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SINERGISTA (Agrotourism Synergy): A Sustainable Tourism Development Strategy Based on Digitalization Through the Pentahelix Collaboration Model to Support the 2030 SDGs

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ABSTRACT

Sustainable tourism is a key pillar in achieving the Sustainable Development Goals (SDGs) 2030. This study introduces SINERGISTA (Sinergi Agrowisata) as a digital-based sustainable tourism development strategy through a Pentahelix Connectors collaboration model involving government, academia, business actors, communities, and media. The objective of this research is to formulate an implementable strategy for digital-based agrotourism development aimed at enhancing economic, social, environmental, and cultural value in a sustainable manner. This study employs a descriptive-exploratory approach through in-depth interviews, field observations, and documentation studies on leading agrotourism destinations in Indonesia. Findings reveal that integrating digitalization into marketing platforms, reservation systems, and virtual reality promotions expands market reach, increases tourist engagement, and facilitates transparent destination management. Moreover, the Pentahelix Connectors collaboration is proven effective in reinforcing synergy among stakeholders in promoting service innovation, improving human resource capacity, and fostering participatory environmental management. Strategic recommendations include strengthening digital literacy among agrotourism actors, ensuring regional government policy support, and providing inclusive and adaptive technological infrastructure.

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1. INTRODUCTION

Indonesia is an agrarian country endowed with abundant natural resources. The availability of extensive land presents a great prospect for developing various businesses, particularly in the agricultural sector. This condition can be leveraged to strengthen the national economy by integrating agronomy with tourism, which can subsequently be developed into the concept of agrotourism. Tourism is one of the largest and most powerful sectors in the global economy. This is due to its capacity to

generate significant foreign exchange revenue for countries and create vast employment opportunities [1], [2]. According to the United Nations World Tourism Organization (UNWTO), the tourism sector contributes approximately 9% of the global GDP [3]. The rapid growth of the tourism industry undoubtedly brings positive impacts, particularly to the economy. However, it also entails negative consequences such as environmental degradation, cultural erosion, and social inequality [4]. These challenges have given rise to new tourism concepts that are environmentally friendly and sustainable, such as agrotourism [5]. Agrotourism has increasingly emerged as an important domain, where sustainable and eco-friendly tourism has become a central priority [6]. Nevertheless, achieving these objectives requires effective strategies for developing agrotourism. In addition, the rapid advancement of globalization and information technology poses complex challenges for the tourism sector.

The development of agrotourism is inseparable from collaboration among tourism stakeholders. Yet, despite the millions of agrotourism destinations across Indonesia, many remain underdeveloped and underexposed [7]. The reasons for this underutilization can be traced to systemic challenges within the tourism sector, including supply-side constraints (product-driven orientation), limited market understanding (market-driven orientation), institutional barriers, inadequate policy support, and the suboptimal partnership between government and the private sector [8], [9]. To effectively and efficiently foster sustainable agrotourism while overcoming these obstacles, collaboration among diverse stakeholders—including government, local communities, academia, businesses, and non-governmental organizations—is essential. This collaborative framework is conceptualized as the Pentahelix Connectors model.

The Pentahelix Connectors illustrate the synergistic relationship among the five stakeholders, working together to achieve the goals of sustainable agrotourism development. Strong collaboration among these actors can yield holistic policies and actions that integrate economic, social, and environmental interests [10]. Building upon the Pentahelix Connectors model, digital innovations—particularly application-based platforms—are crucial to enhance accessibility and connectivity among government, tourism industries, communities, academia, and media.

The Sinergista application, which is the focus of this discussion, embodies the synergy of agrotourism in advancing sustainable tourism, strengthened by the use of digital technologies. This strategy is grounded in the implementation of digitalization within sustainable tourism development. Through the Sinergista application, comprehensive information regarding agrotourism will be made available, including development needs, activity monitoring, maps, funding requirements for business actors, and updated information on agrotourism destinations. All these can be easily accessed by stakeholders.

Overall, the Sinergista strategy, facilitated by digitalization, aims to create sustainable agrotourism that values local wisdom, enhances economic opportunities, strengthens synergy among the five Pentahelix Connectors, and supports the realization of the Sustainable Development Goals (SDGs) 2030. By implementing collaboration and harnessing digital technologies, the development of agrotourism destinations is expected to become more efficient, inclusive, and sustainable.

2. LITERATURE REVIEW

The development of sustainable tourism has become a global issue that has received wide attention, in line with the increasing awareness of the importance of environmental conservation, social empowerment, and inclusive economic growth [11]. This concept emphasizes the balance between ecological, social, and economic interests in every tourism activity. Sustainable Tourism Development (STD),

according to [12], refers to the effort of developing tourist destinations by considering social and ecological capacities through participatory and accountable policies. Thus, sustainability becomes the primary focus in designing destination development strategies. In the context of Indonesia, agrotourism is one of the subsectors with significant potential in supporting region-based development, particularly in agricultural and rural areas [13]. Agrotourism integrates agriculture and tourism sectors to generate dual added value.

According to [14], agrotourism is not only a means of recreation but also education and community empowerment, thereby increasing local income and preserving agrarian culture. Therefore, multi-stakeholder collaboration is essential in developing agrotourism. The Pentahelix model is a collaborative approach involving five key elements: government, academics, business, community, and media [15]. The synergy of these five actors plays a crucial role in ensuring the success of development programs. The Pentahelix collaboration is increasingly relevant in tourism development as it involves all stakeholders in the processes of planning, implementation, and evaluation [16]. This strengthens social legitimacy and reinforces destination sustainability.

The government holds a strategic role in providing regulations and policies to support technology-based agrotourism development [17]. The involvement of local governments is particularly vital in the provision of infrastructure and public facilities. Academics contribute by providing scientific knowledge and applied research to generate innovations in product development and destination governance systems [18]. Academic support facilitates the creation of tourism roadmaps based on data. The business sector plays an important role in providing investment, managing destinations, and marketing tourism products to domestic and international markets [19]. Business actors can expand networks and enhance economic value.

The community or local society represents the primary actor in preserving cultural values and local wisdom while also serving as direct beneficiaries of agrotourism development [3]. Community participation becomes a key parameter for empowerment-based development success. Media functions as a channel of information and destination promotion through both conventional and digital platforms [20]. Media also creates a strong destination image that attracts tourists. Digitalization represents an unavoidable transformation in modern tourism [21]. Information and communication technologies accelerate access to destination information, reservation services, and virtual-based tourist experiences.

According to [22], digital tourism involves the use of online platforms such as websites, applications, social media, and VR/AR to enhance customer experience. These technologies strengthen engagement between tourists and service providers. In agrotourism development, the use of digital platforms enables broader and more efficient promotion while also providing consumer insights through big data [23]. This supports business actors in making more targeted decisions. The study by [24] shows that digital integration can improve visitor flow management, prevent over tourism, and preserve environmental sustainability. Therefore, digitalization is a fundamental pillar of sustainable destination development.

The 2030 Sustainable Development Goals (SDGs) position tourism as a sector that contributes to poverty alleviation, welfare improvement, gender equality, infrastructure development, and climate action [25]. Agrotourism aligns with these goals. It supports SDG 1 (No Poverty) by creating new employment opportunities for rural communities [26], while also strengthening local supply chains to ensure inclusive economic circulation. In the context of SDG 5 (Gender Equality), agrotourism provides employment opportunities for women in hospitality, handicrafts, and local culinary sectors [27]. Women's empowerment is a vital indicator of sustainable destinations.

SDG 8 (Decent Work and Economic Growth) is reflected through agrotourism's contribution to regional GDP and the creation

of micro, small, and medium enterprises [28]. Beyond economic aspects, environmental goals (SDG 13, 14, and 15) remain critical in agrotourism development. Soil, water, and biodiversity conservation practices must be applied to ensure sustainability. Sustainable agrotourism strategies require a holistic approach that prioritizes not only profit but also planet and people, in line with the Triple Bottom Line [29]. This ensures the achievement of long-term destination goals.

The application of digital technologies in destination marketing can enhance competitiveness through strong brand positioning [30]. Digital branding builds tourist trust in destination service quality. According to [31], digital marketing in tourism effectively reaches millennial and Gen Z markets through creative social media content, increasing interest in experience-based travel. Research by [32], demonstrates that the adoption of virtual tours and augmented reality in agrotourism destinations can create pre-experiences that influence visit decisions, thus enhancing tourist excitement.

However, the primary challenges of digitalization in agrotourism include limited digital literacy among local communities, insufficient internet access, and a lack of technological human resources [33]. Therefore, capacity building becomes essential. The SINERGISTA model emerges as a solution by integrating Pentahelix collaboration and digital tourism to optimize sustainable agrotourism development [34]. Through Pentahelix synergy, digital service innovations can be collaboratively developed to overcome cross-sectoral limitations. For instance, governments provide infrastructure, academics deliver training, businesses manage platforms, communities safeguard local culture, and media promote destinations.

The success of this strategy depends on strong commitment, coordination, and communication among stakeholders [35]. Without integrative collaboration, destination development risks stagnation. Furthermore, regular monitoring and evaluation are necessary to ensure the relevance of strategies amid the dynamics of technology, markets, and the environment [36]. Adaptation becomes the key to program sustainability. Thus, SINERGISTA has the potential to serve as a digitalization-based sustainable agrotourism development model that can be replicated across various regions in Indonesia, contributing concretely to the achievement of the 2030 SDGs.

3. METHODS

This study employs a descriptive qualitative approach to illustrate strategies for developing sustainable agrotourism based on digitalization through the Pentahelix collaboration model. A qualitative approach was selected as it is considered suitable for capturing social and cultural dynamics as well as stakeholder interactions within the context of tourism development. The primary focus of this research is an in-depth analysis of stakeholder engagement in the Pentahelix Connectors model and the application of digitalization in agrotourism development.

The research location was purposively selected from leading agrotourism destinations in Indonesia that have adopted elements of digitalization and multi-stakeholder collaboration. The criteria for location selection included: (a) active agrotourism potential, (b) support from local government, (c) implementation of at least one form of digital innovation in promotion, and (d) active involvement of local communities. The main data collection technique was in-depth interviews with stakeholders representing government, academia, business, community, and media.

Semi-structured interviews were conducted to flexibly explore detailed information regarding the implementation of agrotourism development strategies. Government informants included representatives from tourism offices, agricultural offices, and officials responsible for rural tourism development. Academic informants consisted of tourism experts, agricultural researchers, and lecturers specializing in digital technology and community empowerment.

Business informants included destination managers, tourism-related MSME actors, and IT operators involved in agrotourism destinations. Community representatives interviewed comprised local leaders, tourism awareness groups (pokdarwis), and youth organizations actively engaged in agrotourism development. Media representatives included local journalists, destination social media administrators, and content creators promoting the destination.

In addition to interviews, participatory observation was conducted by directly observing destination activities, digital facilities, and tourist interactions. The purpose of observation was to capture the actual context in the field, including the physical condition of destinations, the use of digital technologies, and forms of collaboration among actors. Documentation was also utilized to complement data, such as destination development plans, regional medium-term development plans (RPJMD), activity reports, and digital promotional materials.

Data analysis was conducted using the interactive model of [37], consisting of three stages: data reduction, data display, and conclusion drawing. Data reduction involved selecting relevant information from interviews, observations, and documentation that aligned with the research focus. Data display was carried out in the form of matrices, category networks, and descriptive narratives to facilitate understanding of inter-variable relationships.

Conclusion drawing was conducted inductively to identify findings related to patterns of Pentahelix collaboration and effective digitalization strategies. To ensure data validity, this study applied source triangulation, method triangulation, and theoretical triangulation. Source triangulation was achieved by comparing information across informants from the five Pentahelix elements. Method triangulation was carried out by combining interviews, observations, and documentation to obtain a comprehensive picture. Theoretical triangulation was applied by referring to theories of sustainable development, digital tourism, and multi-stakeholder collaboration.

Dependability was maintained through audit trails, tracing the entire research process from design to conclusion drawing. Confirmability was safeguarded to ensure that findings remained objective and free from researcher bias, with interview recordings and documentation stored as authentic evidence. Data collection was conducted over a three-month period to ensure both the depth of information and continuous observation of strategy implementation. Research ethics were upheld by obtaining informed consent from each informant and guaranteeing confidentiality of informant identities.

Following comprehensive data collection, open coding was conducted to identify key emerging themes. These main themes were further developed into subthemes aligned with the research objectives, particularly regarding the forms of Pentahelix collaboration and the application of digitalization in agrotourism development. Ultimately, the results of the analysis were presented in a descriptive-analytic form to provide a comprehensive overview of the SINERGISTA strategy as a sustainable agrotourism development model in support of the 2030 Sustainable Development Goals.

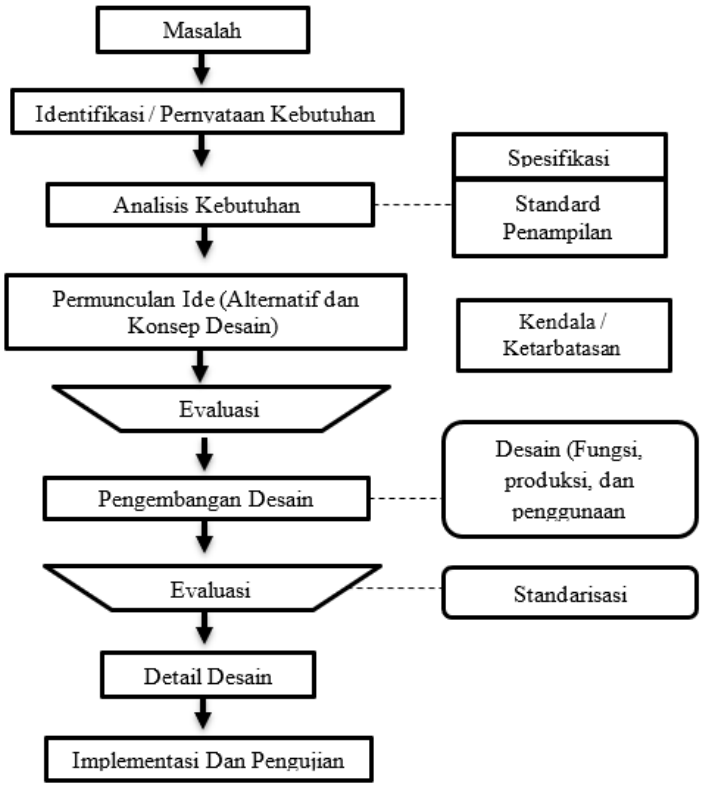

Figure 1. Conceptual Framework for the Development of the Sinergista Application

4. RESULT AND DISCUSSION

4.1 Overview of Agrotourism Potential

The global shift in tourism concepts towards special interest tourism, known as agrotourism, presents a significant opportunity for countries like Indonesia, which is endowed with extraordinary natural resources. This shift has occurred as a result of the increasing tendency of tourists to visit destinations based on natural attractions and local cultural heritage [38]. Indonesia possesses both high agrotourism potential and rich local wisdom, making it highly suitable for further development.

The concept of agrotourism represents an effort to develop agricultural potential into tourism attractions, whether in the form of natural landscapes of agricultural areas or the distinctive cultural practices of farming communities. Agrotourism links natural travel experiences with conservation and environmental stewardship values [39]. At the same time, it is also directed at preserving local cultural identity [40]. Thus, agrotourism is inseparable from efforts in conservation, local economic empowerment, enhancing respect for cultural diversity, and increasing community participation in management [35]. This is what differentiates agrotourism from conventional tourism models that have existed previously.

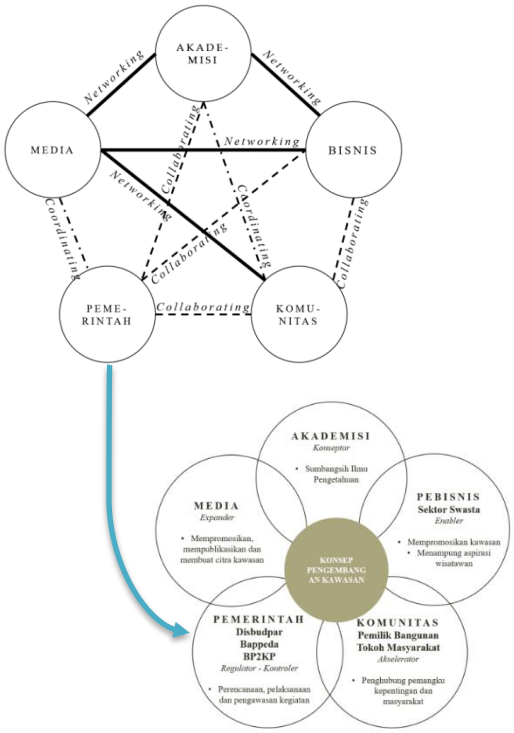

Figure 2. Pentahelix Model Scheme

4.2 *Concept of Sustainable Tourism Development*

The purpose of tourism development is not solely to promote economic growth but also to conserve nature and the environment. While tourism development contributes positively to macroeconomic growth, it often also generates negative social and ecological impacts [41]. Ideally, tourism industry development should adhere to the principle of environmental conservation, as stipulated in Article 5(d) of Law Number 10 of 2009 on Tourism [42]. These challenges have prompted the emergence of new tourism concepts that emphasize sustainability and environmental friendliness.

Sustainable Tourism Development (STD) emerged to address the negative impacts of tourism growth. One form of tourism product derived from this concept is agrotourism development [43]. Sustainable tourism based on agrotourism emphasizes sustainability elements within the tourism industry to reduce negative externalities arising from its rapid growth. Moreover, sustainable tourism highlights the active involvement of local communities to enhance their welfare [44]. In this regard, sustainability encompasses not only environmental issues but also economic, social, cultural, quality, health, safety, and long-term aesthetic considerations [45], [46]. Agrotourism, as a sustainable tourism model, fulfills the needs of travel activities while ensuring the preservation of environmental and socio-cultural sustainability at the destination.

4.3 *The Role of Pentahelix Connectors in Agrotourism Development*

Innovation plays a vital role in enhancing agrotourism development. The realization of innovation requires participation from multiple stakeholders to achieve common goals, particularly in tourism sector development [47]. Such support and participation are often described through the concept

of helices, which continue to evolve in response to societal changes [48]. The development of agrotourism destinations cannot stand alone but requires strategies of mutual support and collaboration.

The success of sustainable tourism development must be supported by collaboration among all agrotourism stakeholders, embodied in the Pentahelix Connectors model. This concept represents a collaborative framework that sustains multiple activities such as tourism, economy, and business in a sustainable manner [49]. It emphasizes collaboration between academics (education), business (industry), community, government, and media [50]. Such collaboration strengthens and expands alliances with stakeholders. The implementation of the Pentahelix model is indispensable for developing agrotourism destinations, as it facilitates coordination, program execution, and evaluation. Pentahelix strategies among tourism actors are therefore essential for implementing agrotourism destination development.

4.4 Sinergista Innovation as an Agrotourism Strategy Supporting the 2030 SDGs

The use of advanced information and communication technologies offers new opportunities in developing sustainable agrotourism by fostering synergy among various stakeholders [51]. The Sinergista concept embodies synergy in agrotourism for sustainable tourism development, reinforced by digital technologies. Sinergista enhances efficiency, accessibility, and connectivity among government, tourism industries, local communities, academia, and media—the five key actors within the Pentahelix Connectors model. This integration facilitates better decision-making in agrotourism development.

The benefits and advantages offered by Sinergista are crucial in supporting the achievement of several Sustainable Development Goals (SDGs) 2030 through sustainable agrotourism development. Sinergista generates new economic opportunities in rural areas, thereby stimulating local economic growth and creating decent employment opportunities for local communities, in line with Goal 8 (Decent Work and Economic Growth). In addition, Sinergista supports land and ecosystem conservation by facilitating environmentally friendly farming practices, ultimately contributing to biodiversity and terrestrial ecosystem preservation in accordance with Goal 15 (Life on Land). Furthermore, Sinergista functions as a collaborative platform that integrates diverse stakeholders—government, private sector, and society—to work collectively toward achieving sustainable development, thus contributing to Goal 17 (Partnerships for the Goals).

Table 1. SMART Analysis of SINERGISTA

SMART Analysis
Spesific
The specific objective of the Sinergista application is to support the development of sustainable agrotourism through the implementation of digitalization-based strategies and the Pentahelix Connectors collaboration model. The application aims to facilitate synergy among government, local communities, businesses and industries, academics, and non-governmental organizations in achieving agrotourism sustainability. In addition, Sinergista serves as a solution that enables easy

access to comprehensive information about agrotourism destinations, activities, and natural resources for the public as visitors.
Measurable
The success of the Sinergista application can be measured through various indicators, such as the number of active users engaged with the application, the level of community participation in agrotourism projects, the degree of sustainability achieved in destination development, the increase in public awareness regarding the importance of sustainable agrotourism, and the positive impacts on both the environment and local communities.
Achievable
The concepts and strategies proposed in the Sinergista application must be feasible to implement with the resources available and in a cost-effective manner. Collaboration among stakeholders and the application of appropriate digital technologies ensure that the development of this application remains both attainable and affordable.
Relevant
The Sinergista application is highly relevant to the needs and challenges in developing sustainable agrotourism. The adoption of digitalization-based strategies and the Pentahelix Connectors collaboration model represents a relevant and effective approach to achieving these objectives.
Time-bound goals
The Sinergista application should be guided by clearly defined timelines for achieving its intended goals. Each stage of the application's development and implementation must adhere to specific deadlines to ensure timely achievements and allow for continuous monitoring and evaluation of progress.

Table 2. SWOT Analysis of SINERGISTA

Kekuatan (*Strenght)*	**Kelemahan (*Weakness*)**
1. The synergy approach in agrotourism provides advantages in integrating diverse stakeholders to achieve common goals in the development of sustainable agrotourism. 2. It facilitates close cooperation among government, local communities, businesses and industries, academia and research, as well as non-governmental organizations, thereby strengthening integration and effectiveness in agrotourism development. 3. The adoption of the Local Genius 6.0 concept enables agrotourism development that focuses on leveraging local wisdom and cultural heritage. 4. The unique natural resources of a region serve as a foundation for building distinctive agrotourism experiences. 5. The utilization of digital technology within the application allows for accessible information, effective marketing, and more efficient destination management. 6. The application is designed to be user-friendly with an engaging interface.	1. In practice, challenges may arise in terms of coordination, communication, and the division of responsibilities. 2. The multitude of features designed may result in difficulties in implementation as planned.
S-O Strategies	**W-O Strategies**
Optimizing features to be user-friendly and engaging in order to enhance public understanding of application usage, while also integrating functions that ensure the protection of user data.	Applying the Participatory Learning and Action (PLA) method to strengthen community understanding and capacity in adopting digital technologies.

S-T Strategies	W-T Strategies
Optimizing features to be user-friendly and engaging in order to enhance public understanding of application usage, while also integrating functions that ensure the protection of user data.	Applying the Participatory Learning and Action (PLA) method to strengthen community understanding and capacity in adopting digital technologies.

Table 3. Benefit Analysis

No	Indicator	Description
1.	**Tourism Aspect**	The implementation of the Sinergista application is expected to serve as a strategy to strengthen the agrotourism sector. The growth of agrotourism can create both direct and indirect employment opportunities for local communities. Sinergista can facilitate the development and management of sustainable agrotourism destinations, thereby providing job opportunities for local residents.
2.	**Economic Aspect**	Through collaboration with local stakeholders, the Sinergista application can help direct the economic benefits of tourism toward local communities. This can increase income levels and improve the standard of living, while also stimulating the development of local businesses. Agrotourism development further contributes to income diversification in regions previously dependent on a single economic sector. By leveraging agrotourism potential through Sinergista, such regions can reduce their reliance on sectors vulnerable to fluctuations.
3.	**Educational Aspect**	The Sinergista application can provide educational content for both tourists and local communities on sustainability and the importance of environmental protection. This can raise environmental awareness and promote responsible actions toward nature. Additionally, Sinergista can deliver information and educational materials about local culture and history at agrotourism destinations. Tourists can learn about traditions, customs, arts, and unique cultural heritage, thereby fostering greater understanding and appreciation of cultural diversity.
4.	**Environmental Aspect**	The Sinergista application can promote environmentally responsible agrotourism practices. Users can access information about environmental management, natural resource conservation, and ecosystem preservation at agrotourism destinations. Through digital-based strategies, Sinergista can also help reduce negative environmental impacts, such as excessive paper use or pollution resulting from poorly managed tourism activities.

4.5 Features of the Sinergista Application

Aplikasi Sinergista (Sinergi The Sinergista (Synergy Agrotourism) application is an Android-based virtual tourism platform designed not only as a medium for collaboration among stakeholders (Pentahelix Connectors) in agrotourism, but also as a promotional tool to showcase and highlight the beauty of tourism destinations across Indonesia.

Figure 3. Illustration of the SINERGISTA Application

Figure 4. Types of Tourists Based on Environmental Interests

Sinergista integrates Augmented Reality (AR) technology to enhance the visual experience of the application, enabling a more optimal introduction to agrotourism areas. Several key features of the application include:

1. Kolaborakyat Feature

   The Kolaborakyat feature embodies the essence of collaboration, serving as the central communication hub among stakeholders within the agrotourism ecosystem. Through this feature, stakeholders can submit questions, provide feedback, report issues, or share ideas with government representatives and other actors. In turn, governments and stakeholders can openly communicate with the community, gather insights from multiple perspectives, and take appropriate actions to support agrotourism development.

2. EcoEvent Planner Feature

   This feature supports the planning and organization of events and research activities. It provides a platform for users—such as students, communities, or

agrotourism entrepreneurs—to submit proposals for events or projects requiring financial support. Sponsors and financial institutions can browse submitted proposals and consider supporting projects aligned with sustainability values and agrotourism objectives.

3. EcoNews Feature

   Serving as an agrotourism information hub, this feature allows users—particularly media stakeholders—to publish news and updates on events or projects. Users can share event details, objectives, schedules, and locations. This facilitates media coverage and dissemination of information related to agrotourism, while also raising public awareness and promoting activities widely.

4. EcoVirtual Experience Feature

   This feature offers users a virtual experience of agrotourism destinations. It allows them to explore sites through a combination of photos, videos, and sound effects. Users can virtually enjoy the natural beauty, cultural richness, and environmental uniqueness of agrotourism destinations.

5. CONCLUSION

Sustainable agrotourism development entails an approach that is ecologically viable, economically feasible, and ethically and socially just for local communities. Such development can only be realized through effective collaboration (good governance) that involves active and balanced participation from government, private sector, and communities.

Overall, the Sinergista strategy, facilitated through digitalization, seeks to create and strengthen synergies among the five Pentahelix Connectors, contributing directly to the achievement of the 2030 Sustainable Development Goals—particularly Goal 8 (Decent Work and Economic Growth), Goal 15 (Life on Land), and Goal 17 (Partnerships for the Goals).

Sinergista is envisioned as an effective medium to enhance connectivity in collaborative governance, aligning the roles and functions of agrotourism stakeholders. In addition, the application provides opportunities to expand new businesses in geographically dispersed locations, creating diverse job opportunities. Importantly, it enables visitors to gain a more interactive and comprehensive understanding of the uniqueness and beauty of the environment, fostering appreciation and stewardship.

By adopting and utilizing digital technologies, the development of agrotourism is expected to become more efficient, inclusive, and sustainable.

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