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Strengthening Se'i Kupang Production through Kesambi Leaf Biobriquette Innovation, Financial Literacy, and Digital Marketing

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Abstract

Se'i, a traditional smoked meat from East Nusa Tenggara, Indonesia, has a strong cultural identity and economic potential; however, its production still relies on conventional firewood, resulting in inconsistent quality, energy inefficiency, and unstable production costs. This study aims to implement an integrated empowerment model that combines green energy innovation, financial literacy, and digital marketing to strengthen the sustainability of se'i micro and small enterprises (MSMEs) in Kupang City. The program was conducted using a Participatory Action Research (PAR) approach within a structured, integrated empowerment framework, including a baseline assessment, biomass briquette training and simulation, financial literacy workshops with SI-APIK digital bookkeeping implementation, digital marketing training, and a before–after evaluation. The results show a 22–28% reduction in fuel consumption per production cycle, improved stability of smoking temperature and product consistency, full adoption of simple financial reporting and cost-of-production calculation among partners, and increased digital engagement and transactions. The integration of biomass briquettes from Kesambi leaves, structured financial management, and data-driven digital marketing synergistically improved cost efficiency, managerial capacity, and market expansion. In conclusion, the integrated empowerment model effectively enhances production efficiency, financial transparency, and business competitiveness, offering a replicable framework for strengthening traditional food MSMEs through green innovation and digital transformation.

Keywords Biomass Briquettes; Digital Marketing; Financial Literacy; SME Empowerment

1. INTRODUCTION

Se'i is a traditional culinary product of East Nusa Tenggara (NTT) that embodies cultural value, local identity, and significant economic potential, particularly in Kupang City. The product is prepared through a smoking process that relies on conventional firewood, a method passed down through generations. Nevertheless, this traditional production system presents fundamental challenges in terms of quality, efficiency, and business sustainability. Dependence on conventional firewood results in inconsistent smoking temperatures and durations, directly affecting the flavor, texture, and color of the se'i. Differences in wood moisture content and the use of manual combustion techniques further contribute to uneven product quality. Empirical studies on the torrefaction characteristics of kesambi biomass indicate that thermal process stability plays a critical role in ensuring consistent calorific value and combustion performance (Dethan et al., 2024).

In addition, research on the optimization of particle size and binder ratio in kesambi leaf biobriquettes confirms that controlling fuel characteristics significantly affects combustion quality and energy efficiency (Dethan et al., 2024). A predictive model of the calorific value of kesambi biomass further demonstrates that this local raw material possesses measurable and practical energy potential for MSME applications (Dethan, 2024). Other studies indicate that the high calorific value of torrefied kesambi leaf biobriquettes can be empirically predicted and meets established standards for alternative fuel quality (Dethan & Kette, 2024). When fuel sources are not standardized, as in traditional firewood, energy inefficiency and increased smoke emissions inevitably result.

Within the context of food-based MSMEs, the adoption of biomass briquettes is closely associated with improved energy efficiency, reduced environmental impact, and enhanced business sustainability. Therefore, traditional production systems not only result in inconsistent product quality and energy waste but also generate environmental risks and instability in production costs. Dependence on conventional firewood underscores the urgent need for more efficient and sustainable alternative energy sources. In the context of NTT, kesambi leaves (*Schleichera Oleosa*) represent an abundant yet underutilized local biomass resource. The development of locally based biobriquettes aligns with the concept of renewable energy for SMEs and embodies a circular economy approach by converting organic waste into productive energy. Numerous studies demonstrate that optimizing torrefaction processes and particle size enhances briquette quality and combustion stability. Perceived economic benefits, policy support, and the readiness of business actors also influence the adoption of

renewable energy technologies among MSMEs. Thus, biobriquettes constitute not merely a technical innovation but an integrated economic and environmental solution capable of reducing production costs, improving quality consistency, and mitigating ecological impact.

The challenges faced by se'i MSMEs extend beyond energy and production concerns. The majority of business operators lack standardized financial record-keeping systems, do not systematically calculate production costs, and are unable to determine their actual profit margins. Financial literacy, financial technology adoption, and digital marketing have been empirically shown to contribute to increased MSME revenues (Nindhya & Widajantie, 2024). Financial and digital literacy significantly influence MSME productivity, with marketing intensity serving as a mediating variable (Sakti et al., 2025). The achievement of sustainable MSME performance is likewise shaped by the integration of digital technology adoption and financial knowledge (Nugraheni et al., 2025). The utilization of the SI-APIK application as a simple financial recording tool has been demonstrated to strengthen business management and financial inclusion among coastal entrepreneurs (Manafe & Seseli, 2017; Manafe, 2024).

Digital financial literacy through social media utilization also contributes to improving MSME financial inclusion (Al-shami et al., 2024). This finding indicates that social media platforms serve not only as marketing channels but also as tools for market education and for facilitating digital transactions. The digital transformation of Indonesian MSMEs presents both challenges and opportunities in advancing business sustainability (Bahtiar et al., 2025). Digital marketing training has been shown to enhance MSME competitiveness by optimizing digital platforms (Manafe, 2024; Manafe et al., 2023; Yani et al., 2025). Strengthening brand image through digital marketing strategies significantly influences consumer perception and sales growth (Hadiwijaya et al., 2019; Manafe). Synergy between digital literacy and e-commerce adoption further reinforces MSME performance (Widiyanti et al., 2024). Determinants of digital marketing adoption in the agroindustry sector emphasize the importance of managerial and technological readiness (Yelfiarita et al., 2025). Consequently, the challenges confronting se'i MSMEs are systemic, reflecting the lack of integration among production processes, financial management, and digital marketing.

Previous studies have examined renewable energy adoption for MSMEs (Dethan, 2024), financial literacy, and MSME digitalization (Nugraheni et al., 2025), as well as digital marketing and branding strategies (Fitriani & Kunci, 2022; Manafe, 2024; Manafe; Nugraha et al., 2022; Sakti et al., 2025; Yelfiarita et al., 2025) in isolation.

However, there remains a limited body of research addressing community-based intervention models that integrate green energy innovation, production cost–based financial literacy, and digital marketing within a single structured empowerment framework rooted in traditional food enterprises. To date, no comprehensive empowerment model has combined these three dimensions within an integrated framework for traditional food MSMEs. This gap constitutes the principal scientific novelty and core contribution of the present Community Service Program (PKM).

The program contributes to achieving the United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 12 (Responsible Consumption and Production). From a socio-economic perspective, the initiative strengthens local economies grounded in traditional food heritage and creates opportunities for replication across other MSME sectors. From a scientific standpoint, it proposes an integrated empowerment model based on green energy innovation, production cost–oriented financial literacy, and digital marketing strategies.

2. METHODS

This study employs an applied research approach with a participatory design, beginning with a preparation and needs assessment stage. At this stage, partner MSMEs were identified and selected based on business scale, readiness to adopt technology, and commitment to business development. This was followed by a baseline assessment, which included an analysis of the production system (type of firewood used, smoking duration, fuel consumption, and product quality consistency), an evaluation of actual production costs and existing financial recording practices, and an assessment of digital marketing capacity. Data were collected through observation, in-depth interviews, and Focus Group Discussions (FGDs) to map, in a participatory manner, the technical, managerial, and digital challenges faced by the partners. Based on these findings, a production technology intervention was implemented by adopting Kesambi leaf biobriquettes to improve energy efficiency and ensure consistent product quality. This intervention included technical training, simulation of its application in the se'i smoking process, and implementation assistance across several production cycles.

The subsequent stage involved managerial intervention focusing on strengthening financial literacy and production cost calculation through training and hands-on mentoring. The activities included enhancing MSMEs' understanding of the distinction between personal and business finances, the concepts of fixed and variable costs, the calculation of the Cost of Goods Manufactured (COGM), and the

determination of profit margins and break-even points. In addition, this study implemented a digital financial recording system using the SI-APIK application, covering daily transaction recording, preparation of simple income statements, and cash flow monitoring, supported by intensive mentoring for 2–3 months to ensure consistent implementation. The intervention was further extended to the marketing aspect by strengthening data-driven digital strategies, including training in branding and product positioning, developing visual identity and packaging, crafting product narratives rooted in local wisdom, and optimizing social media platforms and marketplaces. The variables observed in this study included energy efficiency, production costs, managerial capacity, and digital marketing performance.

The research design adopted a before–and–after approach to measure the effectiveness of the interventions. Quantitative data were obtained by comparing production costs, fuel consumption, financial reports, and sales data before and after the intervention. In contrast, qualitative data were collected through interviews, observations, and participatory evaluation. Data analysis was conducted using descriptive-comparative methods. Monitoring and evaluation were carried out in three stages: a mid-term evaluation, a final evaluation, and a joint reflection with partners. The success indicators included a minimum 20% reduction in fuel consumption, stabilization of the production process, improved financial reporting capacity, and increased market reach and digital transactions. The outputs of this study include enhanced green energy–based production capacity, the establishment of a digital financial recording system using SI-APIK, and the development of an integrated MSME empowerment model (production–finance–marketing) that is sustainable through technology transfer mechanisms, the establishment of MSME learning groups, and replication of the model to other MSMEs.

Figure 1. Flow Diagram of the Empowerment Method for Se'i MSMEs in Kupang

3. FINDINGS AND DISCUSSION

3.1. Findings

3.1.1. Production Technology Intervention: Kesambi Leaf Biobriquettes

The implementation of kesambi leaf biobriquettes demonstrated significant improvements in energy efficiency and the stability of the smoking process. Based on a before-and-after comparison across three production cycles, fuel consumption decreased by approximately 22–28% per cycle. In addition, smoking duration became more stable, with lower temperature fluctuations compared to conventional firewood. This improvement also resulted in a more uniform color and texture of se'i, indicating better consistency in doneness. The enhanced combustion stability is closely related to the optimized calorific value and particle homogeneity of the biobriquettes, which are achieved through torrefaction and controlled particle size distribution (Dethan et al., 2024; Jemmy Dethan et al., 2024; Dethan & Kette, 2024; Dethan, 2024). Field testing further showed that biobriquettes produced a more stable flame than firewood, which often has fluctuating moisture content. Partners also reported reduced smoke and improved control over heat efficiency, consistent with predictive models of kesambi biomass that indicate high and stable energy potential. From an economic perspective, this reduction in fuel usage directly increased production cost efficiency.

3.1.2. Financial Literacy Strengthening

Prior to the intervention, none of the partners maintained structured financial records or systematically calculated the Cost of Goods Manufactured (COGM). However, after training and mentoring, all partners were able to separate their personal and business finances effectively. They also demonstrated the ability to prepare simple income statements using the SI-APIK application and to calculate COGM, enabling them to determine actual business margins. Previously, selling prices were based primarily on market habits without considering cost structures. After the intervention, partners adjusted their pricing strategies based on more rational and accurate margin calculations. The use of SI-APIK contributed to improved managerial capacity and increased business transparency, in line with findings from MSME empowerment studies (Manafe & Seseli, 2017; Manafe, 2023; Manafe, Seseli, et al., 2024). Furthermore, integrating financial literacy and digital tools enhanced partners' readiness to make informed business decisions (Nugraheni et al., 2025; Sakti et al., 2025).

3.1.3. Digital Marketing Strengthening Outcomes

The digital marketing intervention led to notable improvements in promotional practices and customer engagement. Partners became more consistent in uploading promotional content, leading to increased customer interaction, including more likes,

comments, and direct messages. In addition, there was growth in digital transactions conducted via WhatsApp Business and other social media platforms. Partners also began developing branding strategies that emphasized local identity and the uniqueness of traditional smoking processes, combined with environmentally friendly energy innovations. This approach enhanced product differentiation and improved consumers' perceived product quality. Previous studies have shown that digital marketing training can strengthen MSME competitiveness by enabling effective use of platforms (Hadiwijaya et al., 2019; Cruz et al., 2018). Consistent content creation and improved brand image were found to positively influence consumer perception and potential sales growth (Emi Widiyanti et al., 2024). Overall, integrating digital literacy and online marketing improved business performance, supporting the findings of Widiyanti et al. (2024) and Yelfiarita et al. (2025) on key factors in digital marketing adoption in the agroindustry sector.

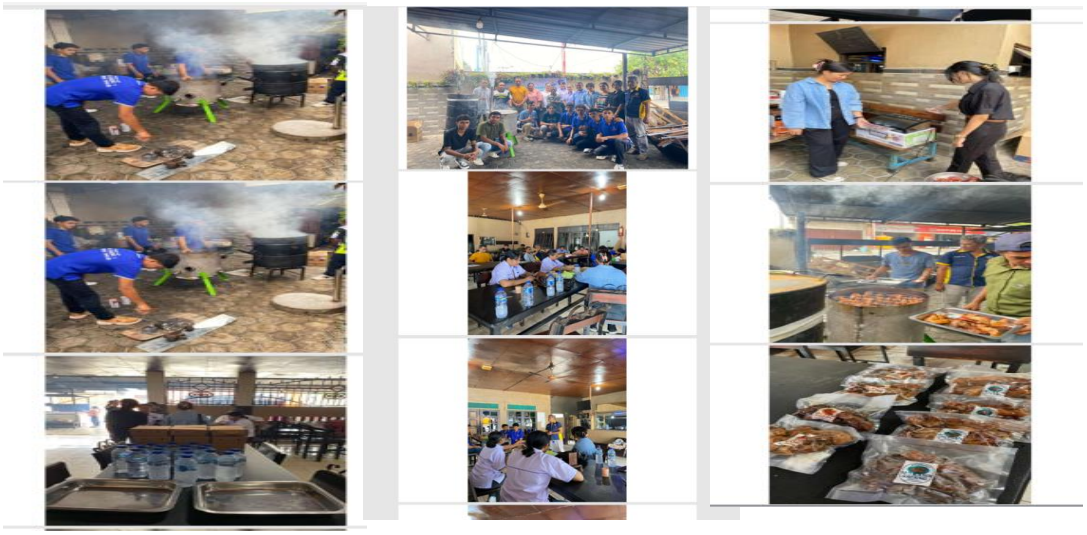

Figure 2. PKM 2025 Socialization and Training Activities

3.2. Discussion

3.2.1. Integration of Green Energy and Production Cost Efficiency

The PKM findings indicate that kesambi leaf biobriquettes not only enhance combustion stability but also reduce energy costs. This confirms previous findings that optimizing torrefaction processes and biomass particle characteristics improves combustion quality and efficiency. In the MSME context, energy efficiency is directly correlated with cost efficiency and business sustainability. The use of local biomass resources further supports circular-economy principles and the optimization of renewable resources. Thus, this innovation contributes not only to technical production improvements but also to environmental and economic dimensions.

3.2.2. Financial Literacy as the Foundation of Business Decision-Making

The findings reveal that, prior to the intervention, the inability to calculate COGM led to selling prices that did not reflect actual costs. After mentoring, partners were able to establish prices based on structured cost analysis. These results reinforce the literature demonstrating that financial literacy and financial technology adoption enhance MSME productivity and income (Nindhya & Widajantie, 2024; Sakti et al., 2025). The integration of financial literacy and digital business management also serves as a determinant of sustainable MSME performance (Manafe et al., 2023; Nugraheni et al., 2025). Therefore, the financial intervention in this PKM program extended beyond bookkeeping training; it represented a transformation toward data-driven managerial mindsets.

3.2.3. Digital Marketing as a Value-Added Lever

The increase in customer engagement and digital transactions indicates that digitalization expands market reach. This finding aligns with evidence that digital transformation creates opportunities for MSME sustainability (Bahtiar et al., 2025). Branding strategies rooted in local identity strengthened product image and enhanced consumer trust (Aisyah, 2022; Fitriani & Kunci, 2022; Nugraha et al., 2022; Perguna et al., 2019; Yanti Setianti et al., 2018). Digital literacy through social media utilization also promotes financial inclusion and market access ((Al-shami et al., 2024; Widiyanti et al., 2024; Sakti et al., 2025). The adoption of digital marketing is influenced by managerial and technological readiness (Yelfiarita et al., 2025). In this program, such readiness was reinforced through integration with financial literacy and improvements in production efficiency.

3.2.4. Model Novelty: The Integrated Empowerment Model

Unlike previous studies that examined renewable energy, financial literacy, or digital marketing separately (Dethan, 2024; Manafe, 2024; Manafe, Rizani, et al., 2024; Manafe, Seseli, et al., 2024; Nugraheni et al., 2025)This program integrates all three dimensions into a single empowerment framework. The model demonstrates that: Production efficiency → reduces costs; Financial recording → improves margin accuracy; Digital marketing → increases revenue.

These three components form a mutually reinforcing cycle of business sustainability. Conceptually, the model contributes to MSME empowerment approaches grounded in green energy innovation and integrated digital transformation, while simultaneously supporting the achievement of SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 12 (Responsible Consumption and Production).

Figure 3. Training, Mentoring, Monitoring & Evaluation Activities

4. CONCLUSION

This Community Partnership Program (PKM) demonstrates that an integrated approach combining green energy innovation, cost–based financial literacy, and digital marketing can improve production cost efficiency while simultaneously strengthening MSME managerial capacity. In addition, this approach contributes to expanding market access through digitalization, enabling MSMEs to reach broader and more diverse customer segments.

Moreover, the program establishes a replicable empowerment model grounded in traditional food enterprises, adaptable to similar contexts. This model not only addresses technical production challenges but also develops a more efficient, transparent, and sustainable business system, thereby supporting the long-term growth and resilience of MSMEs.

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