets (8.77%), rigid plastic (3.9%), and paper/cardboard/cartons (8.96%) can be taken to the Semut Merah waste bank. Other waste that still has economic value, such as metal (0.49%), can be sold to scrap collectors.

The results of this micro-scale waste characterization in RW 05 show trends consistent with the general profile of household waste in Bandung. Puspita and Ainun (2023) reported that the household sector accounts for up to 66.8% of the total waste generated in Bandung (equivalent to 1,066.33 metric tons/day), with a per capita generation rate of 0.435 kg/person/day. In that study, household waste in Bandung consisted of organic waste (58%), residue (21%), inorganic waste (20%), and hazardous waste (1%).

By comparison, the proportion of organic waste in RW 05 (53.8%) is close to the city average (58%; Puspita & Ainun, 2023). Likewise, the proportion of recyclable inorganic waste (plastics, paper, and metals) in RW 05, at 22.12%, is on par with the city's inorganic proportion of 20%. The dominance of the organic fraction, which accounts for more than half of the waste generated, underscores that management strategies at the neighborhood level must focus on processing wet waste at the source. Integrating BSF maggot bioconversion and composting in Merdeka is a highly targeted, concrete step toward breaking the chain of waste accumulation leading to the Sarimukti Landfill.



Figure 2. Waste sampling in RT 01, RW 05, Merdeka Urban Village

Prediction of Waste Reduction to the Landfill

Reducing waste through maggot-based processing, composting, and delivery of waste to the Semut Merah waste bank and the Patrakomala 3R site can serve as a form of environmental management that lowers the amount of waste disposed of directly at the landfill. Based on the sampling data, the average waste generated in RW 05 is 30.656 kg/day. The amount of waste reduced through these management practices can therefore be calculated as follows.

Potential reduction in waste sent to the landfill (citywide):

$$\begin{aligned}
 \text{Waste disposed of at the landfill} &= \text{total household waste of Bandung} - (\text{average waste managed at maggot houses and through composting (organic waste)} + \text{average waste collected by the Semut Merah waste bank (rigid and sheet plastic, paper/cartons/cardboard)} + \text{average waste sent to the Patrakomala 3R site (wood, fabric and textile products, rubber and leather, diapers, and residue)} + \text{average waste sent to scrap collectors (metal)}) \\
 &= 1,066.33 - (16.488 + 6.862 + 6.633 + 0.150) \\
 &= 1,066.33 \text{ metric tons/day} - 30.133 \text{ kg/day} \\
 &= (1,066.33 - 0.030133) \text{ metric tons/day} \\
 &= 1,066.300 \text{ metric tons/day}
 \end{aligned}$$

Percentage of potential reduction in waste sent to the landfill:

$$\begin{aligned}\text{Reduction (\%)} &= \frac{\text{Total waste reduced}}{\text{Total waste generated}} \times 100\% \\ &= \frac{0.030133}{1,066.33} \times 100\% = 0.0028\%\end{aligned}$$

Potential waste reduction in Merdeka alone:

Waste sent to the landfill from Merdeka alone = average total daily waste – (waste processed by maggots and composting + waste sent to the Patrakomala 3R site + waste sent to the Semut Merah waste bank + waste sent to scrap collectors) per day
= 30.656 kg/day – (food scraps + yard waste + diapers + residue + wood + fabric and textile products + rubber and leather + plastics (rigid and sheet) + paper/cartons/cardboard + metal) kg/day
= 30.656 – (16.386 + 0.102 + 1.825 + 4.597 + 0.107 + 0.065 + 0.268 + 3.885 + 2.748 + 0.150)
= 30.656 kg – 30.133 kg
= 0.523 kg/day

Percentage of potential waste reduction in Merdeka:

$$\begin{aligned}\text{Reduction (\%)} &= \frac{\text{Total waste reduced}}{\text{Total waste generated}} \times 100\% \\ &= \frac{30.133}{30.656} \times 100\% = 98.29\%\end{aligned}$$

Thus, improved waste management reduces the amount of waste disposed of at the landfill from an initial average of 30.656 kg/day to 0.523 kg/day. This reduction potential could be increased further by sorting waste with little resale value, such as glass. In addition, the high volume of single-use plastic, which accounts for the third-largest share of waste after organic waste, is a contributing factor. It is crucial to raise awareness among the local community about single-use plastics and to encourage reusable items such as shopping bags and tumblers, among others, to minimize landfill disposal as far as possible.

Because most of the waste is organic (food scraps and yard waste), the most effective environmental management or engineering methods for maximizing the reduction of waste sent to landfills are maggot-based processing and composting. This aligns with the concrete targets of the new regulation issued by the Mayor of Bandung in Circular Letter No. 023-DLH/2026 on the Obligation of Self-Managed and Sustainable Waste Management in Bandung City for 2026.

Potential for Reducing Greenhouse Gas Emissions by Reducing Waste Sent to the Landfill

Greenhouse gases (GHGs) are atmospheric gases that absorb and emit infrared radiation. They can form naturally or result from human activities (Wahyudi, 2016). Various gases are classified as GHGs, such as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and others

Emissions from the waste sector consist of carbon dioxide and methane (Balqis & Chofyan, 2023). Waste management can account for 4% of global GHG emissions (Suharto et al., 2022). Methane emissions result from anaerobic decomposition, whereas CO₂ emissions result from both aerobic and anaerobic decomposition that comes into contact with open air (Bakas et al., 2017). These emissions can be prevented by reducing the direct disposal of waste at the landfill, so that the waste does not decompose anaerobically (Husna et al., 2025). Composting organic waste reduces methane emissions because the waste is decomposed aerobically into a more stable form (compost).

GHG emissions were calculated by estimating methane emissions from the waste data obtained, using the 2006 Intergovernmental Panel on Climate Change (IPCC) methodology (Anifah et al., 2021). The IPCC (2006) guidelines provide three tiers of accuracy for estimating emissions: Tier 1, Tier 2, and Tier 3. In this study, a Tier 1 calculation was performed for methane using data from a household waste management survey in RW 05, Merdeka, including

household waste composition, per capita waste generation, and the fraction of household waste managed. The maggot-based processing facilities in Merdeka can increase the potential for reducing GHG emissions at the landfill. According to the IPCC (2006), processing organic waste with maggots is classified as aerobic biological treatment. Based on the IPCC (2006) Volume 5, Chapter 4 formula for biological treatment, the emissions are calculated as follows.

$$E_{\text{CH}_4, \text{maggot}} = W_{\text{organic}} \times EF_{\text{maggot}} \times 10^{-3}$$

Notes:

W_{organic} = weight of organic waste processed at the TPS (metric tons/year)

EF_{maggot} = emission factor for biological treatment/composting (according to the IPCC [2006], the default value for aerobic composting is 0.4 kg CH₄/metric ton of wet waste or 0.0004 metric tons CH₄/metric ton of waste)

10⁻³ = conversion from kg to metric tons

Based on the waste sampling data from RT 01, Merdeka, average organic waste generation was 16.39 kg/day, with an estimated annual generation of 5,981.01 metric tons/year. The estimated reduction in waste emissions resulting from maggot processing in Merdeka is therefore 0.24%. This reduction potential may seem small, but if every urban village had a waste facility recovery (TPS) and were able to process its organic waste, the potential reduction in methane emissions would continue to increase and could mitigate the greenhouse gas effect of landfills (Septiani et al., 2018).

Waste Treatment Scheme in Merdeka

Maggot processing in Merdeka began after the waste emergency caused by the fire at the Sarimukti Landfill in 2023. The Bandung City Government requires every urban village to set aside a 100 m² plot of land for building maggot houses. The program is funded by the city's regional budget (*Anggaran Pendapatan dan Belanja Daerah*, APBD) through the contingency fund (*Belanja Tidak Terduga*, BTT). In 2025, RW 05 received organic waste processing infrastructure in the form of seven plasma-scale maggot cages through initiative program (*prakarsa*) funding. Nine waste management officers and sorters (*Gaslah*) and four sewer-cleaning officers (*Gober*) are assigned to help transport and shred organic waste, together with four maggot house operators.

The organic waste received by the Gudang Utara maggot house from July 1 to 15 totaled 234.5 kg, and 40 grams of maggot eggs were harvested. BSF eggs at the Gudut maggot house (RT 01, RW 05) are harvested every 3 days or as adjusted to the maggot life cycle. The maggots produced are used as feed for catfish in two ponds built next to the maggot house. Meanwhile, the solid maggot residue (*kasgot*, from *bekas maggot*; frass) has compost-like characteristics and can be used as plant fertilizer in the *buruan sae* urban farm. This direct use of maggot products demonstrates the formation of a circular economy within the food waste processing system in Merdeka.

Waste processing in Merdeka begins with waste collection by the *Gaslah* team. In RWs with processing facilities, disposable organic waste (SOD) is taken directly to those facilities. In RWs without processing facilities, the SOD collected by *Gaslah* is picked up by the village's *Gober* team and shredded with a shredder owned by the LPM (*Lembaga Pemberdayaan Masyarakat*, community empowerment institution) at the village office before being processed through maggot farming. *Gaslah* in RW 05 collect waste every day except Sunday, on the following schedule: RT 01–02 (Monday, Wednesday, and Friday), RT 03–05 (Tuesday, Thursday, and Saturday), and RT 06 (every day). The waste management flow in Merdeka is shown in Figure 3, and the Gudang Utara maggot house and the urban farm are shown before and after construction in Figures 4 and 5.

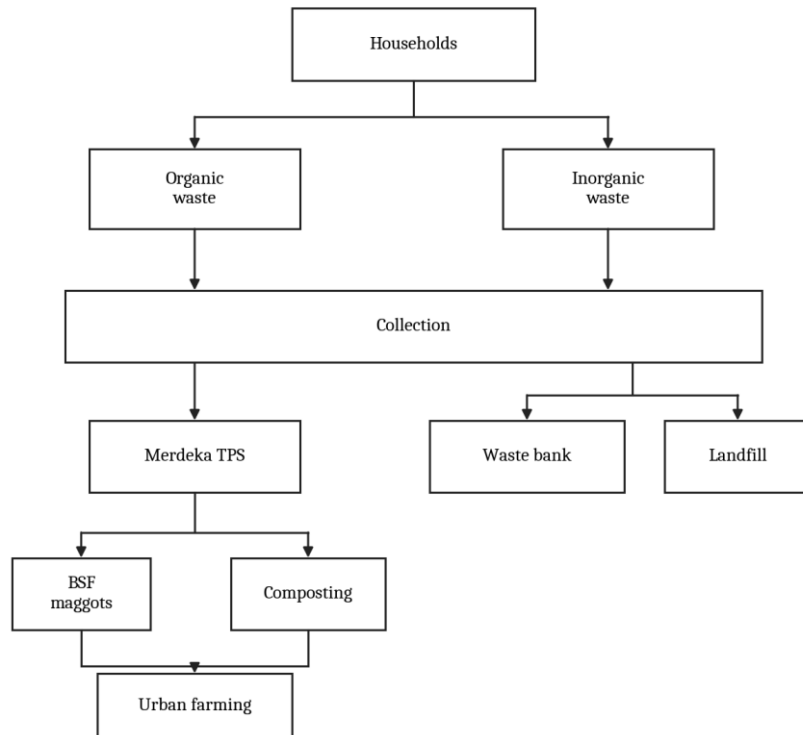


Figure 3. Waste management flow in Merdeka Urban Village



(a)



(b)

Figure 4. Gudang Utara maggot house, Merdeka Urban Village: (a) before and (b) after construction



(a)



(b)

Figure 5. Urban farming in Merdeka Urban Village: (a) before and (b) after planting

Options for Improvement

Based on the waste generation data collected in Merdeka, the waste category with the highest generation rate is food waste, at 53.5%. All other types of waste account for $\leq 15\%$, less than food waste. One improvement option for this largest waste category is to use food waste, particularly organic waste, as maggot feed. The maggots break down this organic waste and thereby reduce the amount of waste sent to the landfill.

Before feeding the waste to the maggots, it can first be passed through a shredder, which accelerates decomposition by the maggots. The maggot life cycle then repeats continuously through egg laying, larval development, and the emergence of adult BSF flies.

In addition to decomposing organic waste, maggot processing yields a residue that can be turned into compost and used as recycled soil for farming in the area. Compost is the product of the decomposition of a mixture of organic materials, a process that can be accelerated by populations of various microbes under warm and humid conditions.

The maggot can be used as fish feed or sold as feed for other livestock. Urban farming under the community service plan in Merdeka began with the construction of a catfish pond fed with kasgot, creating a circular economy through organic waste processing. Another option is to compost organic waste in composter tubes. These tubes will be filled with organic waste that the maggot system cannot fully process, and they yield organic compost. The compost from both the maggot system and the composter tubes will then be used as fertilizer for the plants to be grown around the maggot house. With these two options, the amount of waste will gradually decrease, leaving only a small percentage of other types of waste.

Other waste, such as inorganic waste, can be sorted by material type, for example used bottles, rigid plastics, cardboard, paper, and cartons. A waste bank will first collect and store this waste before it is picked up by manufacturers that need these materials. In addition, residual waste (such as cigarette butts) can be recycled into functional items to reduce the amount sent to landfills. Materials such as wood, rubber, textiles, glass, and metal can likewise be recycled into new products, although the recycling of these types of waste is still rarely practiced in many regions, particularly in Indonesia. Finally, diapers and other residues can be processed into refuse-derived fuel (RDF), which can be used as fuel.

Challenges and Obstacles to Implementation

Although the community-based waste management system in Merdeka RW 05 has shown significant progress, several technical and operational challenges have arisen during this community service program. First, at the waste source, the sorting carried out by residents has not been entirely consistent. Disposable organic waste that should be separated is still found mixed with inorganic waste, which reduces processing efficiency at the maggot house and adds to the workload of the Gober and Gaslah teams, who must re-sort the waste before it is

shredded and fed to the maggots. Similar conditions have been widely reported for waste bank programs and community-based waste management initiatives in other regions of Indonesia, where residents' low ecological literacy and a shortage of community mobilizers are the main obstacles to program sustainability (Rusdiyana et al., 2024).

Second, institutionally, the program's sustainability depends on limited human resources: nine waste sorters (Gaslah), four sewer cleaners (Gober), and four maggot house operators serving 313 households (KK) with 838 residents in RW 05. The collection schedule, which is divided by RT (RT 01–02 on Monday, Wednesday, and Friday; RT 03–05 on Tuesday, Thursday, and Saturday; RT 06 every day), reflects an effort to make the best use of the available personnel. However, the limited number of staff risks becoming a bottleneck if waste volumes increase or the program's coverage is expanded to other RWs in Merdeka. Such manpower limitations are a common challenge when community-based waste management is first established (Rusdiyana et al., 2024).

Third, in terms of product commercialization, the processed products, namely BSF maggots and kasgot, have not yet been fully distributed as marketable goods beyond internal use (catfish feed and fertilizer for the *buruan sae* urban farm). The lack of a "mature" marketing chain for these products is a challenge for realizing a financially sustainable circular economy model, given that community-based waste management programs should ideally not depend entirely on contingency funds (BTT) from the regional budget (APBD) or other temporary programs.

Fourth, in terms of public behavior, the high proportion of single-use plastic waste and the low resale value of certain inorganic fractions, such as glass, indicate that reducing the waste sent to landfills cannot rely solely on downstream processing systems. It also requires changes in consumption behavior at the source through continuous public education. Experience with policies to reduce single-use plastic bags in major Indonesian cities shows that a significant reduction in new plastic waste is achieved only when regulations are accompanied by large-scale, sustained public outreach and campaigns rather than bans alone (Indriani et al., 2025).

DISCUSSION

This study integrates three waste-processing pathways within a single neighbourhood scale (RW) that is organic-waste treatment through Black Soldier Fly (BSF) larvae bioconversion and composting, a waste bank for recyclable anorganic waste, and a 3R Waste Transfer Station (TPS 3R) for residual waste. The circular-economy scheme developed here extends beyond the processing stage itself, closing the loop through the utilisation of end products. The BSF larvae as catfish (*lele*) feed, and larval residue (*kasgot*) together with compost as fertiliser for urban farming, thereby forming a community-based, closed-loop circular-economy model at the micro (RW/neighbourhood) scale. This study further quantifies the potential reduction in greenhouse gas (GHG) emissions using the IPCC 2006 Tier 1 method, based on real household-level sampling data. In addition, the study generates primary data on waste generation and composition at the RW level, which can serve as a baseline for replication in other ward across the City of Bandung in response to Bandung Mayoral Circular Letter No. 023-DLH/2026 on the Obligation for Independent and Sustainable Waste Management.

The principal findings show that average household waste generation in RW 05 Merdeka, reached 30.656 kg/day (across 20 sampled households), with the composition dominated by food waste at 53.45% (53.8% organic fraction overall). Through the integration of the maggot house, composting, the Semut Merah waste bank, and the Patrakomala TPS 3R, the scheme is estimated to reduce waste sent to landfill (TPA) by 0.0028% at the city scale, while the potential waste reduction achieved within RW 05 itself reached 98.29%. In terms of climate-change mitigation, treatment of an estimated 5,981.01 tons/year of food waste through the maggot house was found to reduce CH₄ emissions by 0.239%, based on IPCC 2006 Tier 1 calculations.

The waste-composition values obtained in this study are consistent with the general pattern of urban household waste observed in developing countries. Puspita & Ainun, (2023)

reported that the organic fraction of household waste in the City of Bandung accounts for 58%, a figure close to the 53.8% recorded for RW 05. This dominance of the organic-biodegradable fraction is further corroborated by Datta (2022) review of several cities in developing countries, which confirms that food and kitchen waste consistently constitute the largest component of urban household waste generation. This consistency strengthens the validity of the sampling data used in this study and indicates that source-level organic-waste treatment represents the most relevant intervention for cities with a comparable waste profile.

The effectiveness of BSF-based treatment at the micro scale is consistent with the findings of Chaerul et al. (2025) on a comparable programme in RW 02, Jamaras, Bandung, which likewise applied circular-economy principles based on BSF maggot bioconversion to strengthen community-based organic-waste management. The consistency of outcomes across different RWs within the same city suggests that the maggot-based treatment model, integrated with a waste bank, is not merely a site-specific success but a pattern that can be replicated across neighbourhoods. This is further supported by the review of Wu et al. (2026) and the study of Xiang et al. (2024) both of which confirm that BSF larvae treatment consistently reduces CO₂, CH₄, and N₂O emissions relative to conventional composting. In Xiang et al. (2024), BSF larvae treatment reduced CH₄ and N₂O emissions by up to 87% and 95%, respectively, compared with non-aerated composting. By comparison, the 0.239% reduction in CH₄ emissions reported in the present study appears considerably smaller; this discrepancy does not reflect an inherent limitation of BSF technology itself, but rather a difference in the basis of calculation. The present study expresses the emission reduction as a percentage of the total waste generation of the City of Bandung (a city-wide, macro scale), whereas the laboratory-based studies cited above compare BSF emission efficiency against alternative treatment methods at the process scale (a micro/reactor scale). This difference in the unit of analysis must be emphasised as a limitation in interpreting the 0.239% figure. Nonetheless, this finding of reduced emissions from maggot-based waste treatment points to the substantial potential that could be realised should the maggot-house model be replicated across all kelurahan in the City of Bandung.

The community-based reduction achieved in this study is also comparable to the results reported by Kurniawan et al. (2021) in the Sukunan case study, Yogyakarta, where community-based solid waste management (CBSWM) achieved a 30% reduction in waste generation and avoided approximately 0.2 million tons of CO₂-equivalent emissions from landfill annually. This parallel reinforces the argument that community-driven source segregation, rather than government infrastructure alone is a prerequisite for the success of circular waste-economy programmes in the Indonesian urban context. The waste-bank model, which constitutes one of the pillars of the present programme, likewise aligns with the study by Raharjo et al. (2017) in Padang City, one of the earliest academic studies to document community-based waste-bank programmes in Indonesia as an instrument for improving urban waste management, as well as with the findings of Asmorowati et al. (2025), which demonstrate the effectiveness of urban waste-bank programmes in reducing waste generation and methane emissions.

The study by Fawole et al. (2020) demonstrated that *Hermetia illucens* larval meal can substitute fish meal in the diet of African catfish (*Clarias gariepinus*) a species within the same genus as the *lele* cultivated in Kelurahan Merdeka, without significantly compromising growth performance. Meanwhile, Gebremikael et al. (2022) showed that BSF frass (equivalent to *kasgot*) contributes to increased soil nitrogen availability and plant growth, supporting the agronomic feasibility of using *kasgot* as fertiliser for urban farming, as practised under the "Buruan Sae" programme at the study site. The correspondence of these findings, for both a comparable fish species and a comparable agronomic context, reinforces the conclusion that the value chain linking maggot utilisation for fish feed and *kasgot* utilisation for urban farming, as developed in Kelurahan Merdeka, constitutes an appropriate solution for operationalising a circular economy through organic-waste management.

The implementation challenges identified namely inconsistent source segregation among residents and a limited number of field personnel, are consistent with the findings of Rusdiyana et al. (2024) regarding low ecological literacy and the shortage of community mobilisers as

constraints on the sustainability of community-based waste-bank programmes across Indonesia. These findings are further reinforced by Pambudi et al., (2025) who based on 1,000 respondents across six cities in Jabodetabek and Bandung, found that residents' willingness to segregate plastic waste is significantly influenced by the availability of segregation infrastructure, the welfare of waste workers, and awareness of microplastic impacts. Similarly, the high contribution of single-use plastic waste observed in this study aligns with Indriani et al. (2025) who found that plastic-bag reduction policies are effective in reducing plastic waste generation only when regulation is accompanied by sustained, large-scale public education and campaigns, rather than administrative prohibition alone.

The consistency between the findings of this study and those of comparable studies is most plausibly attributable to shared structural characteristics: waste-management schemes in developing countries, including Indonesia, generally still rely on voluntary resident participation without strong economic incentives, such that outcomes are heavily shaped by environmental literacy and the availability of local field mobilisers (Pambudi et al., 2025; Rusdiyana et al., 2024). Conversely, the divergence between the emission-reduction figures reported here and those from laboratory-scale studies such as Xiang et al. (2024) and Wu et al. (2026) is attributable primarily to methodological differences rather than to any difference in the underlying effectiveness of the technology.

The principal contribution of this study to the fields of waste management and the circular economy lies in providing measurable empirical evidence, at the micro (RW) scale, that the simultaneous integration of BSF maggot treatment, composting, a waste bank, and a TPS 3R can achieve substantial reductions in waste directed to landfill while making a quantifiable contribution to GHG-emission mitigation in the waste sector. Furthermore, this study illustrates how a circular-economy value chain can be constructed without full reliance on imported technology or large-scale investment, rendering this model relevant as a policy reference for other kelurahan with comparable demographic and socio-economic characteristics.

Practically, these findings indicate the need to strengthen the marketing chain for waste-derived products (maggot, *kasgot*, and compost) so that the programme does not remain dependent on temporary regional-budget (APBD) funding, as well as the need to build the capacity of community-based waste sorters and processors as the programme's coverage expands. Future research should apply more accurate emission-quantification methods to validate the Tier 1 results obtained in this study, and should undertake behavioural studies examining the determinants of residents' compliance with waste segregation, following the approach of Pambudi et al. (2025). The Kelurahan Merdeka model can serve as a technical reference for the Bandung City Government in replicating the maggot-house programme across all kelurahan, as mandated by the Bandung Mayoral Circular Letter, with the caveat that successful replication requires sustained institutional support and education, not merely the provision of physical facilities.

CONCLUSION

Average household waste generation in RW 05, Merdeka, was 30.656 kg/day (from 20 sampled households). The waste was dominated by organic food waste (53.45%), which is consistent with the general waste profile of Bandung (44.52%–58%). The other fractions were plastic sheets (8.77%), rigid plastics (3.9%), paper/cartons/cardboard (8.96%), diapers (6.0%), and residues (15.0%), together with hazardous waste (B3) and other materials.

The community service project in Merdeka applied circular economy principles through source separation of waste (dry and wet). Organic waste (food scraps) is processed with BSF maggots at the Gudang Utara maggot house and composted in composters. Recyclable inorganic waste is collected and sold to the Semut Merah Waste Bank. BSF maggots are used directly as feed for livestock and catfish, whereas maggot residue (frass) and compost are used as fertilizer for urban farming (*buruan sae*).

By optimizing organic waste processing at the maggot house and delivering inorganic waste to the waste bank and the 3R site, the potential waste reduction in RW 05 reaches

98.29% (reducing the waste sent to the Sarimukti Landfill from 30.656 kg/day to just 0.523 kg/day). This strategy shows high potential for addressing the challenge of the reduced daily disposal quota at the Sarimukti Landfill. Aerobic/biological processing of 16.39 kg of organic waste per day (estimated at 5,981.01 metric tons per year) using BSF maggots could reduce methane (CH₄) emissions by 2.39% (based on the IPCC 2006 Tier 2 methodology). Replicating the maggot house system across all urban villages in Bandung could significantly reduce GHG emissions from the waste management sector.

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REFERENCES

- Anifah, E. M., Rini, I. D. W. S., Hidayat, R., & Ridho, M. (2021). ESTIMASI EMISI GAS RUMAH KACA (GRK) KEGIATAN PENGELOLAAN SAMPAH DI KELURAHAN KARANG JOANG, BALIKPAPAN. *Jurnal Sains & Teknologi Lingkungan*, 13(1), 17–33. <https://doi.org/10.20885/jstl.vol13.iss1.art2>
- Asmorowati, E. T., Sutrisno, E., Sarasanty, D., Bashiroh, A., & Sholikhah, F. (2025). Evaluasi Efektivitas Program Bank Sampah dalam Mengurangi Timbulan Sampah dan Emisi Metana di Kawasan Perkotaan. *Journal of Engineering and Applied Technology*, 1(2), 120–129. <https://doi.org/10.65310/na9jyc33>
- Balqis, D. A., & Chofyan, I. (2023). Pengelolaan Sampah Rendah Karbon Menggunakan Pemodelan System Dynamics. *Bandung Conference Series: Urban & Regional Planning*, 3(2), 932–941. <https://doi.org/10.29313/bcsurp.v3i2.9295>
- Chaerul, M., Daffa, A. S. N., Kholif, A. N., Aisyarah, N. R., Nurulloh, R. H., & Prayogo, W. (2025). Applying Circular Economy Principles to Strengthen Organic Waste Management Using BSF Maggots in RW 02 Jamaras, Bandung, Indonesia. *International Journal of Community Engagement Payungi*, 5(3), 468–485. <https://doi.org/10.58879/ijcep.v5i3.110>
- Datta, M. G. (2022). Household Solid Waste Management in a Developing World: An Overview. *Asian Journal of Water, Environment and Pollution*, 19(3), 97–102. <https://doi.org/10.3233/AJW220045>
- Fawole, F. J., Adeoye, A. A., Tihamiyu, L. O., Ajala, K. I., Obadara, S. O., & Ganiyu, I. O. (2020). Substituting fishmeal with *Hermetia illucens* in the diets of African catfish (*Clarias gariepinus*): Effects on growth, nutrient utilization, haemato-physiological response, and oxidative stress biomarker. *Aquaculture*, 518, 734849. <https://doi.org/10.1016/j.aquaculture.2019.734849>
- Gebremikael, M. T., Wickeren, N. van, Hosseini, P. S., & De Neve, S. (2022). The Impacts of Black Soldier Fly Frass on Nitrogen Availability, Microbial Activities, C Sequestration, and Plant Growth. *Frontiers in Sustainable Food Systems*, 6. <https://doi.org/10.3389/fsufs.2022.795950>
- Husna, F., Arum, W. F., Aryanti, E., & Hadi, I. (2025). Optimalisasi Pengelolaan Sampah dan Daur Ulang untuk Mengurangi Emisi Gas Rumah Kaca Di Perkotaan. *Lambda: Jurnal Ilmiah Pendidikan MIPA Dan Aplikasinya*, 5(1), 9–24. <https://doi.org/10.58218/lambda.v5i1.1029>
- Indriani, F. M., Lestari, M. P., & Maryono, M. (2025). Efektivitas Kebijakan Penggunaan Kantong Belanja Ramah Lingkungan terhadap Pengurangan Timbulan Sampah Plastik di Provinsi Jakarta: Kajian Literatur. *Jurnal kesehatan komunitas (Journal of community health)*, 11(3), 546–556. <https://doi.org/10.25311/keskom.Vol11.Iss3.2257>
- Irmawartini, I., Mulyati, S. S., & Pujiono, P. (2023). Pengelolaan Sampah dari Hulu ke Hilir di Kota Bandung. *Jurnal Kesehatan Lingkungan Indonesia*, 22(2), 229–236.
- Kurniawan, T. A., Avtar, R., Singh, D., Xue, W., Dzarfan Othman, M. H., Hwang, G. H., Iswanto, I., Albadarin, A. B., & Kern, A. O. (2021). Reforming MSWM in Sukunan (Yogyakarta, Indonesia): A case-study of applying a zero-waste approach based on circular economy

- paradigm. *Journal of Cleaner Production*, 284, 124775. <https://doi.org/10.1016/j.jclepro.2020.124775>
- Mariane, I., Gnagey, M. R., Karali, M. A. M. I., & Hardiyanti, E. (2025). IMPLEMENTASI KEBIJAKAN PENGELOLAAN SAMPAH BERBASIS MASYARAKAT DI KELURAHAN ANTAPANI TENGAH KECAMATAN ANTAPANI KOTA BANDUNG. *Kebijakan : Jurnal Ilmu Administrasi*, 16(01), 93–108. <https://doi.org/10.23969/kebijakan.v16i01.9934>
- Pambudi, N. F., Simatupang, T. M., Samarakoon, S. M. K., Mulyono, N. B., Ratnayake, R. M. C., & Okdinawati, L. (2025). Enhancing public participation in plastic waste management for a sustainable circular economy: Insights from Indonesia. *Journal of Material Cycles and Waste Management*, 27(5), 3366–3389. <https://doi.org/10.1007/s10163-025-02294-5>
- Puspita, G., & Ainun, S. (2023). Identifikasi Timbulan dan Komposisi Sampah Rumah Tangga di Kota Bandung. *Prosiding FTSP Series*, 2131–2135.
- Puspita, M. (2023). Strategi Keberhasilan Pengelolaan Sampah Kota Bandung Melalui Bank Sampah. *Jurnal Digital Bisnis, Modal Manusia, Marketing, Entrepreneurship, Finance, & Strategi Bisnis (DImmensi)*, 3(2), 85. <https://doi.org/10.32897/dimmensi.v3i2.2772>
- Raharjo, S., Matsumoto, T., Ihsan, T., Rachman, I., & Gustin, L. (2017). Community-based solid waste bank program for municipal solid waste management improvement in Indonesia: A case study of Padang city. *Journal of Material Cycles and Waste Management*, 19(1), 201–212. <https://doi.org/10.1007/s10163-015-0401-z>
- Rusdiyana, E., Sugihardjo, Setyowati, R., Widiyanto, & Lestari, E. (2024). Pemberdayaan masyarakat melalui inisiasi bank sampah. *Jurnal Inovasi Hasil Pengabdian Masyarakat (JIPEMAS)*, 7(3), 703–719. <https://doi.org/10.33474/jipemas.v7i3.21259>
- Septiani, V., Nugrahayu, Q., & Natsir, G. M. (2018). POTENSI PENGURANGAN EMISI GAS METAN (CH₄) DARI KEGIATAN DI TPS 3R DAN RUMAH KOMPOS NITIKAN KOTA YOGYAKARTA.
- Suharto, B., Kurniati, E., Universitas Brawijaya, Agustin, D. D., & Universitas Brawijaya. (2022). Perhitungan Tapak Karbon Pada Aspek Pengelolaan Sampah Di TPST 3R Mulyoagung Bersatu Sebagai Upaya Pengurangan Emisi Gas Rumah Kaca. *Jurnal Sumberdaya Alam dan Lingkungan*, 9(1), 22–32. <https://doi.org/10.21776/ub.jsal.2022.009.01.4>
- Wahyudi, J. (2016). Mitigasi Emisi Gas Rumah Kaca. *Jurnal Litbang*, 12(2), 104–112.
- Wu, L., Yan, Q., Li, J., Hu, L., Ding, T., Zhang, D., Zhang, M., & Xu, L. (2026). Organic Waste Recycling by Black Soldier Fly Larvae: Environmental Benefits Beyond Waste Minimization. *Waste and Biomass Valorization*, 17(10), 5311–5322. <https://doi.org/10.1007/s12649-025-03362-5>
- Xiang, F., Han, L., Jiang, S., Xu, X., & Zhang, Z. (2024). Black soldier fly larvae mitigate greenhouse gas emissions from domestic biodegradable waste by recycling carbon and nitrogen and reconstructing microbial communities. *Environmental Science and Pollution Research*, 31(23), 33347–33359. <https://doi.org/10.1007/s11356-024-33308-8>
- Wali Kota Bandung. (2026). *Surat Edaran Wali Kota Bandung Nomor 023-DLH/2026 tentang Kewajiban Pengelolaan Sampah Mandiri & Berkelanjutan Kota Bandung Tahun 2026*. Pemerintah Kota Bandung.
- Yusmaman, W. M., Widiyanto, H., Rohmah, S. N., & Akbarsyah, M. A. (2023). Bahaya Lingkungan Pada Open Dumping Sampah Organik Perkotaan. *Jurnal Bengawan Solo Pusat Kajian Penelitian dan Pengembangan Daerah Kota Surakarta*, 2(2), 85–101. <https://doi.org/10.58684/jbs.v2i2.83>

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