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Implementation of Techno-Edutourism for Smart Farming and Digital Branding in Islamic Boarding Schools Toward a Sustainable Economy

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Abstract

This community service program was implemented at SMKS Pesantren Alam Indonesia (PAI) Barru, South Sulawesi, the only Islamic boarding vocational school in agriculture committed to producing graduates who are both spiritually and technically competent. The area's potential, such as approximately 5 hectares of fertile land, agricultural practice facilities, and strong social support from the local community, makes it ideal for developing a pesantren-based techno-edutourism center. However, resource management remains conventional and has not yet integrated modern technologies. The main problems include the absence of an Internet of Things (IoT)-based monitoring system, the lack of a modern irrigation system, and limited digital promotion for edutourism management. To address these challenges, the program applied the Service Learning (SL) approach, which integrates academic learning with direct community engagement. The implementation involved lectures, demonstrations, and participatory discussions, structured into three stages: preparation, training and hands-on practice, and evaluation. The activities focused on introducing agricultural drone technology, IoT-based monitoring systems, and the development of automated irrigation systems, complemented by digital branding simulations for edutourism. The results indicate an increase in teachers' and students' knowledge of smart farming, improved efficiency in agricultural practices, and the establishment of a digital promotion system to support edutourism development. This program contributes to five Sustainable Development Goals (SDGs), namely SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 17 (Partnerships for the Goals), while also serving as a sustainable pesantren empowerment model that can be replicated in other regions.

INTRODUCTION

SMKS Pesantren Alam Indonesia (PAI) is the only Islamic boarding school with a vocational focus on agriculture located in Barru, South Sulawesi. Established with the vision of producing graduates who are not only grounded in religious knowledge but also possess agricultural skills as a foundation for economic independence and contribution to national food security, the school currently accommodates around 120 active students supported by 12 teachers, most of whom have an educational background in agriculture. Situated at an altitude of approximately 500 meters above sea level, with andosol and latosol soil types suitable for horticultural and plantation crops, SMKS PAI owns a land area of about five hectares and is supported by facilities such as fish ponds, composting units, and a simple greenhouse. These potentials position SMKS PAI as both an educational institution and a prospective center for the development of pesantren-based agriculture with competitive capacity.

Despite this potential, the partner still faces significant challenges that require immediate attention from the perspectives of economics and business. The management of resources remains conventional and inefficient, limiting the optimization of agricultural productivity and value

creation. Edu-tourism, although promising for creating employment opportunities, improving the educational system, and enhancing the competitiveness of the younger generation (Ekasani et al., 2020), has not yet been professionally managed nor integrated with digital marketing strategies. Meanwhile, the concept of agripreneurship defined as the integration of innovation with the agricultural sector to cultivate an entrepreneurial mindset, accelerate economic growth, and create new employment opportunities (Yadav & Kumari, 2024) is still underdeveloped due to limited technological facilities and mentoring. To increase crop yields and economic value, modernization through precision farming is urgently needed.

Precision agriculture has emerged as an innovative paradigm that utilizes advanced digital technologies to enhance crop productivity, reduce the consumption of agricultural inputs, mitigate environmental degradation, and improve the overall profitability of farming systems (Bahmutsky et al., 2024). In contrast, traditional manual farming practices remain labor-intensive, inefficient, and time-consuming (Khan & Minai, 2025). The techno-edu-tourism framework, which merges educational and tourism elements, offers considerable potential for strengthening community participation, particularly among younger generations (Ananda et al., 2023). Moreover, recent studies indicate that the integration of innovative technologies into tourism education can significantly accelerate knowledge dissemination, enrich learning processes, and foster interdisciplinary educational opportunities (Islam et al., 2025). Field visits and collaborative discussions with SMKS Pesantren Alam Indonesia, the project's institutional partner, revealed two main priority areas for development: (1) the adoption of agricultural innovations based on the Internet of Things (IoT) and drone-assisted farming systems, and (2) the digital transformation of promotional strategies and management practices within the edu-tourism sector. These issues were determined according to urgency and mutual agreement with the partner as part of the strategy to develop a pesantren oriented toward technopreneurship and sustainable edu-tourism

The first problem relates to the limited integration of technology in the school's agricultural activities, despite the fact that educational technology integration aims to enhance students' knowledge as well as both soft skills and hard skills (Joshi et al., 2022). All crop cultivation processes, such as watering, growth recording, and pest control, are still carried out manually. There is no IoT-based monitoring system available to measure air temperature, soil moisture, and light intensity, which are essential for precision farming practices and efficient resource utilization. This situation not only reduces the effectiveness of agricultural activities but also restricts students' learning opportunities in modern agriculture. Fundamentally, IoT plays a critical role in contemporary agriculture by offering a data-driven approach to improve productivity while ensuring sustainability (Duguma & Bai, 2025). In addition to IoT, the absence of agricultural drones as spraying tools poses another challenge. Drones designed for automatic spraying of fertilizers and pesticides can save time and labor while reducing the risk of students' exposure to hazardous chemicals. Drones are now widely adopted in precision agriculture, contributing to the achievement of Sustainable Development Goals (SDGs). This technology supports environmentally friendly farming practices, enhances food security, and minimizes negative impacts on nature (Rishikesavan et al., 2025). The proposing team has previously developed a simple prototype of a 10-liter spraying drone, but its utilization has not yet been sustainably implemented in the school. By integrating this drone into the practical curriculum, students can gain hands-on experience with advanced agricultural technologies currently applied in the industry. The collaboration between drones and IoT is transforming sustainable agriculture by making farming practices more precise, efficient, and environmentally friendly (Khan et al., 2024).

The second problem concerns the low capacity for digital promotion. The school does not yet have official media such as a website or digital catalog to present information about its edu-tourism potential. Promotional activities have so far been limited to personal social media accounts, without engaging visual content design or a proper visit reservation system. Digital marketing plays a vital role in enhancing the effectiveness of promotion and the attractiveness of tourist destinations (Cherti, 2024). In fact, the school has considerable potential as an educational tourism destination, uniquely based on the pesantren model and holding high market value. According to the Ministry of Tourism and Creative Economy, the utilization of digital platforms and creative content can serve as an effective educational tool while also fostering visitor trust (Mandey et al., 2023).

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From an economic sustainability perspective, these challenges are highly significant. The lack of technological integration limits productivity, reduces competitiveness, and weakens the school's ability to generate added value from its agricultural resources (Jatiningrum et al., 2025). Meanwhile, the absence of structured digital promotion restricts market access, reduces visibility, and hampers the development of a sustainable techno-edutourism ecosystem. In contrast, the integration of IoT and drone technology can optimize production efficiency, reduce costs, and increase yields, which are crucial for ensuring long-term financial viability. At the same time, digital marketing has the potential to expand market reach, strengthen branding, and attract both domestic and international visitors, thereby creating new revenue streams and employment opportunities. In this sense, techno-edutourism serves not only as an educational innovation but also as a driver of local economic sustainability. As highlighted by Joshi et al., (2022), the integration of educational technology not only strengthens learning outcomes but also fosters the development of essential soft and hard skills that are closely linked to employability and entrepreneurship, which in turn reinforces the sustainability of local economic growth.

Through this program, strategic solutions are designed to address the two main issues, Through this program, strategic solutions are designed to address the two main issues, namely by implementing technology-based agriculture systems (IoT and drones) and developing a professional branding and digital promotion system. In this way, the program is expected to improve the quality of vocational education, empower the surrounding community, and establish a sustainable pesantren-based edu-tourism model. The program is designed to generate social and economic impacts and benefits for both the school and the local community.

The program gap lies in the fact that, despite the school's strong agricultural potential and social support, there has been no systematic effort to integrate advanced agricultural technologies with digital-based promotion for edutourismMost previous empowerment initiatives in pesantren-based agricultural programs have primarily centered on short-term training sessions or isolated projects that provided limited and unsustainable economic benefits. In contrast, the current program adopts a more holistic and innovative framework by integrating IoT-based monitoring systems, drone-assisted farming, and digital branding strategies within a single operational model—an approach that has not yet been implemented in similar contexts.

The distinctiveness of this community engagement initiative lies in its integrative design, which connects the domains of education, technology, and entrepreneurship within a pesantren based ecosystem. By embedding precision agriculture tools and digital marketing techniques into both the vocational curriculum and local community practices, the program not only strengthens pedagogical outcomes but also establishes a replicable techno-edutourism framework. This initiative provides new perspectives on how pesantren institutions can evolve into centers of smart farming, digital innovation, and sustainable local enterprise development an area that has received little attention in previous community-based service efforts.

The anticipated outcomes of this initiative are multidimensional, reflecting progress in education, technological engagement, and community development. Primarily, the use of drone-based spraying systems and IoT technologies is expected to elevate the quality of agricultural learning, equipping students with the competencies required to navigate the complexities of modern farming. Furthermore, the creation of an integrated digital promotion platform enhances the institution's public visibility and opens new avenues for inter-institutional collaboration and partnership. The program also contributes to the growth of pesantren-based edu-tourism, which can serve as an alternative source of income for both the school and the surrounding community. Furthermore, students' technopreneurship skills are strengthened, equipping them to become future actors in modern, digital-based agricultural enterprises. Finally, the local community particularly nearby farmers are empowered through their involvement in the development of organic agriculture based educational tourism. By focusing on the integration of technological innovation and digital promotion, this program not only addresses the partner's current needs but also accelerates the transformation of vocational education toward an adaptive technopreneurship model with long-term and sustainable impacts.

IMPLEMENTATION METHOD

This community service activity was carried out at SMKS Pesantren Alam Indonesia, located at Jl. Poros Barru–Soppeng Km.125, Tompo Lemo Lemo, Harapan Village, Tanete Riaja Subdistrict, Barru Regency, South Sulawesi, on July 27, 2025. The activity involved 10 teachers with educational backgrounds in Agricultural Technology and 20 students. The implementation methodology of this program refers to the Service Learning (SL) approach, a learning model that integrates academic activities with direct and meaningful service to the community. In this context, training activities on Internet of Things (IoT)-based agricultural technology, 3D printing, and automatic irrigation systems were not only intended to transfer knowledge but also to empower the educational community at SMKS Pesantren Alam Indonesia through contextual and applicable learning experiences.

The implementation of this program involved accompanying lecturers, all teachers of SMKS Pesantren Alam Indonesia, and several students as active participants. The training was carried out through three complementary strategies. The initial strategy employed was a lecture-based session, emphasizing theoretical discussions on Smart Farming concepts, Internet of Things (IoT) applications, automated irrigation technologies, agricultural drone utilization, and digital branding for educational tourism. This was subsequently complemented by a series of demonstrations that offered practical, hands on experiences, such as the operation of crop spraying drones, IoT based environmental monitoring, installation of automated irrigation systems, and the use of digital media for promoting edu-tourism activities. To deepen participants' understanding, the training incorporated interactive discussions that enabled both teachers and students to ask questions, share ideas, and critically explore how these technologies could be applied in teaching, agricultural management, and tourism based learning within the school. Through the systematic integration of these three pedagogical approaches lectures, demonstrations, and discussions the program provided a comprehensive learning experience that effectively bridged conceptual understanding with technical competence.

The integration of these three instructional approaches aimed to deliver an inclusive and participatory learning process. The lecture demonstration discussion model proved successful in strengthening participants' understanding and technical competence in a cohesive manner. Overall, the program was implemented through three sequential phases. The preparation phase involved coordination with the school to identify training needs, determine relevant materials and schedules, and prepare the required tools such as agricultural drones, microcontrollers, IoT sensors, automated irrigation systems, and digital media for branding activities. Next, during the implementation phase, activities were carried out face to face, beginning with theoretical sessions followed by practical exercises that included drone operation, IoT-based irrigation installation, and digital branding simulations for edutourism. Finally, the evaluation phase assessed participants' engagement and comprehension of the training materials through pre and post tests as well as structured feedback surveys. These instruments allowed for systematic measurement of learning outcomes and participant satisfaction. To visualize the procedural framework, the methodological stages of the community service program are presented in a flowchart (Figure 1), illustrating the progression from preparation to implementation and evaluation, which collectively yield outputs and impacts for the partner institution.

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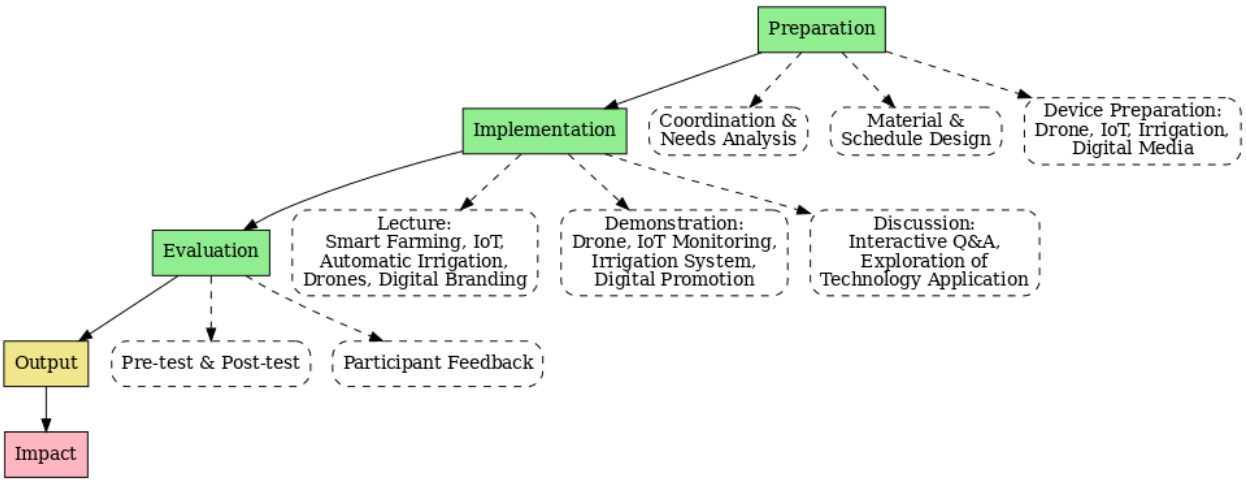

Figure 1. Flowchart of the Implementation Methodology

RESULTS

This community engagement initiative successfully designed and implemented an Internet of Things (IoT) based automatic irrigation system at SMKS Pesantren Alam Indonesia, located in Barru Regency, South Sulawesi. The main goal of the program was to introduce participants to modern agricultural technologies such as IoT applications and drone assisted farming, while simultaneously enhancing teachers competencies in utilizing appropriate technologies relevant to their vocational expertise. To offer a clearer understanding of the program's beneficiaries, Table 1 provides an overview of the demographic and professional characteristics of the participants involved in the activities.

Table 1. Characteristics of Participants in the Community Service Program

Description	Category	Frequency (N)	Percentage (%)
Participant Group	Teachers	10	33.3
	Students	20	66.7
Gender	Male	18	60.0
	Female	12	40.0
Age Range (years)	15–18	20	66.7
	23–26	10	33.3
Educational Background / Role	Vocational Agriculture Program	20	66.7
	Agricultural Education	10	33.3

The community service program was implemented through three stages: preparation, implementation, and evaluation. In the preparation stage, coordination was carried out with the school, followed by a needs assessment to identify teachers' prior understanding of IoT, 3D printing, and agricultural technologies. Three innovations were prepared during this stage. The first was the development of a hexacopter-based agricultural spraying drone designed for stability and efficiency, with components such as brushless motors, ESC, GPS, and microcontroller-based flight control systems (Al-Haddad et al., 2024). The second was the design of an IoT-based sprinkler irrigation system integrated with soil moisture sensors and ESP32 microcontrollers, enabling both automatic and manual control through a web-based application. The third was the development of a digital branding platform in the form of an edu-tourism website, designed to provide institutional profiles, product catalogs, multimedia content, and an online reservation system. This platform was also complemented by promotional materials such as digital brochures and videos to strengthen outreach.

Table 2. Description of Activities

Documentation Photo	Describtion
 	Development and preparation of an agricultural drone and the development results of the IoT controller for the irrigation system
 	Installation of the irrigation system in the greenhouse and the delivery of training materials on the utilization of IoT, agricultural drones, and digital branding
 	Training on the Operation of Agricultural Drones
	Digital Branding Training

The implementation stage was conducted over two days using lectures, demonstrations, and participatory practices. Participants were introduced to the basic concepts of IoT-based irrigation systems, which emphasized the importance of sensor integration for real-time data collection and automation in smart farming (Witczak & Szymoniak, 2024). IoT-based irrigation helps optimize resource utilization and supports sustainable agricultural practices (Abdelmoneim et al., 2025; J, 2024; Roy B.P et al., 2024; García et al., 2020). Agricultural drones were also introduced as spraying tools, highlighting their efficiency, precision, and safety benefits compared to manual spraying (Morales-Rodríguez et al., 2022; Nunes, 2023). While challenges such as regulatory barriers and weather dependency remain (Khanpara et al., 2024), the use of drones in vocational training provided hands-on skills and raised awareness about precision agriculture (Bastomi et al., 2025). Demonstration methods, as employed in this session, have been shown to enhance academic performance by linking theory to practice (Ogunlowo & Ajibade, 2024).

In addition, participants engaged in digital branding training focused on website management and online promotion strategies. The website was developed as a primary branding tool to broaden outreach and promote edu-tourism programs. Digital promotion through online platforms such as websites, SEO, and social media campaigns provides more cost-effective and interactive communication compared to conventional methods (Warmayana, 2018).

Moreover, the rise of the internet has significantly reshaped tourist behavior, as travelers who access information online are more likely to allocate higher spending on tourism related products and services (Musliha & Adinugraha, 2022). Consequently, digital branding has become a crucial factor in sustaining and advancing the long term growth of techno edutourism initiatives (Mandey et al., 2023; Cherti, 2024).

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The final phase involved an evaluation process that utilized pre-test and post-test instruments along with participant feedback surveys to measure both knowledge gains and satisfaction with the training activities. Findings from this stage indicated that the lecture demonstration discussion approach effectively improved participants technological literacy and hands on competencies. Moreover, the program contributed to strengthening the school's institutional capacity in integrating IoT applications, drone technology, and digital branding into its agricultural operations and educational initiatives (Rishikesavan et al., 2025).

The activity evaluation process was carried out comprehensively through the administration of pre tests, post tests, and participant feedback questionnaires. The pre and post tests were designed to assess participants comprehension of modern agricultural technology concepts and their practical applications, particularly in relation to IoT based automatic irrigation systems, the use of drones in farming, and digital branding strategies supporting the school's edu-tourism initiatives. In addition to measuring cognitive improvement, these assessments also aimed to capture shifts in participants attitudes and perceptions toward the introduced technologies throughout the training program.

Furthermore, the implementation team administered feedback questionnaires to gather participants perceptions of the introduced technologies, focusing on their relevance, practicality, and potential application within both teaching activities and agricultural practices at the school. The survey encompassed various aspects, including the clarity of the presented materials, participants enthusiasm toward the technologies, and their readiness to adopt these innovations in classroom learning and Teaching Factory settings. The responses revealed that most participants expressed favorable opinions, considered the training highly relevant to their professional needs, and showed strong motivation to initiate similar projects with their students in the future. For the evaluation process, a Likert scale (1–5) was used to map participants' levels of understanding and responses. The results of the pre-test and post-test are presented in table 3.

Table 3. Pre-test and Post-test Results

Program Achievement Indicators	Pre-test (%)	Post-test (%)	Improvement (%)
You understand/have an overview of the topics and materials delivered during the socialization and training sessions.	60	94	34
You understand/have an overview of Smart Farming & Digital Branding: The Techno-Eduwisata Pesantren Model for Sustainable Economic Empowerment.	58	90	32
You understand/know the tools and materials required in Smart Farming & Digital Branding: The Techno-Eduwisata Pesantren Model for Sustainable Economic Empowerment.	54	92	38
You are skilled in preparing the tools and materials to be used in Smart Farming & Digital Branding: The Techno-Eduwisata Pesantren Model for Sustainable Economic Empowerment.	50	92	42
You are proficient in applying Smart Farming & Digital Branding: The Techno-Eduwisata Pesantren Model for Sustainable Economic Empowerment.	40	94	54

Table 3 shows that participants experienced a significant improvement in knowledge and skills after participating in the Techno-Eduwisata Pesantren for Smart Farming and Digital Branding training program. The pre-test scores ranged from 40% to 60%, indicating limited prior understanding of the materials, while post-test results increased to 90–94% across all indicators.

The highest improvement (54%) occurred in participants' ability to apply Smart Farming and Digital Branding practices, followed by a 42% increase in preparing tools and materials. These results suggest that the practical, demonstration-based learning approach effectively

enhanced both conceptual and technical competencies. Meanwhile, the lowest improvement (32%) was observed in general conceptual understanding, which, although still substantial, indicates the need for continued exposure to the topic.

Overall, the data confirm that the training successfully strengthened participants' understanding, readiness, and confidence in implementing Smart Farming and Digital Branding innovations within the context of sustainable edu-tourism. Meanwhile, participants' satisfaction levels after the training are presented in Table 4.

Table 4. Participants Satisfaction Response

Statement	Average	Category
The training materials were in accordance with the needs of the participants/partners in managing the Edu-tourism Program of Pesantren Alam Indonesia	4,75	Very Agree
The training materials were highly beneficial and relevant to the needs of the participants/partners.	4,75	Very Agree
The training materials delivered were clear, concise, and easy to understand.	4,75	Very Agree
KThe training activities involved the active participation of the participants/partners.	4,75	Very Agree
The training sessions were interactive and not monotonous	4,75	Very Agree
The training activities provided satisfaction for participants during the sessions	4,75	Very Agree
Similar training activities are needed in the future.	5	Very Agree
Total Average	4,75	Very Agree

Overall, the data show that all statements related to the training activities at Edu-tourism Pesantren Alam Indonesia received very positive responses from participants, with an average score of 4.75 on each item, except for the last statement, which received a perfect score of 5 (Strongly Agree). This indicates that participants felt highly satisfied and strongly agreed with the implementation of the training.

In general, the survey results demonstrate that the Edu-tourism training program at Pesantren Alam Indonesia was highly successful and satisfying for participants/partners. All aspects of the training—ranging from the relevance of the materials to participants' needs (4.75), the usefulness of the content delivered (4.75), clarity and comprehensibility of presentation (4.75), active involvement of participants (4.75), an engaging and non-monotonous atmosphere (4.75), and participants' overall satisfaction during the training (4.75)—received highly positive ratings, with an average score of 4.75, indicating that participants strongly agreed with all these elements. In addition, participants unanimously rated the statement concerning the need for similar training in the future with the highest score of 5 (Strongly Agree), indicating a high level of satisfaction and enthusiasm for the continuation of such initiatives. This outcome demonstrates that the program effectively aligned with participants expectations, contributed substantially to the enhancement of Edutourism management at Pesantren Alam Indonesia, and fostered an engaging, meaningful, and interactive learning environment.

DISCUSSION

The analysis of the pre-test and post test results from participants in the training program "Implementation of Techno-Edutourism for Smart Farming and Digital Branding in Islamic Boarding Schools Toward a Sustainable Economy" revealed a substantial improvement in participants comprehension following the training sessions. As illustrated in table 2, the average pre test score categorized as Not Understood, suggesting that prior to the intervention, participants possessed limited knowledge of smart farming practices, IoT based irrigation systems, and digital branding concepts. This knowledge gap can be attributed to the lack of previous exposure to digital technologies and the minimal integration of such tools in agricultural

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learning within the pesantren context. After completing the training, the post test results indicated a marked increase in understanding, with the mean score categorized as Well Understood. This significant improvement demonstrates that the program successfully closed the gap between conceptual knowledge and practical application, fostering participants confidence and competence in applying modern technologies to manage edutourism initiatives at Pesantren Alam Indonesia. These findings are consistent with the study by Hadi, et al., (2024), which emphasized that demonstration based learning tends to produce more effective learning outcomes than discussion-based approaches, as it enables learners to gain direct, experiential insights that strengthen conceptual understanding. Moreover, this learning progression aligns with Kolb's Experiential Learning Theory, which underscores the role of concrete experience, reflective observation, abstract conceptualization, and active experimentation in promoting deep learning. Through these stages, participants not only grasped the material but also developed critical thinking and problem solving skills essential for advancing modern vocational education.

The improvement in participants comprehension reflects more than a mere cognitive advancement; it signifies a meaningful transformation in both technical proficiency and behavioral adaptability that are essential for sustainable development. The experiential learning process, which allowed participants to assemble IoT based irrigation controllers, operate agricultural drones, and manage digital branding platforms, provided a multidimensional educational experience that engaged both intellectual and practical dimensions of learning. This finding supports Budiarto et al. (2025), who argue that learning environments emphasizing participation and experience enhance knowledge retention and cultivate innovation oriented competencies. Within the framework of Human Capital Theory, these outcomes demonstrate that investing in vocational skill development generates long term advantages by increasing human productivity and adaptability to technological advancements. The improvement of technical expertise among teachers and students consequently contributes to the development of human capital that underpins the sustainability of rural economies (Rochman et al., 2023). Moreover, according to Rogers' Innovation Diffusion Theory, the successful adoption of smart farming and digital branding technologies during this training indicates that participants functioned as early adopters, facilitating the dissemination of agricultural innovation within their community. The measurable improvement between pre-test and post-test results, as shown in Figure 8, therefore reflects not only learning effectiveness but also the beginning of a knowledge diffusion process within the educational ecosystem.

The survey analysis results presented in Table 3 further strengthen the evidence of training success. Participants rated the training very positively, with an average satisfaction score across nearly all indicators covering relevance, usefulness, clarity, interactivity, and enjoyment while the statement regarding the need for similar training in the future received a perfect score. This high satisfaction level demonstrates that the training materials and methods were highly relevant to the participants' actual needs in managing edu-tourism programs. The high level of satisfaction can also be attributed to the participatory design process carried out before implementation. Through a structured needs assessment, the facilitators identified the gaps in knowledge and technical competencies among the teachers and students, ensuring that the program was contextually adapted and problem-oriented rather than theoretical. Such contextual alignment between participant needs and training content is one of the strongest predictors of training success (Rishikesavan et al., 2025). The participatory learning design adopted in this program combining lectures, demonstrations, and hands-on practice encouraged interaction and collaboration among participants. This interactive learning climate aligns with Knowles' andragogical principles, emphasizing that adult learners benefit from self-directed, experience-based learning processes. Teachers and students worked collaboratively, exchanged insights, and reflected on how the introduced technologies could be integrated into their school-based agricultural activities. This is consistent with the constructivist principle that knowledge is built through social interaction and meaningful engagement (Witczak & Szymoniak, 2024), further explaining the very positive participant responses observed.

Beyond the cognitive and affective outcomes, the training program also generated concrete, tangible impacts at the institutional level. The integration of IoT-based irrigation systems

and agricultural drones improved the efficiency, precision, and sustainability of greenhouse operations at Pesantren Alam Indonesia.

The findings demonstrate that incorporating technological innovation within the education sector can lead to tangible improvements in productivity, consistent with global evidence suggesting that smart farming practices enhance resource efficiency and promote sustainable agricultural systems (Abdelmoneim et al., 2025; Roy et al., 2024). The use of drone-based spraying technology further improved safety and operational performance by minimizing manual labor demands while ensuring environmental protection (Morales-Rodríguez et al., 2022; Nunes, 2023). In parallel, the digital branding component enabled participants to design professional websites and create online promotional content, thereby strengthening the school's reputation as an edutourism hub.

The evaluation results revealed an increase in both visitor numbers and sales of local products after the program, providing empirical evidence that the impact of the training extended beyond academic learning to generate real economic benefits. These observations are consistent with the conclusions of Warmayana, (2018) and Musliha & Adinugraha, (2022), who reported that digital branding strategies significantly enhance public engagement and profitability within tourism and agribusiness sectors. Collectively, these outcomes highlight that integrating digital technologies into vocational education fosters a synergistic relationship between knowledge acquisition and entrepreneurship, serving as a catalyst for sustainable local economic development.

From a wider perspective, the implications of this training extend beyond educational enhancement, influencing social, economic, and technological transformation within the local community. The integration of smart farming, IoT-based systems, and digital branding represents a holistic framework that connects innovation, learning, and sustainability. Smart farming contributes to increased productivity and environmental responsibility, digital branding broadens market accessibility and institutional reputation, while edu-tourism serves as a unifying platform that integrates these elements into a community driven development model. These interconnections reinforce the notion of techno edutourism as an ecosystem that simultaneously nurtures technological literacy, economic empowerment, and cultural continuity. Moreover, the institutional transformation resulting from this initiative demonstrates that vocational schools can evolve into centers of innovation, linking formal education with community based entrepreneurship. This finding supports the perspective of Mandey et al. (2023) and Cherti, (2024), who argue that technology integrated education plays a vital role in revitalizing rural economies through sustainable tourism development.

Within the broader framework of Indonesia's ongoing educational reform, this program aligns closely with the Merdeka Belajar Kampus Merdeka (MBKM) initiative, which promotes active engagement of higher education institutions in community development and applied innovation. The initiative also reflects the principles embedded in global agendas such as UNESCO's Education for Sustainable Development (ESD) and the United Nations Sustainable Development Goals (SDGs) notably Goal 4 on Quality Education, Goal 8 on Decent Work and Economic Growth, and Goal 12 on Responsible Consumption and Production. By positioning education as both a catalyst and a beneficiary of technological progress, the program underscores the critical role of vocational institutions in driving sustainable and inclusive growth. Furthermore, beyond its academic significance, this model exemplifies how strategic collaboration among universities, schools, and local communities can foster the co creation of innovative solutions that simultaneously address local issues and contribute to broader national and international sustainability objectives.

Overall, the discussion confirms that the training program was highly effective in delivering relevant, applicable, and transformative knowledge while fostering an engaging and participatory learning atmosphere. The improvements in comprehension, satisfaction, and institutional outcomes collectively validate the effectiveness of the program. More importantly, the initiative highlights the novelty of integrating techno-edutourism and smart farming within a pesantren-based framework an approach that not only enhances educational quality but also contributes directly to economic sustainability. This community service initiative can serve as a scalable and adaptable model for other educational institutions aiming to integrate learning, technology, and

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entrepreneurship within their programs. Over time, such integration has the potential to enhance local innovation capacity, empower rural populations, and make a meaningful contribution toward realizing Indonesia's broader vision of sustainable and inclusive development while also resonating with global sustainability efforts.

CONCLUSIONS

From the implementation of the community service initiative titled "Implementation of Techno-Edutourism for Smart Farming and Digital Branding in Islamic Boarding Schools Toward a Sustainable Economy", it can be inferred that the program effectively met its intended objectives and outcomes. The training sessions not only improved participants understanding and practical competence in smart farming and digital branding, but also created an engaging and participatory learning environment that promoted active involvement. These achievements highlight the potential of pesantren based vocational institutions to evolve into techno-edutourism hubs that integrate education, technology, and entrepreneurship within a sustainable development framework. One of the primary challenges faced during implementation was the limited duration of activities, which restricted deeper exploration of the training content. However, this constraint was mitigated through the application of effective instructional strategies and structured delivery methods. To ensure the continuity and long term impact of the initiative, it is recommended that similar training programs be organized periodically with an expanded range of topics particularly those addressing emerging innovations in smart farming and digital branding. In addition, ongoing mentoring and systematic evaluation are crucial to strengthen institutional capacity and maintain the program's ability to generate lasting educational, social, and economic benefits for both the school and the broader community.

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ETHICAL CONSIDERATIONS

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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