

TECHNOLOGY-BASED COMMUNITY EMPOWERMENT: SMART FARMING, AQUAPONICS, AND DTF APPLICATIONS IN KERANGGAN ECOTOURISM

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ABSTRACT

Keranggan Ecotourism in South Tangerang holds significant potential for developing nature-based tourism and creative economy initiatives; however, it faces challenges such as limited technological adoption, lack of business diversification, and low community capacity. To address these issues, this community service program introduced solutions through the application of IoT-based smart farming for cassava cultivation, aquaponics systems, and Direct to Film (DTF) technology for the creative industry. The implementation methods included socialization, training, technology installation, evaluation, and continuous mentoring. Activities were conducted from August to September 2025 in the Keranggan Ecotourism area, involving the local tourism awareness group (Pokdarwis) and residents of RW 12, with 30 participants attending the socialization stage and 26 participants attending the training sessions. Questionnaire results indicated an effectiveness rate of 80,35%, reflecting significant improvements in knowledge, skills, and technology adoption. Smart farming enhanced cassava cultivation efficiency, aquaponics provided sustainable food production while serving as an educational attraction, and DTF opened opportunities for creative businesses through tourism merchandise. The program outputs include the implementation of appropriate technology, strengthened community capacity, and the establishment of a technology- and local wisdom-based ecotourism empowerment model that can be replicated in other regions.

Keywords: Aquaponic, Community Empowerment, Direct to Film (DTF) Printing, Ecotourism Development, Smart Farming

1. INTRODUCTION

Keranggan Ecotourism, located in South Tangerang, is one of the nature- and culture-based tourism areas that holds significant potential for sustainable development. (Kalalo, 2023) This area not only offers natural attractions, biodiversity, and local traditions but also provides economic opportunities that can support community welfare through the utilization of local resources. (Suwoyo, 2024) However, this potential has not been fully optimized due to limited technological adoption, lack of business diversification, sustainable energy and the relatively low capacity of the community in managing economic opportunities within ecotourism. (Saputri, 2024) Therefore, community empowerment initiatives are needed to enhance the capacity, skills, and self-reliance of local partners so they can utilize opportunities more productively and sustainably. One strategic approach that can be applied is strengthening the production sector through the implementation of smart farming based on the Internet of Things (IoT), the development of an aquaponics cultivation system, and the utilization of a Direct to Film (DTF) printing machine for creative business diversification. The application of smart farming in cassava cultivation is highly relevant, as cassava is a local commodity that is easy to cultivate and has significant economic value, beside peanuts. (Octasyilva, 2023) By using soil moisture sensors, automatic irrigation systems, and IoT-based monitoring, the productivity and quality of cassava crops can be significantly improved. (Peerawoot, 2021) (Duong, 2024) This technology also reduces water usage, increases labor efficiency, and provides real-time data that helps farmers make better cultivation decisions.

In addition, the development of an aquaponics system serves as an innovative solution that integrates fish farming and plant cultivation within a mutually beneficial ecosystem. Aquaponics not only enables the community to meet the demand for healthy and environmentally friendly food but also has the potential to become an educational attraction for visitors to Keranggan Ecotourism. Through this system, communities can produce both fish and vegetables simultaneously, thereby creating added economic value while reinforcing environmental sustainability. (Setiawan, 2024) (Nugraha, 2024) On the other hand, the utilization of a Direct to Film (DTF) printing machine creates opportunities for the development of creative businesses and home industries in the field of merchandise and printing. Creative products using DTF, such as t-shirts, tote bags, and souvenirs unique to Keranggan, can serve as local identity products while also enhancing the tourism appeal. (Muh, 2024) Business diversification through this technology also strengthens community economic independence, particularly among the younger generation, by creating new job opportunities and expanding marketing networks both offline and online. (Safitri, 2024)

These three technological interventions are designed to complement one another. Smart farming enhances agricultural productivity, aquaponics supports sustainable food production and education, while DTF strengthens the creative economy sector aligned with tourism development. (Hera, 2025) This synergy is expected to increase the competitiveness of Keranggan Ecotourism, positioning it as a model for community empowerment based on technology and local wisdom. Through this community service program, partners in Keranggan Ecotourism not only gain new knowledge and skills but are also encouraged to be more independent in managing their local potential. (Julaeha, 2024) Through technology transfer, training, and mentoring, the community will be equipped to produce value-added products, increase household income, and strengthen the sustainability of community-based tourism ecosystems. (Wahyu, 2025) This activity also aligns with the Sustainable Development Goals (SDGs), particularly in the areas of poverty alleviation, food security, decent work, (Suwoyo, 2024) industrial innovation, and environmental preservation. Therefore, the program is expected to contribute significantly to improving community welfare (Setiany, 2025) and strengthening Keranggan Ecotourism as a leading destination based on technology and local wisdom. (Juliana, 2024)

2. METHOD

The implementation method of this community service program in Keranggan Ecotourism, South Tangerang, is designed systematically to ensure that the activities of empowerment and technology transfer can be carried out effectively, sustainably, and with measurable outcomes. The approach combines socialization, training, technology application, evaluation, and continuous mentoring, all of which are integrated to strengthen the capacity of local partners and maximize the potential of the ecotourism area.

1. Socialization

The first stage of the program involves socialization activities aimed at introducing the objectives, benefits, and expected outcomes of the program to the community and stakeholders. (Andika, 2024) Socialization is carried out through community meetings, discussions with local leaders, and coordination with stakeholders managing Keranggan Ecotourism. The process ensures transparency and inclusivity, while also encouraging active participation from the community. During this stage, participants are also introduced to the three main areas of intervention: smart farming with IoT for cassava cultivation, aquaponics systems, and the use of Direct to Film (DTF) printing machines. This stage plays a crucial role in building awareness, fostering motivation, and aligning program activities with the needs and aspirations of the community.

2. Training

After socialization, structured training sessions are conducted to equip the community with technical knowledge and practical skills. Training activities are divided into three thematic areas. First, training on IoT-based smart farming, which includes the use of soil moisture sensors, automatic irrigation systems, and data monitoring platforms. Second, aquaponics training, covering the design of systems, water quality management, fish cultivation, and vegetable planting techniques. Third, training on DTF machine operations, including digital design preparation, printing, heat pressing, and quality control of merchandise products. The training adopts participatory methods, combining theoretical explanation with hands-on practice to ensure that participants can directly apply what they learn.

3. Technology Implementation

The next stage involves the direct application of technologies introduced during the training sessions. In this phase, smart farming systems are installed in selected cassava cultivation plots, aquaponics systems are developed in designated demonstration areas, and DTF machines are set up for merchandise production. Community members actively participate in the installation and initial operation of these systems under the guidance of the project team. This stage emphasizes learning-by-doing, ensuring that the community not only understands the technology but also gains confidence in operating it independently.

4. Evaluation

Evaluation is carried out periodically to measure the effectiveness and impact of the program. Both qualitative and quantitative methods are used, including pre- and post-training assessments, field observations, interviews, and production output analysis. The evaluation process focuses on identifying improvements in technical skills, productivity levels, product quality, and income generation. Feedback from participants is also collected to refine future activities and address potential challenges. This stage ensures accountability while providing valuable insights into the sustainability of the implemented technologies.

5. Mentoring and Assistance

The final and continuous stage is mentoring, which provides long-term support to the community after the implementation of technology. Mentoring includes periodic visits, technical assistance, problem-solving consultations, and guidance in marketing and business management. The mentoring process also encourages community groups to form networks, share experiences, and collaborate in maintaining the sustainability of the introduced technologies. This stage aims to strengthen independence, ensure the sustainability of the program's outcomes, and create a multiplier effect where empowered groups can transfer knowledge and skills to others within the community.

Through these stages, the program is expected to build a holistic empowerment model that not only transfers technology but also enhances awareness, skills, and self-reliance among the community of Keranggan Ecotourism. The synergy of socialization, training, technology implementation, evaluation, and mentoring ensures that the program can generate sustainable impacts, improve community welfare, and strengthen the role of Keranggan as a model of ecotourism development based on technology and local wisdom.

3. RESULTS AND DISCUSSION

The community service program conducted at Keranggan Ecotourism, South Tangerang, was implemented in a structured and collaborative manner through a series of activities held between August and September 2025. The program aimed to empower the local community, particularly the tourism awareness group (Pokdarwis) and residents of RW 12, by introducing and applying three main technological innovations: IoT-based smart farming for cassava cultivation, aquaponics systems for sustainable food production, and Direct to Film (DTF) printing technology for creative industries. The following section elaborates on the implementation process, outcomes, and overall impact of the program.

1. Socialization Stage (August 16, 2025)

On August 16, 2025, three consecutive socialization sessions were held, each focusing on the three technological interventions. Smart Farming Socialization was delivered by Heru Suwoyo to 30 participants. The session highlighted the principles of IoT in agriculture, the use of sensors for soil moisture monitoring, and the benefits of automated irrigation for cassava cultivation. Participants gained insights into how technology could optimize productivity and reduce labor costs. Aquaponics Socialization, conducted by Julpri Andika also gathered 30 participants. The presentation explained the integration of fish farming and plant cultivation in a closed-loop system, emphasizing sustainability, resource efficiency, and the potential for educational tourism. DTF Socialization, led by Rizky Dinata introduced the community to creative printing technology capable of producing high-quality merchandise such as shirts, tote bags, and souvenirs. The session also illustrated the economic potential of creative industries in supporting local tourism.



Figure 1. Socialization Stage, (a) Smart Farming Socialization, (b) DTF Socialization, (c) Aquaponics Socialization, (d) The participants of socialization

The socialization activities successfully raised awareness and stimulated enthusiasm among participants, who expressed strong interest in engaging further with the program.

2. Technology Installation (August 30 and September 6, 2025)

Following the socialization, the next step involved hands-on installation of the technologies.

On August 30, 2025, smart farming systems were installed under the supervision of Dr. Heru Suwoyo and his team. The installation included setting up sensors, automatic irrigation, and a control unit integrated with IoT monitoring platforms. Demonstration plots of cassava were selected within the ecotourism area to serve as pilot sites. On September 6, 2025, aquaponics units and the DTF pressing machine were installed by Julpri Andika, Rizky Dinata, and their team. The aquaponics system comprised water tanks, pumps, biofilters, and grow beds planted with leafy vegetables. Meanwhile, the DTF press machine was installed and calibrated for local use, ensuring that the community could begin producing creative merchandise.



Figure 2. Technology Installation Stage, (a) Installation of pump to get the water from the river, (b) Installation of IoT, (c) The components of aquaponics, (d) Installation of Aquaponics, (e) Installation of DTF, (f) Setting of DTF

These installations transformed theoretical knowledge from the socialization phase into tangible practices, making the technologies accessible and visible to the community.

4. Training Sessions (September 11–13, 2025)

To enhance skills and build confidence, three training sessions were organized, each attended by 26 participants.

On September 11, 2025, Dr. Heru Suwoyo and team conducted Smart Farming Training. Participants practiced using IoT sensors, interpreting data, and managing irrigation systems. The training emphasized the role of digital monitoring in improving decision-making for cassava cultivation. On September 12, 2025, Julpri Andika and team led Aquaponics Training. Participants engaged directly with the system by feeding fish, monitoring water quality, planting vegetables, and learning maintenance techniques. The training demonstrated the practicality of aquaponics as both a food source and a tourism attraction. On September 13, 2025, Rizky Dinata and team conducted DTF Training. Participants were introduced to digital design preparation, film printing, pressing techniques, and final product finishing. They also discussed strategies for marketing creative products as part of Keranggan's tourism identity.



Figure 3. (a) The Participants start to farm the cassava, (b) Part of Smart Farming, Water spreads out from the sprinkle, (c) The Participants check the water flow, (d) Training sessions of Aquaponics, (e) Training Sessions of DTF, (f) The Participants of DTF

All three training sessions were highly participatory, enabling participants to apply the skills they learned immediately. The following Table 1 is the results of the questionnaire conducted by the implementation team.

Table 1. The Results of The Questionnaire Conducted by the Implementation

<i>Questions</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>Stand. Dev.</i>	<i>SA</i>	<i>A</i>	<i>D</i>	<i>SD</i>
The community service material is in accordance with the problems faced by the community.	1	4	3,3333	0,8841	16	10	2	2

<i>Questions</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>Stand. Dev.</i>	<i>SA</i>	<i>A</i>	<i>D</i>	<i>SD</i>
The community service method used is appropriate with the theme and objectives of the community service program.	1	4	3,1333	0,9732	14	8	6	2
Supporting facilities and infrastructure for community service activities are adequate.	1	4	3,2667	0,8683	15	9	5	1
The community service implementation team appears to be cohesive in carrying out the activities.	2	4	3,2333	0,7739	13	11	6	0
The implementation team has the competence relevant to the material provided.	1	4	3,2667	0,9803	17	6	5	2
The implementation team is very engaging in delivering the community service program.	1	4	3,3333	0,7944	14	12	3	1
The community is enthusiastic in participating in the community service activities.	2	4	3,1667	0,8339	13	9	8	0
The community greatly benefits from the community service program provided.	1	4	3,2667	0,7397	12	15	2	1
The community is highly interested and enthusiastic about the service activities.	1	4	2,8667	1,0743	11	8	7	4
Overall, the community feels satisfied with the community service program carried out.	2	4	3,1667	0,7466	11	13	6	0
The community service program meets the expectations of the community.	1	4	3,2222	0,9248	13	13	1	3
The duration of the community service program aligns with the community's expectations.	2	4	3,3667	0,6687	14	13	3	0
Average	1,333	4	3,1239	0,8552				

SA: Strongly Agree, A: Agree, D: Disagree, SD: Strongly Disagree

The questionnaire results indicate that the community service program in Keranggan Ecotourism was well-received, with the majority of respondents expressing strong agreement or agreement across all indicators. The mean scores, ranging mostly between 3.1 and 3.3, show that participants perceived the materials, methods, facilities, and implementation team as relevant and effective. The program was also considered beneficial, engaging, and aligned with community expectations. With a high level of satisfaction on Equation 1

$$\begin{aligned}
 \text{Effectiveness} &= \frac{\text{Mean Score}}{\text{Maximum Score}} \times 100 \\
 \text{Effectiveness} &= \frac{3,1239}{4} \times 100 = 80,35\%
 \end{aligned}
 \tag{1}$$

(overall effectiveness of 80,35%), the data confirm that the activities successfully enhanced knowledge, skills, and enthusiasm, while strengthening community empowerment and sustainability of ecotourism development.

5. Mentoring and Assistance (September 20, 2025)

The final stage involved mentoring and ongoing assistance by the entire project team. The session emphasized troubleshooting, problem-solving, and developing sustainability strategies. Participants received guidance on how to maintain equipment, manage production, and integrate the new technologies into their daily practices. Discussions also covered business management and networking strategies to expand market opportunities. The mentoring stage was crucial to ensure that the knowledge and technologies introduced could be sustained beyond the program's timeline.

4. CONCLUSION

In conclusion, the community service program at Keranggan Ecotourism successfully achieved its objectives of empowering local communities through technology transfer, skill enhancement, and economic diversification. The integration of IoT-based smart farming, aquaponics systems, and DTF technology significantly improved knowledge, productivity, and creativity among participants. The program not only enhanced the welfare of the local community but also strengthened Keranggan's position as a model of community-based ecotourism that combines technology with local wisdom.

The 80,35% satisfaction rate from participants indicates a high level of acceptance and potential for continuity. With proper follow-up and collaboration between the community, academic institutions, and local government, the outcomes of this program can be sustained and expanded, ensuring long-term benefits for the people of Keranggan and beyond.

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