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Transforming Organic Waste into Economically Valuable Products through Community Empowerment Based on Maggot Cultivation

Transformasi Sampah Organik Menjadi Produk Bernilai Ekonomi Melalui Pemberdayaan Masyarakat Berbasis Budidaya Maggot

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Abstract

Tourism activities in Desa Budaya Pampang, Samarinda, have increased the volume of organic waste to 1.5–2 tons per month, with more than 60% of it left unmanaged and largely burned or landfilled. This community service program aimed to transform organic waste into economically valuable products by strengthening three interrelated partner capacities, namely production, business management, and marketing, integrated within a single Black Soldier Fly (BSF) maggot bioconversion process. The approach applied was educative, participatory, and applicative, involving 16 members of the Tourism Awareness Group (Pokdarwis) of Desa Budaya Pampang through nine field visits organized into four phases over eight months. Data were collected through pre-tests and post-tests, practice observation, documentation, and focus group discussions, then analyzed descriptively using quantitative and qualitative approaches. The results showed a substantial increase in participants' understanding across all three aspects: the proportion of participants who understood to strongly understood production practices rose from 0.6% to 100%, marketing from 0% to 99.4%, and business management from 0% to 90.6%. In practice, partners successfully implemented the organic waste processing workflow into maggot feed, cultivated BSF larvae, and produced dried maggot and compost that began to be packaged with a distinct brand identity and marketed. This program confirms that transforming waste into economic value requires not only bioconversion technology but also the integration of stronger business institutions and market access, while supporting the sustainability of Desa Budaya Pampang as an eco-cultural tourism destination.

Keywords: Organic Waste; Black Soldier Fly; Maggot Cultivation; Community Empowerment; Circular Economy

Abstrak

Aktivitas ekowisata di Desa Budaya Pampang, Samarinda, meningkatkan volume sampah organik hingga 1,5–2 ton per bulan, sementara lebih dari 60% di antaranya belum dikelola secara produktif dan sebagian besar masih dibakar atau ditimbun. Program pengabdian ini bertujuan mentransformasikan sampah organik tersebut menjadi produk bernilai ekonomi melalui penguatan tiga kapasitas mitra secara terintegrasi, yaitu produksi, manajemen usaha, dan pemasaran, yang dirangkai dalam satu proses biokonversi berbasis budidaya maggot *Black Soldier Fly* (BSF). Pendekatan yang digunakan bersifat edukatif, partisipatif, dan aplikatif, melibatkan 16 anggota Kelompok Sadar Wisata (Pokdarwis) Desa Budaya Pampang melalui sembilan kali kunjungan lapangan yang tersusun dalam empat fase kegiatan selama delapan bulan. Data dikumpulkan melalui *pre-test* dan *post-test*, observasi praktik, dokumentasi, serta diskusi kelompok terarah, kemudian dianalisis secara deskriptif kuantitatif dan kualitatif. Hasil menunjukkan peningkatan pemahaman peserta yang besar pada ketiga aspek: proporsi peserta yang memahami hingga sangat memahami aspek produksi naik dari 0,6% menjadi 100%, aspek pemasaran dari 0% menjadi 99,4%, dan aspek manajemen usaha dari 0% menjadi 90,6%. Secara praktik, mitra berhasil menerapkan alur pengolahan sampah organik menjadi media pakan, membudidayakan maggot BSF, serta menghasilkan produk maggot kering dan pupuk kompos yang mulai dikemas dengan identitas visual dan dipasarkan. Program ini menegaskan bahwa transformasi sampah menjadi nilai ekonomi tidak cukup ditopang oleh teknologi biokonversi semata, melainkan membutuhkan integrasi dengan penguatan kelembagaan usaha dan akses pasar, sekaligus turut mendukung keberlanjutan Desa Budaya Pampang sebagai destinasi *eco-cultural tourism*.

Kata Kunci: Sampah Organik; *Black Soldier Fly*; Budidaya Maggot; Pemberdayaan Masyarakat; Ekonomi Sirkular

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INTRODUCTION

Tourism growth adds to the waste burden of destinations worldwide, including food waste from hotels, restaurants, and food stalls. Diaz-Farina et al. (2020) estimated that the main tourism activities in Tenerife generate about 0.40 kg of mixed waste per tourist per day. This contribution often stays hidden behind residential waste flows, so local governments set waste service fees without accurate data on who produces the waste. In Lhasa, tourists account for about 15% of food waste in the hotel, restaurant, and café sector (Wang et al., 2021). Filimonau and De Coteau (2019) showed that effective food waste management in hospitality depends on in-house competencies, training, initial investment costs, and the savings operators can capture. Indonesia faces the same problem at the national scale. Its recycling rate remains below 25%, most of the remaining waste ends up in landfills, and community-based units such as waste banks need capacity building for their administrators to deliver economic benefits (Budiyarto et al., 2025). Tourism villages bear the same pressure, because growth in tourist visits is not always matched by adequate waste management capacity (Putridira & Ramdhani, 2025; Sary et al., 2021, 2024).

Desa Budaya Pampang, in North Samarinda District, Samarinda City, is one of East Kalimantan's leading cultural tourism destinations and represents the life of the Dayak Kenyah indigenous community, with an average of 400–850 visitors per month (Aprianti et al., 2024; Chahyani, 2022). Field observation and interviews with the board of the Tourism Awareness Group (Pokdarwis) showed that organic waste on Saturdays and Sundays can reach 50–80 kg per day, or about 1.5–2 tons per month, and more than 60% of it is organic and left unused. Most of this waste is still burned or dumped without further processing, a practice that degrades the appearance of the tourism area and can cause air pollution and serve as a source of disease vectors (Vinti et al., 2021). The Pokdarwis partner faces three interrelated problems: (1) in production, members have not mastered sorting, chopping, fermentation, and maggot cultivation; (2) in business management, the group has no business institution, cost records, or production plan; (3) in marketing, the partner has no brand, packaging, or digital sales strategy for products derived from organic waste. Meanwhile, members' income depends on art performances, souvenir sales, and tourist visits, so it rises and falls with visitor numbers. These two conditions justify this community service program: organic waste that now burdens the village can become an additional income source if the partner receives mentoring in all three aspects.

In terms of potential, the environment of Desa Budaya Pampang suits Black Soldier Fly (BSF) maggot bioconversion technology, with a tropical climate averaging 28–32°C and 65–75% humidity that supports optimal larval growth (Defriatno et al., 2025). BSF maggots break down organic waste quickly while producing economically valuable residues in the form of dried maggot for animal feed and compost (kasgot) (Bibin et al., 2024; Mahmood et al., 2021). International studies reinforce these findings. BSF larvae convert food waste, agro-industrial by-products, and livestock manure into protein and fat for feed, and the residue can serve as organic fertilizer (Amrul et al., 2022; Siddiqui et al., 2022; Surendra et al., 2020). Gold et al. (2018) added that larvae grown on biowaste can be sold as a raw material for feed, and the revenue helps waste management systems remain financially viable. The social capital of the Dayak Kenyah community, accustomed to mutual cooperation and open to innovation, further supports the adoption of such new technology (Ibrahim & Surya, 2025). (Gold et al., 2018)

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However, bioconversion technology does not generate economic empowerment on its own; its success depends on strengthening production capacity, business governance, and market access together, as shown by studies of household- and community-scale maggot-based organic waste processing (Hervé et al., 2025; Pasyimi et al., 2022; L. C. Sari et al., 2023). Barragán-Fonseca et al. (2023) observed a similar pattern among smallholder farmers in Colombia: the transition to insect-based organic waste management is multidimensional and requires work on socio-economic, technical, communication and marketing, and educational aspects. A survey of BSF producers in Africa, Asia, and Latin America recorded obstacles such as an unstable supply of raw materials, market instability, and limited technology for scaling up production (Barragán-Fonseca et al., 2023). Chia et al. (2019) proposed inclusive business models that involve smallholder farmers in the insect feed value chain. Kirchherr et al. (2017) noted that definitions of the circular economy rarely name business models as enablers; this gap matters because processed waste yields no economic value for a community without a business unit and market access. Policy also supports this approach. The program aligns with SDG 2 through new bioconversion-based income, SDG 11 through sustainable waste management in tourism areas, SDG 12 through productive organic waste recycling, and the National Research Master Plan in food security, environmental management, and appropriate technology (Kementerian Riset dan Teknologi/Badan Riset dan Inovasi Nasional, 2020).

The program offers an integrated solution that uses waste bioconversion as the entry point to a community value chain: waste becomes feed, feed raises maggots, maggots become products, and the group's business unit sells those products to the market. The team designed three intervention packages. The production package covers training and mentoring on sorting, chopping, fermentation, feed formulation, BSF cultivation, harvesting, and drying, supported by an organic waste shredder, a maggot dryer, and cultivation trays and racks. The business management package covers forming a business group, assigning roles, recording costs and sales, and planning production. The marketing package covers market identification, pricing, branding, packaging, and social media promotion. The approach is educative, participatory, and applicative: Pokdarwis members run production and the business, while the implementation team facilitates training, mentoring, and technology transfer. The program's novelty lies in integrating the three packages into one process, which positions maggot cultivation as an instrument for community economic empowerment in a cultural tourism area.

The program aims to transform organic waste into economically valuable products by building community capacity in waste processing and maggot cultivation, strengthening business management, and developing product branding and marketing in Desa Budaya Pampang. This article measures changes in Pokdarwis members' understanding of production, business management, and marketing, and documents how they applied it to produce dried maggot and compost.

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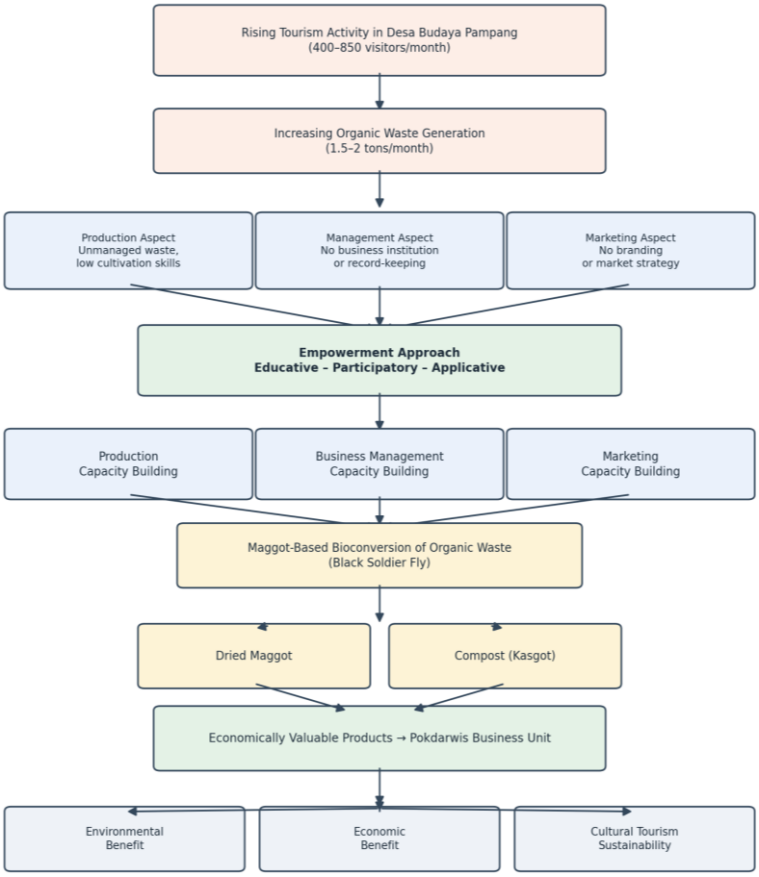


Figure 1. Conceptual Framework of the Maggot Cultivation-Based Community Empowerment Program

IMPLEMENTATION METHOD

Location and Partner

The program took place in Kelurahan Budaya Pampang, North Samarinda District, Samarinda City, East Kalimantan, with the Tourism Awareness Group (Pokdarwis) of Desa Budaya Pampang as the target partner. The group has 16 members, consisting of dancers, craftspeople, and caretakers of the Lamin traditional house. Members previously relied on cultural tourism, souvenir sales, and traditional art performances for income, so their earnings fluctuated with the number of visitors.

Program Approach

The program used a participatory community empowerment approach built on three principles: educative, participatory, and applicative. The partner acted as the main actor in production and business management, while the implementation team served as facilitator, mentor, and provider of appropriate technology transfer.

Implementation Stages

The program ran through nine field visits grouped into four phases: diagnosis and awareness, production capacity building, business capacity building, and market development. Table 1 details the stages.

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Table 1. Program Implementation Stages

Phase	Date	Activity	Main Output
Diagnosis & Awareness	June 6, 2026	Site survey, partner coordination, problem mapping	Partner problem map
	June 13, 2026	Program socialization and introduction to maggot cultivation	Initial partner awareness
Production Capacity Building	June 20, 2026	Training on organic waste sorting and processing, and maggot cultivation	Basic production skills
	June 27, 2026	Mentoring on chopping, fermentation, and feed formulation	Maggot feed medium
	July 4, 2026	Technical mentoring on maggot cultivation	Cultivation cycle running
Business Capacity Building	July 11, 2026	Training on business management and financial record-keeping	Business group formed
	July 18, 2026	Mentoring on record-keeping and business group management	Business record-keeping system
Market Development	July 25, 2026	Training on market potential, branding, and packaging	Product brand concept
	August 1, 2026	Mentoring on branding, packaging, and product marketing	Market-ready product

Data Collection Techniques

Data were collected through four complementary techniques. First, pre-tests and post-tests measured changes in participants' understanding of the three program aspects (production, business management, and marketing), each consisting of ten items with five scaled response categories (strongly understand, understand, moderately understand, poorly understand, do not understand). Second, observation recorded how participants applied practical skills such as sorting, chopping, fermentation, cultivation, harvesting, and drying. Third, documentation captured photos and videos of activities, products, and cultivation facilities. Fourth, group discussions with the partner evaluated constraints, experiences, and sustainability needs.

Data Analysis

Pre-test and post-test data were analyzed descriptively by comparing the proportion of response categories before and after the intervention. Qualitative data from observation, documentation, and group discussions were analyzed descriptively to explain changes in skills and technology use in the field.

Success Indicators

Success indicators were set together with the partner for the three activity aspects, as presented in Table 2.

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Table 2. Partner Problems, Interventions, and Achievement Indicators by Activity Aspect

Aspect	Partner Problem	Intervention	Achievement Indicator
Production	Unmanaged organic waste; no sorting or maggot cultivation skills	Training and mentoring on sorting, chopping, fermentation, and BSF cultivation	≥50 kg/week of waste processed; ≥2 cultivation cycles; dried maggot & kasgot produced
Business Management	Weak business governance; no financial records or production planning	Training on institutions, financial record-keeping, and production planning	1 business group formed; record book used routinely
Marketing	No marketing strategy; branding, packaging, and digital marketing not yet in place	Training on branding, packaging, and local-digital marketing	1 product brand in use; ≥10 sales in the initial phase

RESULTS AND DISCUSSION

Baseline Conditions and Partner Problem Mapping

Before the intervention, the partner had no real practice of sorting or processing waste, although organic and inorganic waste bins were available. Waste was generally burned or dumped, consistent with findings that waste facilities alone cannot change management behavior without strengthening community capacity and institutions (Putridira & Ramdhani, 2025; Vinti et al., 2021). Economically, the partner's livelihoods depended on cultural tourism, souvenir sales, and art performances, leaving them vulnerable to fluctuations in visitor numbers. Pre-test results from 16 Pokdarwis members across the three program aspects showed consistently low baseline understanding: only 0.6% of participants fell into the understand-to-strongly-understand category for production, while the share for business management and marketing was zero (0%). Most participants fell into the poorly-understand-to-do-not-understand categories across all three aspects, at 90–96%.

Transforming Waste Management through Maggot Cultivation

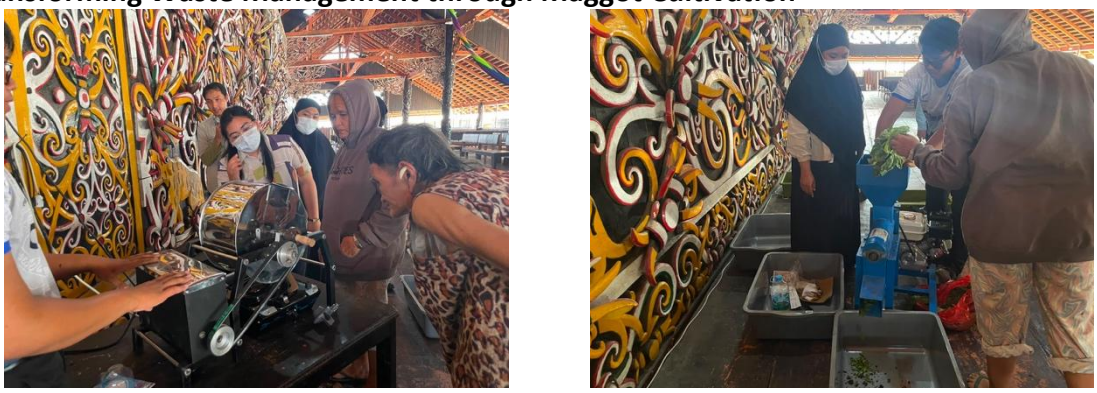


Figure 2. Training on Processing Organic Waste into Dried Maggot and Compost

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The production intervention shifted the partner's waste management from burning or dumping to using waste as a production input processed through seven sequential steps: sorting leftover waste from tourist and household consumption, chopping, fermenting for 24–48 hours, formulating maggot feed, hatching BSF eggs and rearing larvae, harvesting, and washing and drying, resulting in two main products, dried maggot and compost (Figures 2 and 3). This workflow is consistent with household- and community-scale BSF bioconversion practices proven to reduce organic waste volume while generating economically valuable products (Bibin et al., 2024; Hervé et al., 2025; Pasyimi et al., 2022; L. C. Sari et al., 2023). The temperature and humidity of Desa Budaya Pampang, within the optimal range, also supported the application of this technology in the field (Defriatno et al., 2025).

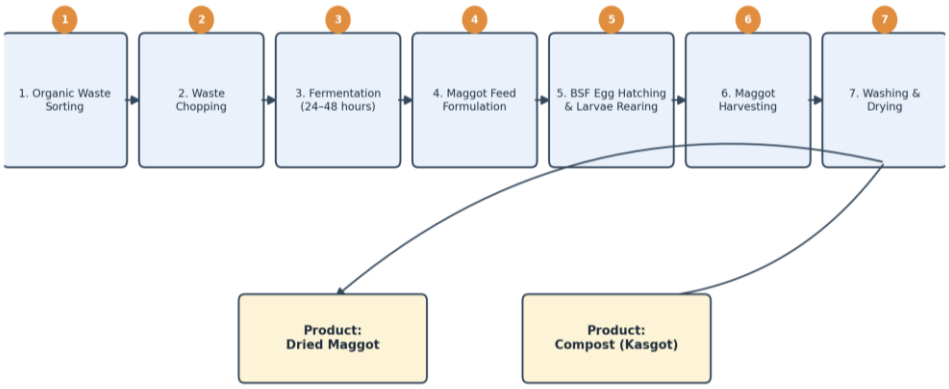


Figure 3. Production Workflow from Organic Waste to Dried Maggot and Compost

Building Capacity in Production, Business Management, and Marketing

Pre-test and post-test comparisons showed a sharp increase in understanding across all three program aspects (Figure 4, Table 3). In production, the proportion of participants who understood to strongly understood rose from 0.6% to 100%, with all 16 participants in that category after training. In marketing, the proportion rose from 0% to 99.4%, and in business management from 0% to 90.6%. All three aspects followed a consistent pattern of improvement, although business management left a relatively higher proportion of participants who poorly understood the material (7.5%) than the other two aspects, indicating that business governance needs more intensive follow-up mentoring than the technical production and marketing aspects. This finding aligns with Budiyarto et al. (2025), who identified capacity building for administrators as a condition for community-based waste management units in Indonesia to deliver their full benefits.

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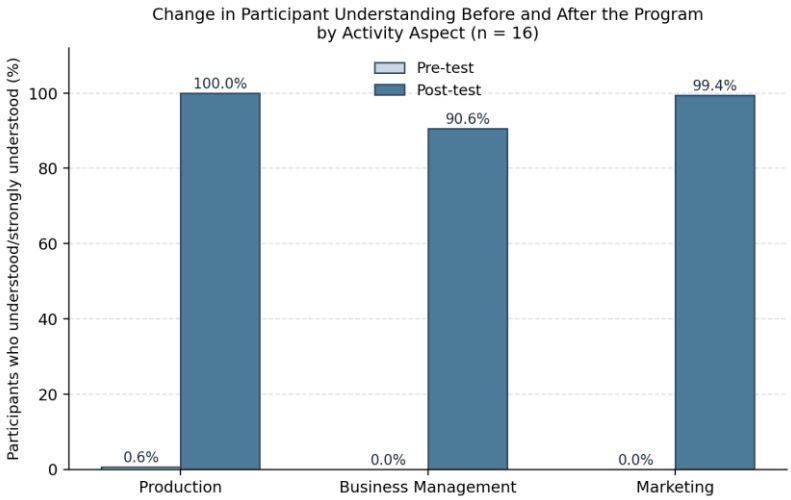


Figure 4. Participant Understanding Before and After the Program by Activity Aspect

Table 3. Understanding Before and After the Program (n = 16). High: understand to strongly understand; Mid: moderately understand; Low: poorly or do not understand

Aspect	High (Pre, %)	Mid (Pre, %)	Low (Pre, %)	High (Post, %)	Mid (Post, %)	Low (Post, %)
Production	0.6	8.1	91.3	100.0	0.0	0.0
Business Mgmt.	0.0	4.4	95.6	90.6	1.9	7.5
Marketing	0.0	10.0	90.0	99.4	0.6	0.0

The increase in understanding matched what the partner achieved in practice. In production, the partner carried out sorting, chopping, and fermentation of organic waste independently and ran a maggot cultivation cycle that produced dried maggot and compost as the program's main products. In business management, mentoring focused on forming a business group, dividing tasks, and introducing simple records of production costs and sales, laying the governance foundation for a self-sustaining maggot business unit. In marketing, the partner learned to identify target markets, set selling prices, and use social media to promote products, and dried maggot began to be packaged with a visual identity and introduced to the public through regional media coverage. This sharp rise in understanding matches outcomes of household organic waste education programs based on BSF maggots elsewhere, which also showed a jump in participant understanding after socialization and hands-on training (Gustina et al., 2024; Windianingsih & Kahar, 2023).

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Figure 5. Business Management Training and Marketing Training

Turning Waste into Economically Valuable Products

The change produced by the program extends past knowledge about maggot cultivation to the function of waste itself, which shifted from an environmental burden to a production resource. Organic waste that was previously burned or dumped now serves as raw material for a production chain of dried maggot and compost managed as a Pokdarwis business unit. This change can be described as a waste-to-value empowerment model: waste shifts into a resource, then into a product, is managed as an enterprise, sold in the market, and generates economic value for the community (Figure 6). This transformation pattern is consistent with studies of community-based BSF bioconversion showing that integrating bioconversion technology with institutional strengthening advances circular economy principles and community economic empowerment (Chineme et al., 2023; Syafitri et al., 2024). Kirchherr et al. (2017) emphasized that the circular economy requires a systemic shift; in this program, that shift appeared when the group began managing waste as a business input, complete with records and marketing.

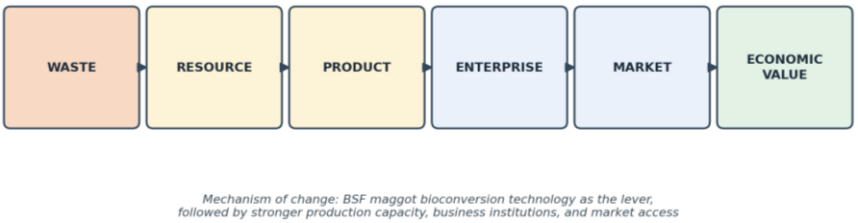


Figure 6. Waste-to-Value Empowerment Model Based on Maggot Cultivation

Product identity lies at the core of this model's sustainability. The dried maggot produced by the partner began to carry its own label and visual identity, an important step because physical quality testing of products derived from organic waste serves as the reference for setting market-ready quality standards (Wijaya et al., 2025). With dried maggot selling for Rp40,000–Rp60,000 per kilogram and compost for Rp10,000–Rp20,000 per kilogram in Samarinda, based on the initial market study that informed program planning, this business unit could provide a more stable alternative income than the partner's reliance on fluctuating tourist visits. The group needs to build a buyer network from the early stage, because market instability is one of the main obstacles faced by BSF producers in the Global South (Barragán-Fonseca et al., 2025).

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Constraints, Supporting Factors, and Program Sustainability

The program faced a scheduling conflict with the Annual Festival of Desa Budaya Pampang, which the team resolved through rescheduling, close coordination with the Pokdarwis chair, and grouping several activities into single visits. Several factors supported the program: strong support from the chair and all Pokdarwis members, the partner's enthusiasm, the fit between the identified problems and the partner's actual needs, and the partner's willingness to provide the site, labor, and raw materials. This pattern of local institutional support is consistent with findings that the sustainability of tourism village programs depends on active participation from the community groups driving tourism (Suyatna et al., 2024).

In terms of outputs, the program produced an activity video uploaded to the LP2M Universitas Mulawarman YouTube channel, a news article in RRI Samarinda, and dried maggot as the main economically valuable product. The realized budget of Rp46,220,000 allocated the largest share (57.8%) to technology and innovation, reflecting the program's emphasis on applying BSF cultivation technology in the field, followed by honoraria and services (24.0%), consumables (10.0%), and travel (8.2%). Table 4 details the program outputs.

Table 4. Program Outputs and Achievements

Output Type	Achievement	Status
Production capacity building	Skills in sorting, chopping, fermentation, and BSF maggot cultivation	Achieved
Marketing capacity building	Understanding of marketing strategy and development of product brand identity	Achieved
Main product	Economically valuable dried maggot and compost (kasgot)	Achieved
Audio-visual output	Activity video on the LP2M Universitas Mulawarman YouTube channel	Achieved
Mass media publication	News article on RRI Samarinda (August 17, 2026)	Achieved
Business institution strengthening	Pokdarwis business unit based on maggot cultivation	Ongoing, being strengthened

Program sustainability also connects to Desa Budaya Pampang's image as an eco-cultural tourism destination. A cleaner tourism environment, resulting from less burning and dumping of waste, can strengthen the area's appeal, in line with findings that successful environmental management in tourism villages contributes to destination image and competitiveness (Maulana et al., 2025; A. K. Sari et al., 2022). The program's impact therefore extends beyond environmental and economic benefits and strengthens Desa Budaya Pampang's position within a sustainable cultural tourism ecosystem.

CONCLUSION AND SUGGESTIONS

The maggot cultivation-based community empowerment program in Desa Budaya Pampang addressed the partner's three main problems (production, business management, and marketing) in an integrated way, with consistent gains in participant understanding

across all three: from 0.6% to 100% in production, from 0% to 99.4% in marketing, and from 0% to 90.6% in business management.

Black Soldier Fly maggot cultivation functioned as a transformation mechanism that turned organic waste, previously burned and dumped, into economically valuable dried maggot and compost through a production workflow the partner now runs independently.

Stronger business management and marketing turned the bioconversion output into a community business unit with its own brand identity and opened market access for the Tourism Awareness Group of Desa Budaya Pampang.

Overall, the waste-to-value empowerment model applied in this program shows that turning waste into economic value requires integrating bioconversion technology with institutional and market capacity, supporting environmental management and the economic sustainability of a culture-based tourism village.

Based on these findings, the authors propose several steps to sustain the program's results: maintaining continuous maggot production through a regular cultivation schedule; keeping business records consistently as a basis for evaluating the business group's performance; expanding market networks for dried maggot and compost, including partnerships with agribusiness operators in Samarinda City; strengthening product branding in line with Desa Budaya Pampang's identity as an eco-cultural tourism destination; and integrating the maggot business unit into the wider tourism village economy, including further mentoring on business management, where understanding still trails the other two aspects.

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ETHICAL APPROVAL

This activity was a community service program consisting of training and mentoring. The program partner, the Tourism Awareness Group (Pokdarwis) of Desa Budaya Pampang, approved both the implementation of the activity and the publication of its results. Participants took part in the training, pre-test, post-test, and group discussions voluntarily. This article presents data in aggregate form without identifying individual participants.

DECLARATION OF INTEREST

The authors declare no financial, professional, or personal conflicts of interest that could have influenced the conduct of the program or the writing of this article.

TRANSPARENCY OF DATA

The data supporting this article consist of pre-test and post-test results from 16 participants on production, business management, and marketing, observation notes, and activity documentation. The authors do not publish raw individual-level data to protect partner confidentiality. Aggregated data are available from the corresponding author on reasonable request.

FUNDING

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AI USAGE STATEMENT

The authors used generative artificial intelligence only to check the English grammar of the manuscript. AI was not used to write content, generate or analyze data, or draw conclusions. The authors take full responsibility for the content of the manuscript.

AUTHORS' CONTRIBUTIONS

The first author designed the program, coordinated implementation, led training on processing waste into maggot feed, and conducted monitoring and evaluation. The second author led training and technical mentoring on maggot cultivation. The third author led training on business management, branding, packaging, and digital marketing. The fourth author developed the community empowerment analysis framework and wrote and revised the manuscript. The fifth and sixth authors supported field activities, collected data, and compiled documentation. All authors read and approved the final manuscript.

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