

DOI: <https://doi.org/10.38035/dijefa.v7i4><https://creativecommons.org/licenses/by/4.0/>

Received: 15 September 2026 | Revised: 30 September 2026 | Accepted: 02 October 2026

Household Economic Empowerment through Black Soldier Fly (BSF) Cultivation and Integrated Microfinance Management: A Case Study in Kampung Sereh, Jayapura Regency

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Abstract: This study examines household economic empowerment through Black Soldier Fly (BSF) cultivation integrated with microfinance management in a household-scale enterprise in Kampung Sereh, Jayapura Regency. The study employed a qualitative case study approach involving interviews, direct observation, and business records. Data were analyzed through thematic interpretation, Business Model Canvas (BMC), and an assessment of integrated microfinance management covering financial literacy, business management, household capacity, and sustainability. The findings show that BSF cultivation converts organic waste into economically valuable products, including maggot and kasgot, while also reducing household expenditure through the use of maggot as animal feed. During May–June, the enterprise generated Rp15.83 million in revenue with operating costs of Rp2.43 million and a recorded net profit of Rp13.40 million. Financial practices included simple record keeping, profit allocation, reinvestment, cost control, and partial separation of business and household funds. These practices contributed to business capacity, household income generation, and economic resilience. The study proposes an integrated empowerment model linking organic waste utilization, BSF cultivation, value creation, financial management, and household economic resilience.

Keywords: Black Soldier Fly, household economic empowerment, microfinance management, circular economy, household enterprise.

INTRODUCTION

Household economic empowerment is increasingly understood as a process of strengthening people's capacity to access productive resources, participate in economic decisions, and improve their ability to sustain livelihoods rather than merely increasing household income. Narayan (2005) conceptualizes empowerment in terms of expanding people's assets and capabilities to participate in, influence, and control institutions and resources affecting their lives. Similarly, participatory development emphasizes recognizing

local knowledge, capabilities, and resources rather than positioning households merely as recipients of external assistance (Chambers, 1997). In the context of household enterprises, this perspective implies that sustainable empowerment requires a combination of productive opportunities, entrepreneurial capacity, financial capability, and the ability to manage economic resources effectively.

One potential pathway for such empowerment is the utilization of organic waste through *Black Soldier Fly* (BSF; *Hermetia illucens*) cultivation. BSF larvae have demonstrated substantial potential for converting organic waste into biomass while simultaneously reducing waste volume. Mahmood et al. (2021) demonstrated the feasibility of household-level BSF waste management and highlighted its potential to reduce the burden of organic waste while creating economic value. Earlier field research also showed that BSF larvae can substantially reduce organic waste and generate harvestable biomass suitable for productive use (Diener et al., 2011). More recent research places BSF within a circular bioeconomy framework, where organic waste can be transformed into protein-rich biomass and other value-added products, thereby connecting waste management with resource recovery and economic value creation (Bruno et al., 2025).

The economic potential of BSF cultivation is particularly relevant for household-based enterprises because the activity can generate more than one form of benefit. Maggot can be marketed as an alternative feed product, while residual material such as frass or kasgot can be utilized as organic fertilizer. BSF-derived products can therefore contribute to income diversification as well as potential cost savings through their use in household livestock and fish production. A recent systematic review confirms that BSF can convert various organic substrates into insect biomass and fertilizer, while creating opportunities to reduce pollution, resource costs, and dependence on conventional feed and fertilizer inputs (Siddiqui et al., 2024). Indonesian studies likewise document the use of household organic waste as a substrate for BSF cultivation and its potential contribution to waste reduction and community-based economic activity (Haruna et al., 2024; Lestari, 2024).

However, the existence of a productive enterprise does not automatically guarantee sustainable household empowerment. Financial management is an important determinant of whether income-generating activities can be maintained and expanded. Systematic evidence indicates that entrepreneurs' financial literacy is related to financial access and enterprise performance (Anshika & Singla, 2022), while recent evidence on MSME financial literacy emphasizes the importance of financial knowledge and financial capability for enterprise management and performance (IS et al., 2024). The Asian Development Bank (2023) similarly reports that financial literacy interventions can improve financial outcomes, although their effects are generally modest and may vary across disadvantaged groups. At the household level, financial management involves planning, controlling, and monitoring financial resources to support household welfare and economic stability (Indania et al., 2024).

These considerations are highly relevant to the case examined in this study. The BSF enterprise operated by Pak Alexander in Kampung Sereh, Kabupaten Jayapura, developed from the practical need to obtain more affordable livestock feed while addressing household and market organic waste. The enterprise subsequently became a household economic activity involving family members in organic-waste collection, cultivation, harvesting, and marketing. The study documents an organic-waste processing capacity of approximately 50–100 kg per day and the production of fresh maggot and other outputs. Nevertheless, the enterprise still relies on relatively simple financial-management practices. Financial recording is conducted manually, business and household finances are not yet fully separated, and formal planning of cash flow, production costs, and business expansion remains limited.

This situation suggests that the economic value generated through BSF cultivation needs to be considered together with the capacity to manage and sustain that value. In this study,

Manajemen Keuangan Mikro Terpadu (MKMT) refers to the integration of financial planning, transaction recording, expenditure control, risk management, and reinvestment of business returns. This perspective is consistent with the broader microfinance literature, which emphasizes that financial services should be considered within a wider financial-market system and linked to the needs and sustainability of microenterprises and households (Ledgerwood et al., 2013). The study further uses Integrated Microfinance Management (IMM) as an analytical framework linking financial management with business management, household capacity, and business sustainability. Importantly, IMM is not treated as a formal intervention already implemented in the case enterprise; rather, the study examines whether existing practices reflect relevant IMM principles.

The research therefore addresses a gap between two strands of literature. BSF studies have extensively examined organic-waste conversion, biomass production, feed applications, fertilizer potential, and circular-economy benefits (Bruno et al., 2025; Diener et al., 2011; Mahmood et al., 2021; Siddiqui et al., 2024). Meanwhile, financial-literacy and microenterprise studies have focused on financial capability, access to finance, and enterprise performance (Anshika & Singla, 2022; Asian Development Bank, 2023; IS et al., 2024). Less attention has been given to how a household-scale BSF enterprise can connect resource valorization with integrated financial management and broader household empowerment within a single analytical framework.

Accordingly, this study analyzes the household-scale BSF enterprise of Pak Alexander in Kampung Sereh, Kabupaten Jayapura. The study examines its business model using the nine elements of the Business Model Canvas, analyzes its contribution to household income and economic resilience, assesses the implementation of MKMT, and evaluates the relevance and practical effectiveness of IMM in relation to business management, financial management, household capacity, and sustainability. The study ultimately seeks to formulate a household economic empowerment model that integrates organic-waste utilization, BSF cultivation, value creation, financial management, and business sustainability.

METHODS

Research Design and Study Setting

The study employed a qualitative case-study design to examine the operation and economic significance of a household-scale Black Soldier Fly (BSF) enterprise managed by Pak Alexander in Kampung Sereh, Kabupaten Jayapura. The single-case orientation was selected because the analysis centered on one identifiable business unit and its interaction with household economic activities. The inquiry combined a descriptive approach with the Business Model Canvas (BMC) to map the enterprise across nine business components: value proposition, customer segments, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure.

Fieldwork was conducted at the enterprise site on Jalan Permai Blok G No. 03, Kampung Sereh, Kabupaten Jayapura, over a two-month period. The location was selected because it represents an operating household BSF enterprise with direct relevance to household economic empowerment and provides access to business actors, operational activities, and supporting records.

Participants and Data Collection

Participants were selected through purposive sampling based on their direct involvement in BSF cultivation, household economic activities, or the enterprise's market network. The primary informant was Pak Alexander as the business owner. Supporting informants consisted of Ibu Fanny, the owner's wife; three customers (Novy Selly, Catur Pratz, and Welly Morin); and Steven Eluay, Head of Kampung Sereh. The interviews lasted approximately 15–30

minutes per participant and explored business strategy, division of household roles, marketing practices, financial-management routines, and perceived economic effects.

Primary evidence was generated through in-depth interviews and participatory observation. Observation covered the cultivation process, product handling, marketing activities, and day-to-day financial practices. Secondary evidence was drawn from financial notes, production and sales records, field photographs, and relevant scholarly and documentary sources.

Analytical Procedure

The analysis combined Business Model Canvas mapping with thematic interpretation of household economic outcomes. First, the nine BMC elements were used to reconstruct the enterprise structure, with particular attention to value creation, customer relationships, revenue generation, production activities, resources, partnerships, and cost structure.

Second, the contribution of the enterprise to household empowerment was examined through four analytical dimensions: economic improvement, business capacity, financial management, and household independence. Indicators included changes in income, business continuity, production skills, product innovation, financial recording, financial planning, decision-making capacity, and access to resources. The financial-management component was examined through revenue streams, cost structure, and key business activities, while the IMM assessment considered business management, microfinancial practices, household empowerment, and enterprise sustainability.

Data processing followed the interactive analytical logic of Miles & Huberman (1994) through successive stages of data reduction, data display, and conclusion development. Interview transcripts, observation records, and business documentation were compared throughout the analytical process to identify recurring patterns and relationships among production, revenue generation, financial practices, household participation, and business continuity.

Trustworthiness

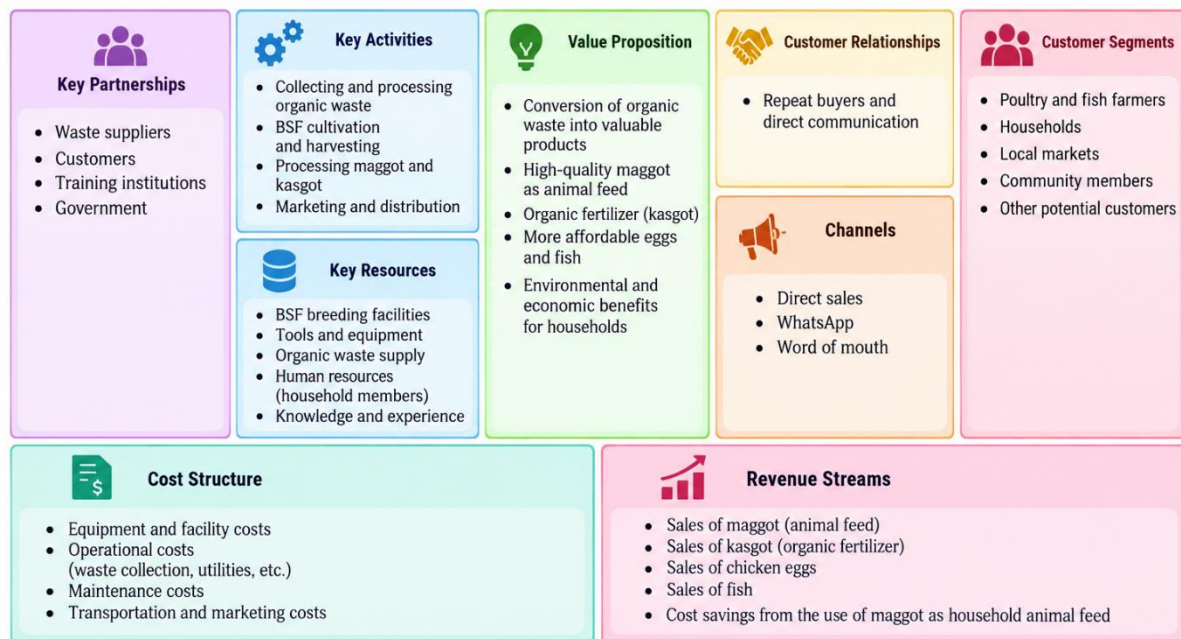
Data credibility was strengthened through source triangulation, method triangulation, member checking, and an audit trail. Source triangulation involved comparing information obtained from the business owner, family member, customers, and documentary records. Method triangulation compared interview evidence with direct observation and documentation. Member checking was used to confirm the accuracy of interview interpretations with the relevant informants, while an audit trail was maintained to document the research process and support traceability of the analytical decisions.

RESULTS AND DISCUSSION

Business Model of the Household-Scale BSF Enterprise

The business operated by Pak Alexander is structured around the conversion of organic waste into marketable and household-use products. The Business Model Canvas (BMC) identifies nine interconnected components covering value proposition, customer segments, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. Rather than functioning as an isolated waste-processing activity, the enterprise links material sourcing, biological conversion, household labor, market access, and financial returns within one production system.

Business Model Canvas



Source: Author's analysis, 2026.

Figure 1. Business Model Canvas of the Household-Scale BSF Enterprise

The value proposition is built around three connected outputs: fresh maggot as an alternative feed, kasgot as an organic fertilizer, and the conversion of organic waste into productive input. This configuration gives the enterprise a dual value proposition. Buyers obtain a functional input for poultry or fish production, while the household simultaneously converts a low-value material into an economic resource. The residual material is also retained within the local production cycle instead of being discarded.

The customer base comprises poultry farmers, freshwater fish farmers, and households engaged in gardening or small-scale agriculture. These groups correspond to different uses of the enterprise's outputs: maggot is directed primarily toward poultry and fish feed, whereas kasgot serves users requiring organic fertilizer. The presence of several customer groups reduces dependence on one market category and creates room for product diversification.

Market access is maintained through direct transactions, WhatsApp communication, repeat customers, and word-of-mouth referrals. The enterprise does not rely on a complex distribution infrastructure. Instead, short-distance transactions and direct contact allow customers to obtain products from the production site or arrange delivery according to need. This arrangement also facilitates communication concerning stock availability, harvest schedules, and product requirements.

Customer retention is supported by product availability, direct communication, and perceived quality. Repeat purchasing reported by customers indicates that trust has become an embedded component of the enterprise's market mechanism. Word-of-mouth promotion additionally reduces the need for paid promotion. The resulting customer relationships therefore serve not only a marketing function but also provide information about demand and product requirements.

Revenue generation extends beyond fresh maggot. The enterprise earns from maggot and kasgot and has additional economic outputs through poultry and freshwater fish production, while BSF eggs are generally retained to maintain the production cycle. Maggot is also redirected to the household's own poultry and fish activities, producing a cost-saving effect alongside direct sales.

Table 1. Synthesis of the Business Model

BMC element	Empirical configuration	Business implication
Value proposition	Maggot, kasgot, organic-waste utilization	Value creation from waste and feed/fertilizer products
Customer segments	Poultry farmers, fish farmers, gardeners	Multiple demand sources
Channels	Direct sales, WhatsApp, word of mouth	Low-cost market access
Customer relationships	Repeat buyers and direct communication	Market continuity
Revenue streams	Maggot, kasgot, BSF eggs when available, poultry and fish	Revenue diversification
Key resources	Organic waste, land, facilities, knowledge, family labor	Low-input production base
Key activities	Waste collection, cultivation, harvesting, processing, marketing	Integrated production cycle
Key partnerships	Waste suppliers, customers, training institutions, government	Resource and market support
Cost structure	Initial investment, transport, utilities, packaging, supplementary inputs	Cost control supported by local inputs and family labor

Source: Field data, 2026.

The resource configuration is particularly important. Organic waste from markets and households forms the principal feed input, while land and production facilities support the biological cycle. Knowledge acquired through experience and training represents a less visible but critical resource. Family members provide labor across cultivation, packaging, sales, and administration, reducing dependence on paid workers.

Overall, the BMC reveals that the enterprise's economic logic rests on resource efficiency rather than high-cost input procurement. The availability of organic waste lowers feed-related expenditure, while household labor reduces wage expenditure. Revenue diversification then compensates for the limitations of a small local market. This configuration is consistent with the circular-bioeconomy potential of BSF systems, in which organic residues can be redirected into feed and fertilizer products while retaining economic value within the production cycle (Bruno et al., 2025; Siddiqui et al., 2024).

Economic Contribution and Household Resilience

The economic contribution of the enterprise is visible through both additional receipts and reduced expenditure. Before the BSF enterprise developed, the household relied primarily on income from motorcycle taxi services, reported at approximately Rp1,000,000. Once the enterprise became operational, household receipts were derived from several activities, including maggot, kasgot, poultry, and fish.

Table 2. Product Sales Recorded in May–June

Product	Production	Selling price	Revenue
Maggot	215 kg	Rp50,000/kg	Rp10,750,000
Kasgot	31 kg	Rp50,000/kg	Rp1,550,000
Chicken eggs	960 units	Rp3,000/unit	Rp2,880,000
Fish	13 kg	Rp50,000/kg	Rp650,000
Total revenue			Rp15,830,000
Operating costs			Rp2,429,000
Net profit			Rp13,401,000

Source: Source: Field observations, 2026.

The figures indicate that maggot contributed the largest share of recorded sales, followed by chicken eggs, kasgot, and fish. The combination illustrates how one production activity generates downstream economic outputs. Maggot is sold directly, transformed into feed for household poultry and fish, and thereby indirectly supports the production of other saleable products. The enterprise consequently operates through both income generation and expenditure reduction rather than relying solely on cash sales.

One interpretive caution is necessary: the Rp15.83 million figure represents the sales period documented in May–June, whereas the Rp1 million figure describes the household's earlier income situation. Therefore, these values should not be presented as a statistically comparable monthly before-and-after estimate. The appropriate interpretation is that the enterprise introduced substantially more diversified revenue channels into the household economy, with the documented May–June period generating Rp13.401 million after reported operating costs.

The second dimension is enterprise stability. The business has remained active since 2023, supported by relatively continuous organic-waste availability and recurring customers. Repeat purchasing reported by customers indicates that demand is not exclusively dependent on occasional transactions.

The capacity dimension is also visible in the development of production skills. Pak Alexander acquired cultivation techniques through experimentation, practical experience, and training. Skills now cover breeder management, egg hatching, substrate preparation, moisture control, feeding, and harvesting. Better technical control has reduced production failures and improved consistency.

Product diversification reinforces this capacity. In addition to maggot and kasgot, the household maintains poultry and fish activities that use maggot as an internal feed source. This arrangement transforms by-products from one activity into inputs for another activity, producing an interlinked household production system.

The findings therefore support a multidimensional interpretation of economic empowerment. Table 3 summarizes the observed dimensions.

Table 3. Household Economic Empowerment Outcomes

Dimension	Indicator	Empirical finding
Economy	Income	Additional revenue from maggot, kasgot, poultry, and fish
Economy	Business stability	Production and repeat purchasing maintained
Business capacity	Production skills	Technical skills improved through experience and training
Business capacity	Innovation	Product and activity diversification
Financial management	Recording	Transactions recorded manually
Financial management	Planning	Part of returns allocated to operating needs and reinvestment
Independence	Decision-making	Household participates in operational and financial decisions
Independence	Resource access	Organic waste, land, training, customers, and partnerships available

Source: Field data, 2026.

The findings align with the empowerment perspective that economic improvement involves expanding the capacity to use resources and make choices, rather than income alone (Narayan, 2005; Suharto, 2017). In this case, organic waste, family labor, training, and market relationships operate as productive resources. Their conversion into income, savings on feed expenditure, and reinvestment capacity indicates that empowerment is occurring through a combination of resource access, productive capability, and economic agency.

Integrated Microfinance Management in the Enterprise

The financial-management practices reveal a mixed pattern: several elements of integrated financial management are already present, while formal financial administration remains limited. Transactions involving sales and operating expenditures are recorded manually. The records help the household monitor cash inflows and outflows, but they do not yet form complete financial statements.

The household also practices financial allocation. A portion of returns is directed toward equipment purchases, expansion of the cultivation area, biopond improvements, and other production requirements. Another portion supports household consumption and associated livestock or fish activities. This indicates that the household does not treat all business receipts as immediately disposable income.

Cost control is strengthened by the availability of organic waste as a low-cost production input. Expenditures are concentrated on transport, utilities, packaging, supplementary materials, and other operating requirements. Maggot used as internal poultry and fish feed further reduces the household's dependence on commercial feed.

The principal weakness concerns the incomplete separation of business and household funds. Business receipts may still be used directly for household requirements, which makes precise calculation of net business profit difficult. Nevertheless, the allocation of part of the returns for reinvestment indicates an emerging functional distinction between consumption and productive capital.

Table 4. Integrated Microfinance Management Practices

MKMT component	Observed condition	Interpretation
Financial integration	Present	Moderately established
Transparency	Present but basic	Requires strengthening
Accountability	Not yet optimal	Requires strengthening
Financial control	Present	Moderately established
Risk management	Mitigation strategies present	Established
Reinvestment	Practiced	Established
Business-household separation	Incomplete	Weakest component

Source: Author's analysis, 2026.

The configuration suggests that the household is operating with functional financial management rather than formal accounting. This distinction matters. The current system is sufficient to support basic operational decisions, but incomplete separation of funds limits the precision of profitability assessment and weakens accountability. Consequently, MKMT functions in the study as an intermediate mechanism: production generates economic returns, while financial practices determine how much of that return remains available for household use, risk absorption, and enterprise reinvestment.

Relevance of Integrated Microfinance Management

The IMM assessment indicates that several principles are already embedded in the enterprise even though IMM has not been formally implemented as a structured program. Four dimensions are particularly visible: financial literacy, business management, household capacity, and sustainability.

Financial literacy is reflected in the routine recording of sales and expenditure and in the decision to retain part of business returns for productive purposes. However, the absence of formal income statements, cash-flow reports, and systematic separation of household and business accounts means that this capability remains at an introductory operational level.

Business-management capacity is more developed at the production level. The enterprise maintains a defined sequence from organic-waste collection and preparation to larval feeding,

maintenance, harvesting, processing, and marketing. Sales are supported by repeat customers, direct communication, word-of-mouth promotion, and social media.

Household participation represents another important dimension. Pak Alexander concentrates on production and major business decisions, while Ibu Fanny contributes to financial administration, sales management, and marketing. This arrangement reduces dependence on external labor and distributes business responsibilities within the household.

Economic independence is strengthened through multiple revenue sources and reduced feed expenditure. The enterprise therefore affects household economic capacity in two directions: it generates additional receipts while lowering selected production costs.

Table 5. Assessment of IMM Practices

Indicator	Evidence from the case	Assessment in thesis
Financial recording	Manual recording of sales and expenditures	Effective
Business planning	Reinvestment in equipment and facilities	Effective
Production management	Integrated cultivation-to-processing sequence	Very effective
Marketing management	Repeat customers, word of mouth, social media	Effective
Family involvement	Production, finance, sales and decisions shared	Very effective
Economic independence	Multiple revenue streams and feed savings	Very effective
Business development	Raw material availability, demand, low operating costs	Very effective
Replication potential	Simple technology and family labor	Effective
Financial-business-household integration	Present but informal	Effective

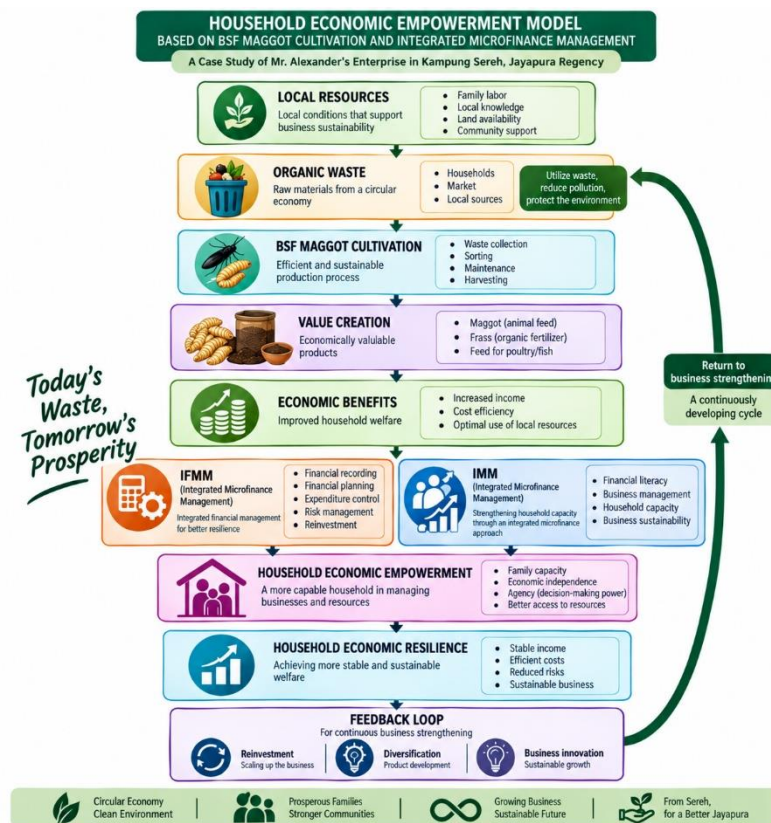
Source: Author's analysis, 2026.

The findings should nevertheless be interpreted as evidence of practical alignment with IMM principles, rather than proof of a formal IMM intervention effect. This distinction is important because the enterprise did not undergo a controlled IMM implementation. The evidence instead indicates that several practices associated with the framework have emerged organically through business experience, family participation, training, reinvestment, and market interaction.

This pattern corresponds with research emphasizing that financial literacy and financial capability matter for microenterprise decision-making and performance (Anshika & Singla, 2022; IS et al., 2024). The case also illustrates a point emphasized in microfinance literature: access to financial resources is more useful when connected with management capability and sustained enterprise activity (Ledgerwood et al., 2013).

Integrated Household Empowerment Model

The synthesis of the four research questions produces a cyclical rather than linear model. Organic waste constitutes the initial resource; BSF cultivation converts that resource into marketable outputs; the resulting revenue and feed savings create household-level economic benefits; MKMT governs the allocation of those benefits; and IMM connects financial practices with business management and family capacity.



Source: Author's analysis, 2026.

Figure 2. Household Economic Empowerment Model Based on BSF Cultivation and IMM

The model contains seven interconnected stages: organic waste as productive input, BSF cultivation as value conversion, income and expenditure effects, MKMT as the financial-management mechanism, IMM as the integrative mechanism, household economic empowerment, and household economic resilience.

The first stage is resource conversion. The enterprise processes approximately 50–100 kg of organic waste per day, converting material originating from households, markets, vegetable vendors, and agricultural activities into cultivation inputs. This finding places resource access at the beginning of the empowerment chain rather than treating capital financing as the sole starting point.

The second and third stages combine production and economic value creation. Organic material becomes maggot and kasgot, while some maggot is redirected into household poultry and fish production. Consequently, the production system generates cash revenue and reduces selected household costs.

The fourth stage, MKMT, determines how those returns are managed. Recording, expenditure control, reinvestment, and planning provide an operational bridge between revenue generation and business continuity. The weakness in this stage, the incomplete separation of household and business finances, also identifies the principal managerial issue requiring further strengthening.

IMM then expands the scope from financial administration to household capability. Its empirical expression includes financial recording, production management, marketing, family participation, risk management, and business development. The resulting empowerment is multidimensional: income and enterprise stability represent the economic dimension; production and marketing skills represent business capacity; recording and reinvestment

represent financial-management capacity; and joint household decision-making represents economic independence.

The final component is economic resilience. The household reduces exposure to a single income source through product diversification, maintains customer relationships, controls selected costs, reinvests part of business returns, and retains access to locally available organic material. The model consequently operates through a feedback loop: improved business capacity supports production, production generates revenue and savings, those returns are partially reinvested, and reinvestment supports further production and diversification.

This integrated configuration extends the conventional interpretation of household BSF cultivation. The contribution of the enterprise does not reside solely in the biological conversion of waste or the sale of maggot. Its broader significance emerges from the interaction between resource utilization, value creation, income diversification, cost reduction, financial practices, family participation, and reinvestment. This interpretation is consistent with the circular-bioeconomy literature on BSF, which identifies waste valorization and multiple downstream products as central to the economic relevance of the technology (Bruno et al., 2025; Mahmood et al., 2021; Siddiqui et al., 2024).

At the same time, the case indicates that replication should not be assumed automatically. The thesis identifies simple cultivation technology, relatively accessible inputs, family labor, and economic-environmental co-benefits as factors supporting replication. However, sustained replication would require technical training, financial-literacy strengthening, market access, institutional support, and continuing mentoring.

Thus, the proposed model can be characterized as a household-level circular economic empowerment mechanism in which organic waste becomes a productive asset, BSF cultivation generates value, MKMT organizes the resulting financial flows, and IMM links those practices with household and enterprise capability. The synthesis in the thesis likewise identifies the model as integrating environmental resources, production, economic returns, financial management, household participation, and resilience in a feedback-oriented system.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study concludes that the household-scale *Black Soldier Fly* (BSF) enterprise in Kampung Sereh represents an integrated economic activity in which organic waste is converted into productive inputs and diversified outputs through a family-based business model. The Business Model Canvas analysis shows that value creation is supported by organic-waste availability, family labor, direct and digital market access, repeat customers, diversified revenue streams, and partnerships with suppliers, customers, training institutions, and local government. The enterprise contributes to household economic empowerment through additional income, reduced feed expenditure, improved cultivation and business skills, wider access to productive resources, and greater participation in household-level business decisions. Manajemen Keuangan Mikro Terpadu (MKMT) is practiced through basic financial recording, expenditure control, financial planning, risk mitigation, and reinvestment, although separation between business and household finances remains incomplete. The findings also indicate that existing practices reflect several principles of Integrated Microfinance Management (IMM), particularly financial literacy, business management, household participation, and business sustainability, although IMM has not been implemented as a formal intervention. The principal contribution of the study is an integrated household empowerment model that connects organic-waste utilization, BSF value creation, financial management, household capacity, and economic resilience within a circular production cycle.

Limitations

This study has several limitations that define the scope of its interpretation. First, the analysis focused on a single household-scale BSF enterprise operated by Pak Alexander in Kampung Sereh, Kabupaten Jayapura, so the findings describe the conditions and practices of this specific case rather than representing all BSF enterprises, household businesses, or regions. Second, the financial evidence was derived from available business records, observations, and interview accounts, including a documented May–June sales period, and therefore does not provide a longitudinal financial assessment across multiple production cycles. Third, the evaluation of IMM was based on the extent to which existing practices reflected its principles rather than on a formally implemented IMM program or an experimental comparison. The findings should therefore be interpreted as context-specific empirical evidence concerning the relationship between BSF cultivation, household economic management, and empowerment rather than as a generalized estimate of IMM effectiveness.

Recommendations

Future research should examine multiple BSF household enterprises across different locations to identify similarities and variations in business structures, financial practices, household participation, and market conditions. A longer observation period would strengthen assessment of income stability, reinvestment patterns, production risks, and the durability of household economic resilience across successive production cycles. Further studies could also introduce quantitative financial indicators, comparative case designs, or mixed-method approaches to examine the relationship between BSF-based enterprise development, financial management, and household empowerment more systematically. In particular, future research should assess the implementation of IMM as a structured intervention and compare outcomes before and after implementation, while also examining variables such as financial literacy, access to finance, digital marketing, market expansion, production efficiency, and environmental benefits. Such extensions would help refine the proposed model and determine the conditions under which it can be adapted to other household-based circular-economy enterprises.

Author Contributions

Meike Iriani Rumbiak: Conceptualization, investigation, data collection, data analysis, interpretation of findings, manuscript drafting, and revision. Asep Mulyana: Conceptualization, development of the theoretical framework, supervision, interpretation of findings, and critical revision of the manuscript. Yunizar: Conceptualization, research supervision, methodological guidance, interpretation of findings, and critical revision of the manuscript. All authors contributed to the development of the manuscript and approved the final version for publication. All authors take responsibility for the integrity and accuracy of the work.

AI Disclosure Statement

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist with language refinement, manuscript restructuring, English-language editing, and improving the clarity and organization of the manuscript. The authors independently reviewed, verified, and edited all AI-assisted content and take full responsibility for the accuracy, originality, interpretation, and final content of this publication. ChatGPT was not used to generate or fabricate research data, research findings, or citations.

Acknowledgment

The authors would like to express their appreciation to the owner and family members of the BSF cultivation enterprise in Kampung Sereh, Kabupaten Jayapura, as well as the customers, community representatives, and other participants who provided information and access during the field research. Their cooperation and practical insights contributed to the completion of this study.

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