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Reflection-based community learning design for sustainable ecotourism: Integration of design thinking and indigenous climate education in digital-social agrotourism

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Abstract

The development of sustainable ecotourism that integrates design thinking and indigenous Climate education in Digital-Social Agrotourism is supported by the important role of reflection-based community learning design. The community in this study is a reflective actor who actively designs and manages the adaptive and participatory learning process. Key elements in learning design implemented through cross-stakeholder collaboration, including learning facilitators, local governments, creative industry players, and indigenous peoples, are case studies to be analyzed. Thematic analysis focusing on in-situ and post-implementation reflection identifies challenges and opportunities in the community learning process, such as integrating digital technologies, preserving local wisdom, and adaptation to climate change. The development of social innovation capacity and ecotourism management that is ecologically and socially sustainable will also be supported by community reflection. The results of this study highlight the importance of facilitator capacity building and ongoing collaboration in supporting a responsive and inclusive community learning ecosystem. The implications of this research can guide the development of community learning models and ecotourism support policies based on digital technology and local wisdom in the future.

Keywords: Community learning, Digital-social agrotourism, Indigenous climate education, Sustainable ecotourism.

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Institutional Review Board Statement: Ethical review and approval were waived for this study because it is a non-interventional, minimal-risk evaluation of a community learning design in ecotourism that collected only anonymized, non-sensitive data and involved standard educational/workshop activities without clinical procedures or biological specimens. The Institutional Review Board (Komite Etik Penelitian) of Universitas Negeri Malang issued an Ethical Exemption (Keterangan Layak Etik) for this protocol (Letter No. 19.06.13/UN32.14.2.8/LT/2026), valid from 19 June 2025 to 19 June 2026. The study followed widely accepted ethical principles for human research and community engagement, including respect for persons and the FPIC (Free, Prior and Informed Consent) principles for Indigenous communities. Documentation can be provided to the editorial office upon request.
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1. Introduction

Multidimensional challenges such as climate change and environmental degradation demand community protection strategies that can foster reflective awareness and critical decision-making skills related to ecological sustainability [1]. Sustainable ecotourism in this context is not only a tourism activity, but also an educational and economic empowerment instrument that combines nature conservation, strengthening cultural identity, and local livelihoods [2]. Combining this approach with the principles of design thinking (DT), which focuses on creative problem-solving based on empathy towards the user and the local context, would be a powerful approach [3]. The development of DT-integrated ecotourism will encourage communities to design innovative solutions relevant to socio-cultural conditions and adopt Indigenous Climate Education that places local wisdom as the main foundation of sustainability [4].

This great potential still faces several obstacles, especially in implementing community-based reflective learning models. The majority of ecotourism programs focus only on economic aspects and tourism promotion, while the dimensions of critical education, environmental ethics, and locally-based climate knowledge are less paid attention [5]. Then, there are still a few learning initiatives that incorporate digital technologies to expand socio-environmental impacts, even though the literature shows that technology can act as an effective bridge for interaction, promotion, and documentation [6]. In addition, the challenges faced are also related to the issue of equitable distribution of ecotourism benefits, especially for vulnerable groups or indigenous peoples who are often on the periphery of the mainstream of tourism development [7].

Within this scope, the role of local communities is expected to be operational managers as well as learning experience designers who can integrate reflective learning elements into their educational tour packages [8]. Strengthening knowledge in learning curriculum planning, facilitating the collective reflection process, and utilizing digital technology to enrich educational narratives needs to be done because community capacity is often still limited to technical management and tourism services [9]. Key factors in optimizing the role of the community in the domain are non-formal education, continuing training, and long-term mentoring [10].

Digital transformation not only opens up opportunities but also becomes a challenge in itself. On the one hand, social media, online platforms, and interactive technology can support the promotion and dissemination of educational messages with a wider scope [11]. On the other hand, limited infrastructure, digital literacy, and adaptation to new communication patterns are obstacles that are often faced in the adoption of technology in rural communities [12]. Indigenous Climate Education acts as a balancer to ensure digital innovation does not erode traditional cultural values and ecological knowledge, but rather strengthens its integration. The key to creating authentic and contextual sustainability models is reflective collaboration that blends modern technology with traditional practices [13].

This research enriches the literature on ecotourism and community education, focusing on integrating design thinking and indigenous education as a reflection-based learning framework. Previous research that has been used has discussed the potential of ecotourism as an environmental education tool [14] and the role of local wisdom in climate change mitigation [15] but exploring how communities can actively design learning experiences that utilize digital technology for social, cultural, and environmental sustainability goals has not been widely researched. Therefore, this research aims to answer the gap by asking the question: What challenges and opportunities arise in community reflection related to digital-social-based sustainable ecotourism learning practices and management?

This article has a structure that begins with a background, which explains the design thinking framework, the concept of indigenous climate education, and the principles of reflective learning in the context of sustainable ecotourism. The method is a section that describes the background of the case study, participant profile, learning project design,

implementation of activities, and data collection and analysis techniques. The findings presented the main themes of the community reflection analysis, which included the dynamics of the role as learning facilitators, technology integration strategies, and synergy between local wisdom and digital innovation.

The three contributions produced in this study are first, strengthening the role of the community as a reflective learning designer in ecotourism, so that it becomes a tourism provider and an agent of environmental education. Second, it introduces a model combining design thinking and indigenous education to design digital-social-based ecotourism programs relevant to the local context. Third, compile key learning design elements to guide communities in developing and facilitating sustainable ecotourism experiences that impact ecological awareness, social empowerment, and cultural preservation.

Therefore, this research provides an academic contribution to community-based education and sustainability and provides a practical framework for various communities worldwide to adapt to environmental and social challenges in the era of climate change and digital transformation.

2. Background

2.1. Design Thinking as a Framework in Digital-Social Ecotourism

Design Thinking (DT) is a structured approach that is used to solve problems creatively and collaboratively by involving various cognitive and affective processes, skills, methods, and certain mindsets [16]. In the scope of Digital-Social Agrotourism, DT is an effective system for designing human-centered ecotourism programs, paying attention to important things such as the needs of visitors, local communities, and the environment in a balanced manner [17].

Community learning by implementing DT allows facilitators and community members to start the process from the empathy stage to understanding cultural values, local wisdom, and environmental challenges. Next, a method is defined to formulate the main problems ecotourism faces, such as limitations in accessing technology or knowledge gaps about climate. Furthermore, the ideate stage will foster creative ideas integrating important components such as digital technology, indigenous knowledge-based educational strategies, and tourism service innovation. The prototyping stage will design learning modules, interactive digital media, or educational tour packages that combine hands-on experience in the field. The test and reflection stage is the last stage used to measure the program's effectiveness, including visitor acceptance and benefits to the community [18].

Non-linear and adaptive are DT [19] These are relevant to dynamic tourism conditions, where environmental conditions, technology, and visitor preferences vary. Therefore, to help ensure that each member understands the flow of innovation, increases a sense of belonging, and encourages social, cultural, and ecological sustainability, a visualization of the DT process in community training is carried out [20].

2.2. Indigenous Climate Education in Sustainable Ecotourism

In Indigenous Climate Education (ICE)'s integrated community-based social digital ecotourism program, facilitators must answer fundamental questions—why, what, how, with whom, where, and when learning is conducted—to ensure meaningful and culturally relevant learning experiences [21]. Socio-cultural, ecological, and technological dimensions that are interrelated, as well as placing local wisdom as the main foundation for knowledge transfer, must be considered in the design to be prepared [22]. Deep empathy for the participants' backgrounds, both from indigenous peoples, ecotourism actors, and visitors, is very necessary, so that learning can be informative and transformative [23].

Many conceptual designs and design principles of local knowledge-based learning have been developed to support the integration of ICE in sustainable ecotourism [24]. One example, a participatory approach adapted from [25]. Can be used to ensure the authentic involvement of local communities in designing and implementing programs. Five dimensions can encourage two-way knowledge exchange between indigenous peoples, tourism managers, and tourists: meaningful, effective, contextual, political, and educational. Within this scope, the political dimension includes the recognition of traditional knowledge ownership rights, while the contextual dimension ensures that learning content is in harmony with local ecological and social conditions [26].

Three important elements identified by Busch, et al. [27] and relevant to ICE learning in the field are experimental activities, real-world applications, and characterized consequences. Experimental activities include traditional farmland conservation practices, while real-world applications connect participants to local climate challenges, such as seasonally adaptive planting patterns [28]. An explanation of the ecological and social consequences of the intervention helped participants understand the long-term impact on the environment and community well-being [29]. The key to the success of this program lies in the alignment between learning objectives, field activities, and communication strategies.

ICE's learning design must also support locally-based reflection and experimentation. Multisensory learning—observing natural changes, feeling soil textures, and tasting crops—can increase emotional and cognitive engagement [30]. The implementation of inquiry-based learning will provide an opportunity for participants to try, experience failure, and re-evaluate the approaches they use. Reflective moments are an important means to deepen understanding and strengthen relationships with ecosystems, such as cross-generational discussions or field journaling [31].

The Reflective Indigenous Climate-based Learning framework, adapted from [32]. Guides managing an open learning process, where participants use divergent and convergent thinking to identify environmental challenges and sustainable management opportunities. Key elements of this framework include empathy for communities and ecosystems, active participation of local communities, sustainability-based learning objectives, real-world contexts of ecotourism, design thinking processes, materials that integrate technology and traditions, conducive field learning environments, cross-stakeholder collaboration, collective reflection, and the role of facilitators as a link between traditional knowledge and

modern innovation [33]. This framework allows ICE learning to be a means of community empowerment and a tangible contribution to ecological and social resilience.

Table 1.
Key elements in community learning design: characteristics and references.

Key Elements	Brief Description, Characteristics, and References
Ecological and cultural empathy	An important element of the community-based design thinking process includes a deep understanding of local ecosystem conditions, cultural values, and indigenous peoples' aspirations. Empathy helps facilitators and participants design solutions that are in harmony with nature and tradition [34].
Authentic community participation	Meaningful, effective, contextual, political, and educational participation ensures two-way knowledge transfer. Recognize the issue of power related to the ownership of local knowledge and provide equal voice space for all parties [25].
Learning objectives and success criteria	All activities are designed based on the learning objectives of sustainability, cultural preservation, and strengthening climate adaptation capacity. Success criteria are socialized openly to guide reflection and evaluation [27, 29].
Framework for the real challenge of ecotourism	The design brief connects the participants' experiences with real challenges on the ground, such as land degradation, water management, or the preservation of local food varieties [27].
Design thought process for sustainability	Combining divergent thinking (exploring innovative ideas) and convergent thinking (choosing realistic solutions) to generate sustainable ecological, social, and economic value [32, 33].
Clear instruction & contextual learning resources	Provide clear guidance regarding each activity's goals, steps, and impact. The learning material combines digital media, local wisdom, and visual documentation from field practice [27, 30].
Field and experimental learning environment	An exploration-oriented process uses diverse media, tools, and natural spaces such as rice fields, forests, and community gardens for hands-on learning [29, 30].

2.3. Community as Learning Experience Designers

Previous research emphasizes the importance of the multifaceted role of local communities as facilitators, co-designers, and mentors in integrating the design thinking (DT) and Indigenous Climate Education (ICE) processes into sustainable ecotourism [27, 35]. In the scope of digital-social agrotourism, the community is the implementer of tourism activities and the designer of culturally and ecologically relevant learning experiences. This role includes active efforts to address the global challenges of climate change by designing educational activities that support community self-reliance, promote environmental conservation, and strengthen local values [36].

In community-based learning ecotourism, it is considered a collaborative design work that demands diverse problem-solving, integration of local and global perspectives, and decision-making in the midst of ecological and economic uncertainty [37]. Communities can foster concern for visitors and nature, accept uncertainty as part of the creative process, and redefine tourism as a means of continuous education by adopting a designer's perspective [38]. This principle opens opportunities for creating informative learning experiences and forms awareness and environmentally friendly behavior for participants.

However, other research shows that integrating DT and ICE into community ecotourism programs often faces limitations in technical knowledge and skills [39]. These limitations include challenges in the process of managing open and iterative designs, the use of digital technology for the promotion and documentation of learning, and the balancing between traditional values and modern innovations. A similar conflict with formal education arises when the commercial orientation of tourism must be balanced with the exploratory and reflective nature of design-based learning [40].

In addition, in formal education, many of the DT and ICE models that have been compiled have not reflected the social, ecological, and cultural complexities in the field [41]. Existing models often fail to capture the implicit knowledge, intuition, collective reflection, and spontaneous decisions taken by community members during ecotourism activities [42]. Therefore, an in-depth understanding of the community dynamics and local values involved in developing contextual learning design frameworks is needed.

The research Rahimian, et al. [43] It highlights the importance of understanding "backstage" activities in ecotourism management, starting from preparing educational materials and then regulating the flow of visits, environmental maintenance, and digital media management. These activities are often abstract and unstructured [44]. But they are very strategic to ensure the smooth learning process on the "frontstage" or main activities in the field. As a key actor, the community has a strategic role in expanding the application of design-based learning in the sustainable tourism sector. This emphasizes the need for empirical research to explore the framework, invisible work of the community, and their experience in managing long, open, and non-linear creative processes [45].

2.4. Reflective Practices in Community Ecotourism Learning

Reflective practices are important for facilitators, educators, and community members within the scope of community learning design for sustainable ecotourism. Developing a learning plan that integrates design thinking and Indigenous Climate Education must follow a linear procedure and involve complex dynamics, uncertainties, and uniqueness in each situation [46, 47]. emphasize that design is not only rational problem-solving but also a process of continuous reflection that combines actions and thoughts about real situations.

Ecotourism learning activities in field practice often take place spontaneously, adjusting to natural conditions, local culture, and unexpected social dynamics [48]. Continuous reflection becomes an integral part of the process when the facilitator plays the role of the learning designer [49]. This includes evaluating successes and obstacles, adapting learning strategies, and utilizing new insights to strengthen learning experiences [50].

Internal dimensions that affect interactions in ecotourism activities are also involved in the reflection process, such as attitudes, emotions, roles, and mindsets [43]. In a community-based learning approach, it is very important to strengthen awareness of the importance of conservation, cross-generational collaboration, and the maintenance of local wisdom, which can be done through collective reflection [28]. The design studio's pedagogical model, adapted to the ecotourism context, allows participants to understand the complex design process, manage the diversity of materials and natural resources, and develop a more adaptive mindset [51].

Therefore, reflective practice can serve as a post-activity evaluation and a dynamic framework that supports the sustainability of digital-social agrotourism-based ecotourism learning, maintaining a balance between technological innovation and cultural and environmental preservation.

3. Method

The research method will outline the case study, the participants involved, and the description of the reflection-based community learning design for sustainable ecotourism. The approach integrates design thinking and Indigenous Climate Education within the framework of Digital-Social Agrotourism. After that, the presentation on the application of key elements of learning design, as well as data collection and analysis procedures to obtain relevant findings [52].

3.1. Case Study Research Setting

This research was carried out for three months in Wonokerso Village, Pakisaji District, Malang Regency, East Java. This village has a uniqueness between the potential of ecotourism, the richness of local wisdom, and socio-ecological challenges relevant to the sustainability theme. The area is known as an agricultural and agrotourism hub, with landscapes of rice fields, gardens, and conservation areas that are nature-based tourist attractions. However, several issues need to be addressed through community-based learning innovations, namely climate change, land conversion, and limited access to digital technology [53].

The Tunggal case study approach is used because it can provide an opportunity to explore the application of reflection-based community learning design in the context of digital-social ecotourism integrated with Indigenous Climate Education (ICE). Referring to Gamez-Djokic [54] and Čustović, et al. [55] This approach will allow researchers to understand complex learning dynamics by recognizing interaction and interpretation as part of the construction of knowledge.

This research is inspired by the Research-Practice Partnership (RPP) model [56]. Where researchers play an active role with the community in designing, implementing, and reflecting on programs, the goal is to generate academic knowledge and increase community capacity in managing sustainable ecotourism through the integration of design thinking and ICE. Collaboration between researchers and residents of Wonokerso Village is established in every stage of the design and implementation of research programs. In addition, this study contains elements of analytical autoethnography according to the explanation [57]. Where analytical reflexivity is used to understand social phenomena more broadly in community ecotourism practices.

3.2. Participants

The participants involved in the study amounted to 130 participants, consisting of farmers, tourism actors, and youth from Wonokerso Village. The purposive sampling method [58]. The criteria were used to select participants based on their active involvement in agricultural activities, ecotourism, and village development programs. The requirements aim to obtain a deep understanding from each participant with direct and relevant experience in reflection-based sustainable ecotourism development.

Farmers involved as participants know traditional agriculture and are familiar with digital-social agrotourism practices through village training activities. Tourism actors consist of lodging or homestay managers, tour guides, and local artisans who have integrated the narrative of local wisdom in their tourism services. Meanwhile, village youth were chosen because of their role as agents of change and drivers of innovation, especially in utilizing digital technology to promote and manage tourist destinations.

All participants were introduced to the concept of design thinking and indigenous climate education before the activity started, which will be a framework for community learning. Researchers and local facilitators collaborated to design collaborative sessions that encouraged cross-group exchange of ideas, creating a reflective learning atmosphere that combined field experiences with creative approaches. Direct community involvement is expected to strengthen the suitability of learning design with the real needs of the village, while ensuring the sustainability of ecotourism initiatives [59].

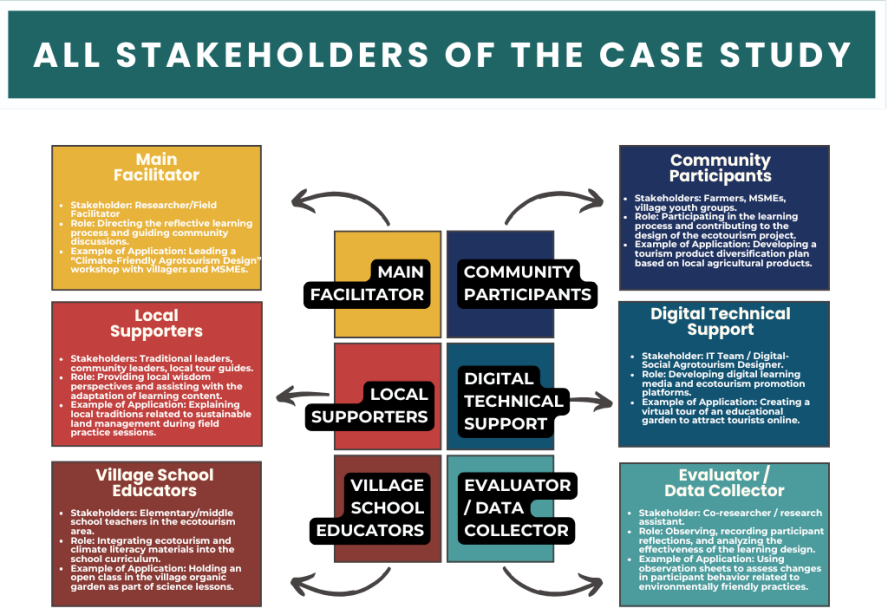

Figure 1.
All stakeholders of the case study. The analysis focused on the reflection of two key figures of local communities (e.g., indigenous leaders and young ecotourism actors).

3.3. Project Design and Key Learning Elements

The main objective of this research is to integrate project-based learning with a cross-stakeholder collaborative approach – including the people of Wonokerso Village, ecotourism MSME actors, village youth, educators, and researchers – to design innovative solutions that can support the strengthening of the ecotourism ecosystem based on local wisdom. The focus of this design lies in "co-design and co-reflection" in developing Digital-Social Agrotourism innovations that combine the principles of design thinking [16] and Indigenous Climate Education [30] to create sustainable ecotourism strategies relevant to the community's needs.

The initial stage of implementing this research began with identifying needs through field observations, focus group discussions, and in-depth interviews with ecotourism actors, farmers, and village youth. Participants used empathy maps to explore socio-ecological challenges, business development opportunities, and local cultural narratives. The data obtained from this stage will be the foundation for the preparation of how-might-we questions that are used to guide the creative process, ensuring solutions are designed according to the local context and aligned with sustainability principles [60].

Furthermore, the ideation process is collaboratively carried out in a structured brainstorming session. The participants' formulation of ideas considered resource limitations, environmental sustainability, and the wealth of local wisdom. The ideas collected are selected using the dot voting method to obtain potential concepts. This stage prioritizes maintaining the relevance of ideas to the vision of sustainable ecotourism while providing space for digital technology innovation as a medium for promotion, education, and destination management.

Afterward, the participants developed initial prototypes or mock-ups of solutions—ranging from digital platforms for MSME promotion, culture-based tour packages, to creative waste management concepts. The prototypes that have been developed will be tested directly with the community to obtain feedback that will then be used in the next iteration of the design. This approach refers to the Double Diamond framework [61]. This emphasizes the cycle of divergence and convergence of ideas in the design process.

Implementation in the field provides various innovative results. For example, a digital platform that integrates village event calendars, MSME product catalogs, and tour reservation features; educational tour packages that blend sustainable farming practices with local folklore; and a collaborative business model that allows business actors, farmer groups, and village youth to work together in managing and marketing destinations. All products are designed to be adaptable and further developed independently by the community.

The learning design data sources were obtained from observation notes, research reflection journals, activity documentation, and interview and survey results. Project-based learning [62] design thinking, and integrating digital technology to reinforce stakeholder collaboration are references to learning principles. Referring to the view [63] technology must be used as a tool and as part of a flexible learning ecology that can be modified as needed. Learning objectives and success indicators are evaluated periodically to ensure alignment with the project's vision and participants' progress.

This research approach produces innovative products and builds the community's reflective capacity to design creative solutions based on cultural values and climate awareness for sustainable ecotourism. It is hoped that the co-reflective design approach can be a replication model in developing sustainable ecotourism by harmoniously combining local potential and digital technology for other villages.

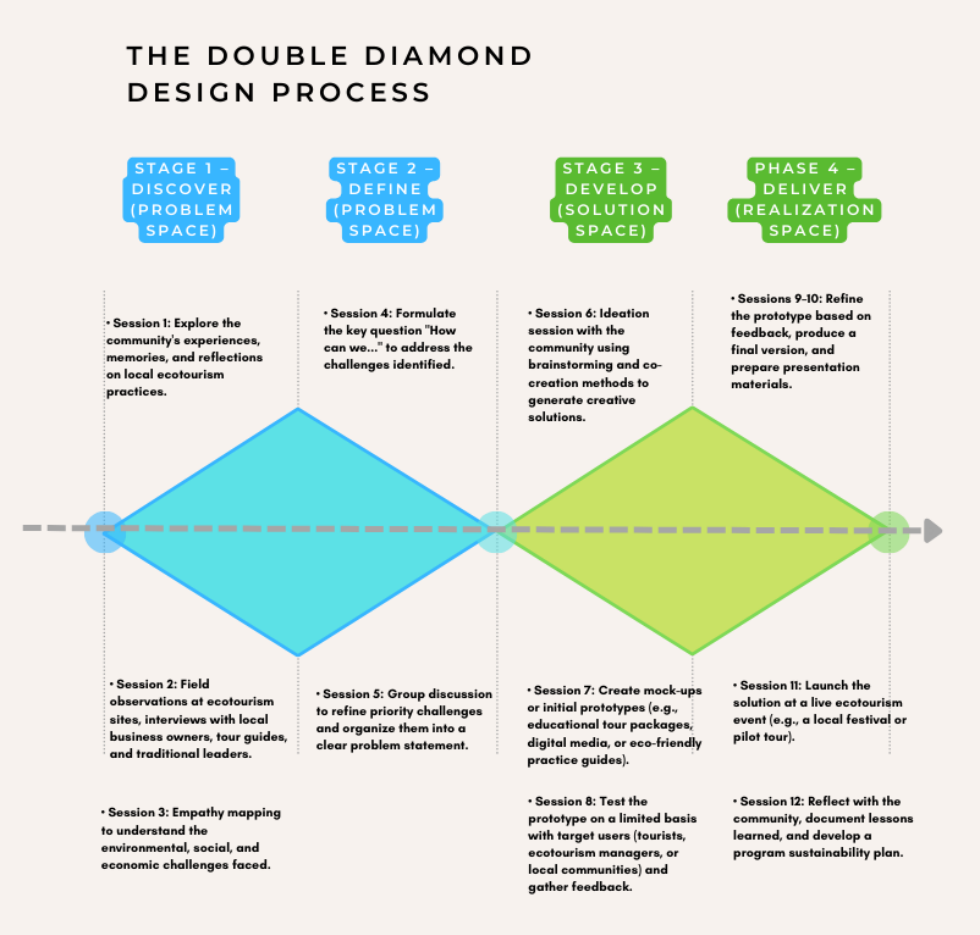

Figure 2.
Double Diamond-based design workflow and community-based tasks.

Figure 3.
Community end product: Season-based tour packages, local education boards, and travel digital apps that are responsive to visitor feedback.

3.4. Data Collection Techniques

The data collected consisted of various types of data that were expected to be able to support the research objectives in the case study of research development of Reflection-Based Community Learning Design for Sustainable Ecotourism: Integration of Design Thinking and Indigenous Climate Education in Digital-Social Agrotourism. The main focus of this research emphasizes the perspective of community facilitators and local community leaders in the co-design and co-facilitation process of the program. Each training session, 12 in-situ reflections are recorded using a recording device to capture experiences, challenges, and ideas that can drive the continuation of the design process. A few weeks after the program is completed, a 60–90-minute semi-structured interview is conducted to gain an in-depth understanding of planning, management, and facilitation strategies from both perspectives. Field notes, facilitator reflection journals, and learning materials help describe the implementation of key elements in the project. At the same time, photo documentation describes the community design process and the resulting final prototype [64].

Table 2.
Implementation of learning design elements and examples of their application in the field.

Key Elements	Examples of Implementation in the Field
Empathy in Planning	Interview and hands-on observation sessions with farmers, local tour guides, and village artisans to understand their needs, challenges, and aspirations. Students and facilitators mapped out an "empathy map" related to the potential and problems of ecotourism. The teacher/facilitator integrates the results of these observations into digital learning modules and group reflection activities.
Participation	Cross-generational collaboration between village youth, farmer groups, MSME actors, and educational tourists. Co-design activities to develop agro-based tourism packages and local culture. All members are given an active role in decision-making related to tourism.
Learning Objectives	General objective: to build ecological awareness and sustainable ecotourism management skills. The objectives of each session: understand the principles of Indigenous Climate Education, apply digital technology for promotion, and develop a tourism narrative that reflects local values. Assessment criteria: ability to design environmentally friendly tourism programs, implement digital promotion technology, and maintain cultural authenticity.
Design Brief	Project challenge: "Design and promote a Digital-Social Agrotourism package that integrates sustainable farming practices, local wisdom values, and climate change mitigation." Character: open, contextual, collaborative, and accommodates participants' creativity.
Design Process	The "Double Reflective" model combines the stages of design thinking with cultural reflection sessions. Participants underwent a cycle of exploration, reflection, prototype, and evaluation, both manually and digitally.
Instructions and Materials	Each session includes a step-by-step guide, a visual worksheet, and a short video tutorial on ecotourism and digital marketing practices. The material is presented in simple but contextual language, according to the participants' personalities.
Experimental Learning Environment	Combine field practices (visits to farmland, conservation areas, and craft centers) with digital tools such as simple drones, 360° cameras, and online marketing platforms. Participants are free to test ideas and prototype virtual tours.
Collaboration and Shared Learning	Participants were divided into heterogeneous groups based on background and skills. Facilitators, traditional leaders, and ecotourism practitioners served as equal mentors. Each group presented its progress to get input from the other groups.
Reflection and Argument	At the end of each session, participants wrote reflection notes in a digital journal, presented their findings, and had argumentative discussions about their design choices. Reflection was also directed at conforming to sustainability principles and local wisdom.
Facilitator Role	Facilitators play the dual roles of mentors, community liaisons, and digital technical directors. They collaborate with local leaders in organizing activities and encourage openness to experimentation despite uncertainty.

3.5. Data Analysis Techniques

The data analysis used is thematic analysis. The goal is to manage in-depth interview transcripts, field observation notes, and reflective journals of researchers as the main data, equipped with photo documentation, audio-video recordings, and the results of community questionnaires and local MSME/ecotourism actors. This analysis follows the six stages described by Vural, et al. [65] providing flexibility in identifying, analyzing, and uncovering communities' challenges and opportunities during reflection-based learning and design thinking. A holistic perspective is used to understand how data-driven elements emerge, especially those related to integrating Indigenous Climate Education in Digital-Social Agrotourism. The MAXQDA 2022 qualitative analysis software is a tool used to manage all data [66].

Incorporating theory-driven coding (referring to the elements of a pre-formulated learning design) and open coding is used during the analysis process through several iterative rounds to capture new findings from field practice. The resulting code includes explicit (semantic) and implicit (latent) meaning dimensions, such as the practice of local wisdom in tourism management, cross-generational collaboration patterns, and adopting digital technology in ecotourism marketing.

The initial theme was discussed collaboratively with research team members and community representatives to ensure the validity of the findings, the representativeness of perspectives, and the accuracy of interpretation. The final stage of the analysis produces key themes that enrich the reflection-based learning design framework, complemented by direct quotations from participants to reinforce the narrative. The results of this analysis are then integrated into the discussion section to provide a conceptual and practical contribution to developing a sustainable ecotourism model based on local wisdom [64].

4. Findings

The research dataset contains all the key elements of the identified theory-based learning design, and several insights can be drawn from these elements. The focus of the analysis is the role of community facilitators and their pedagogical practices, emphasizing the in-situ and post-implementation reflections of the main facilitators. The codes formed from the data include reflections on how facilitators manage the reflection-based community learning design process for sustainable ecotourism, integration of design thinking, and Indigenous Climate Education within the framework of Digital-Social Agrotourism. In addition, uncertainties were found related to the mastery of digital technology, various emotions and pressures during the process, and pedagogical challenges and limitations faced (see Figure 4). This section highlights three interrelated themes in practice-based reflection: (1) facilitators as design leaders, (2) cross-community collaboration, and (3) co-reflection. The results of this study provide a new dimension to the role of facilitators in guiding and supporting the reflection-based learning process, in line with the proposed learning design model [67, 68].

4.1. Community as a Design Leader

This research highlights the role of local communities as beneficiaries and the main drivers in the reflection-based learning design process. The communities involved in digital-social agrotourism consist of ecotourism actors, local artisans, and farmers who actively lead the direction of idea development, prioritize needs, and integrate Indigenous Climate Education values into learning designs. The results of data analysis show that this leadership role emerges through several main dimensions, namely collaborative decision-making, maintenance of local wisdom, and technological adaptation to support ecotourism sustainability.

One of the community leaders, Mr. Surya, in an interview stated:

"We want to ensure that every step taken protects our nature and culture. Technology is important, but don't let it lose the identity of ecotourism inherited from generation to generation."

This statement illustrates that community leadership not only talks about the innovations produced but also maintains a balance between technological advances and the preservation of local cultural values. This view is in line with the literature that emphasizes the importance of community-led design in the context of continuing education [69].

The community demonstrated strong initiative in designing a learning flow that incorporated field practice, reflective workshops, and the use of digital media during the mentoring process. They led discussion sessions to determine relevant learning modules, such as the "Low Carbon Footprint in Ecotourism" guide proposed by a local coffee farmer group.

One participant, Ibu Ratna, explained:

"We discussed together what tourists need most, then looked for ways to explain it in simple language on social media. But we still have to touch the local story."

These results show that the role of community leadership also involves culture-based storytelling skills, which serve as a bridge between local knowledge and broader public understanding. In the design thinking literature, this is categorized as the empathize and define stage, which is led directly by the owner of the context [16].

In addition, field data shows that communities are able to gradually lead the digital technology adoption process. For example, training on the use of digital marketing platforms is carried out by adjusting the material to be in harmony with the planting and harvest season schedules. This reinforces the concept that successful continuous learning design requires synchronization between technology and the rhythm of local life.

The researchers' notes on post-activity reflection show that community involvement as a design leader results in a high sense of program ownership. This minimizes resistance to new technologies while strengthening the commitment to ecotourism sustainability goals.

As revealed by Mr. Andi, one of the facilitators:

"When they are in charge, we as a companion only give technical direction. The decision remains in their hands, and it makes all parties more enthusiastic about running the program."

These results support the view [70] That community-driven leadership in reflection-based learning design can strengthen the material's relevance while improving the sustainability of program implementation.

In this subchapter, it can be concluded that the community's role as a design leader in reflection-based Digital-Social Agrotourism can integrate technology, local wisdom, and sustainability values in one adaptive learning framework. The success of this model lies in the community's ability to direct the design process while maintaining the ecotourism identity that characterizes its region.

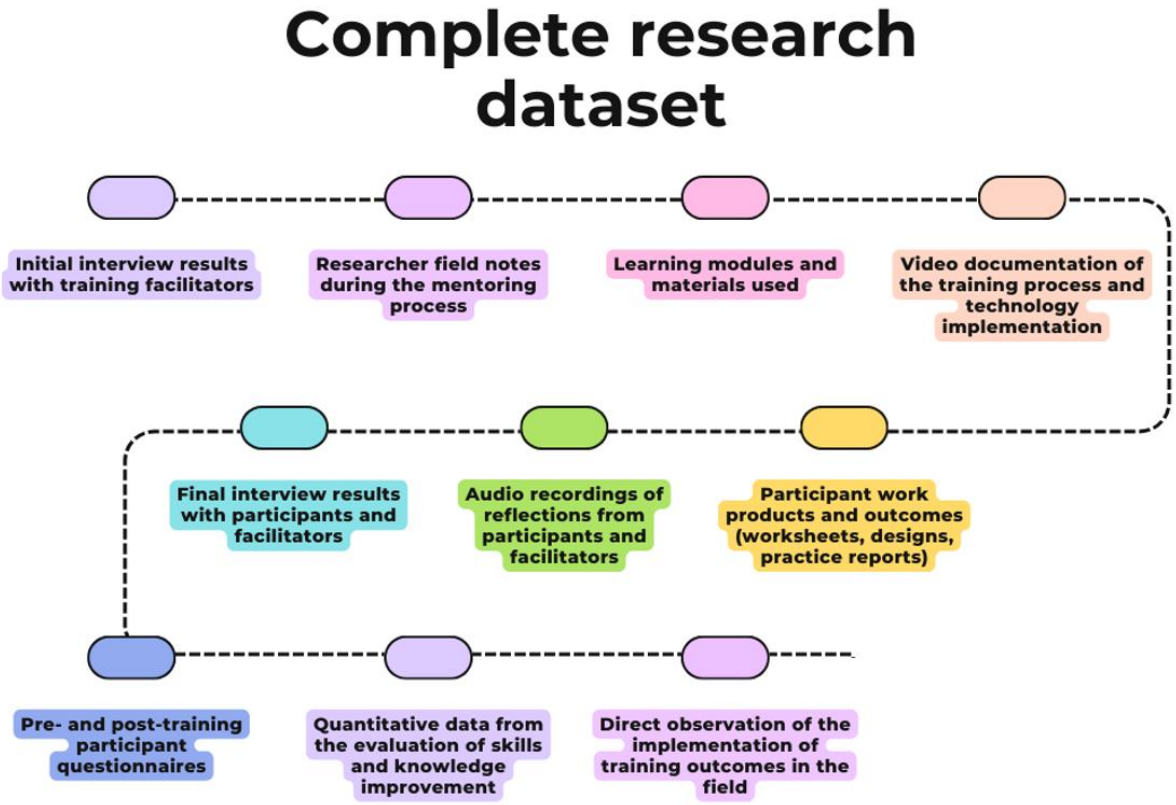

Figure 4.
The full dataset of the study, the part of the data used, is marked in gray.

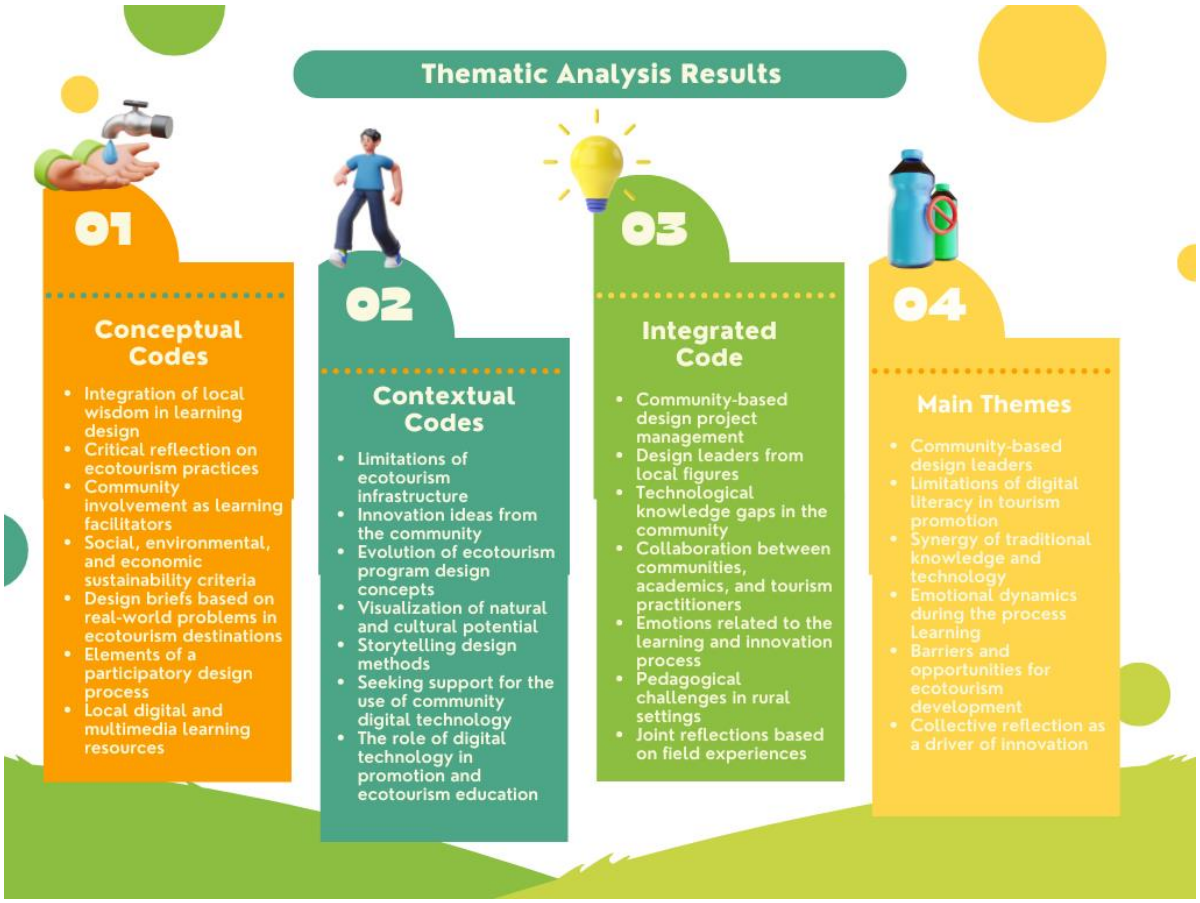

Figure 5.
Results of thematic analysis based on participant reflection.

4.2. Cross-Generational and Inter-Sector Collaboration

In learning design, cross-generational and inter-sectoral collaboration has a core role in the sustainable ecotourism that is designed. Indigenous leaders, village youth, academics, tourism industry players, and local governments are the actors involved in the collaboration process. The parties held a brief discussion to determine the role's focus according to their respective expertise before the activity began, for example, who led the Indigenous Climate Education introduction session, managed the digital documentation, and guided the field practice. However, some participants considered that the division of roles should be discussed in more detail from the beginning of the project.

A traditional leader said, "If it is clear from the beginning who holds what part, it will be smoother. For example, I hold the traditional stories, young people hold the media. So we are not confused in the middle of the road" (Post-Activity Interview, Pak Surya).

In addition, the discussion also discussed the importance of preparing a strategy to deal with unexpected situations, such as extreme weather that can disrupt the schedule of field activities or the sudden busyness of team members. A youth facilitator said, "Sometimes heavy rain makes the agenda change completely; fortunately, there is a reserve of digital activities that can run even indoors" (Audio Reflection, Rani).

This collaboration provides complementary strengths despite facing challenges. Village youth bring digital skills to promote agrotourism through social media, while traditional leaders ensure that the narrative conveyed still maintains local values. Academics provide technical input on sustainable tourism design, and industry players help map market opportunities.

However, external support is needed for the program's sustainability. One of the homestay managers said, "Without the assistance of equipment from partners, it is difficult to continue with virtual tours or online bookings" (Post-Activity Interview, Ibu Sari).

An important lesson that can be learned from this research is that synergy across generations and sectors not only expands technical capacity but also builds community confidence in combining technology with local wisdom. A local teacher concluded his reflection by saying: "If I were alone, I probably wouldn't try this technology. But because there was cooperation, I dared to try, and it turned out to be useful" (Post-Activity Interview, Mrs. Rina).

This collaboration shows that the success of community-based learning for sustainable ecotourism is largely determined by careful coordination, flexibility in the face of challenges, and the courage to experiment across generations and sectors.

4.3. Collective Reflection and Perspective Change

The process of collective reflection is an important component of this reflection-based community. Reflections were carried out together during and after each activity was completed by traditional leaders, village youth, academics, tourism industry players, and local governments, as well as through follow-up interviews a few weeks after the project ended. Most of the reflections in the field focused on the challenges faced, such as time constraints, knowledge gaps between generations, the need for support for the use of digital technology, and how the role of technology is positioned in the context of sustainable ecotourism.

In the early stages, the participants' optimism emerged when combining Indigenous Climate Education with a digital approach, such as creating a virtual tour of a coffee plantation or interactive documentation of harvest rituals. When creative ideas are successfully realized, they are overjoyed, such as using drones to record village landscapes or creating folklore content for social media. However, negative emotions also arise, such as frustration and lack of confidence, especially when faced with uncertainty in using digital devices or new applications. A village youth revealed, "At first I was very excited, but when the laptop started to error, the signal was lost, immediately confused and down. It feels like a complete failure" (Audio Reflection, Andi).

This uncertainty sometimes lowers motivation and raises questions about who should be responsible for the technical aspects. An indigenous leader said, "I understand customs, but technology is not my territory. So, do I really need to master this as well?" (Post-Activity Interview, Mr. Surya). Meanwhile, academic facilitators emphasized that uncertainty is a natural part of the design process, and following structured design steps can help manage those emotions. "We have to believe in the same process. Sometimes we don't see the results at the beginning, but if we go through the stages, something will definitely appear" (Post-Activity Interview, Dr. Lestari).

Sharing doubts and emotions with cross-generational teammates can also be done with collective reflection. One of the local teachers said, "If I were alone, I wouldn't be able to give a solution. But if we discuss together, the burden feels reduced, even though we both don't know the answer" (Audio Reflection, Mrs. Rina). This situation raises the question: how to maintain the trust of the participants when the facilitators themselves are learning. Some overcome this by informing participants that this process is a learning journey together, so all parties feel equal.

When technical and coordination challenges were successfully overcome, all participants felt pride and satisfaction. Indigenous leaders, youth, and academics feel that this collaboration produces attractive digital tourism products and strengthens social relationships and cross-generational understanding. A homestay actor said, "It's great to see young people being able to make a virtual tour of our village. This is not only cool, but it can also be a new source of income" (Post-Activity Interview, Ibu Sari).

Ideas for future development also emerged when doing the final reflection, such as involving more technologists for more in-depth digital training and integrating small business management modules so that digital ecotourism can be economically sustainable. This cross-generational project was suggested by participants to become a routine program,

through consistent cross-sectoral support, as advocated by participatory learning theories that emphasize the sustainability of community engagement [71].

Thus, collective reflection in this project can be a means of evaluation and a space for the formation of a new identity for the community, namely as an actor who is able to combine local wisdom and technological innovation for a sustainable ecotourism future.

5. Discussion

This study aims to explore the dynamics of cross-generational and inter-sectoral collaboration in reflection-based community learning design for sustainable ecotourism. The three main themes presented from the analytical and interrelated analysis results include the integration of design thinking, the application of Indigenous Climate Education, and the use of Digital-Social Agrotourism as a collaborative medium. The results of this study are in line with the view [72] that continuous learning requires synergy between actors and cross-generational perspectives. The following discussion relates the results of the research to relevant literature and implications for the development of community learning models.

5.1. The Dual Role of Communities: Learners, Designers, and Movers

During the post-activity research and interview process, the reflection process emphasizes the dual role of the community, which is aligned with the reflection-based learning framework [46] and the principles of Indigenous Climate Education [30]. This role includes positioning the community as active learners, designers of design-based solutions, as well as drivers of socio-ecological change in the context of sustainable ecotourism. In this scope, communities become beneficiaries as well as determinants of the direction of digital-social agro-tourism development in their area.

Communities as learners are directly involved in the process of understanding local environmental issues, such as land degradation and changing planting patterns, while seeking linkages to global challenges such as the climate crisis. The Indigenous Climate Education approach encourages them to reflect on the interconnectedness between traditional knowledge, nature conservation, and village economic sustainability. Some community members stated that this process helped them revisit old practices—such as intercropping systems—as relevant solutions in climate change mitigation, in line with findings [73] on the role of local wisdom in resource management.

The community as a designer adopts a design thinking framework to create innovations in ecotourism management. This stage involves problem identification, idea exploration, prototyping, and testing of tourism programs. From senior farmers to students, cross—generational engagement enriches perspectives and ensures the resulting designs are relevant to all stakeholders. In addition, another part of the design strategy is the use of digital technologies, such as social media platforms and virtual tours. However, it is inseparable from the diverse digital literacy challenges among members. The results of this study are in line with the opinion [34] that design thinking can increase collaboration and innovation in the community.

As a driver and decision-maker, the community plays a strategic role in mobilizing human, natural, and financial resources. Important decisions—such as limiting the number of tourists in certain seasons—are made to balance economic benefits and environmental sustainability. This approach reflects the principles of community-based tourism as explained by Samal and Dash [5] where community-based management is able to increase sustainability through the active participation of citizens.

This role also faces challenges, such as limited digital technology capacity among senior citizens, hindering the optimization of online promotion and management. Potential conflicts of interest, such as between land conservation and the construction of new tourism facilities, require careful mediation. In addition, the reflection methods used need to be adapted to be accessible to various educational and cultural backgrounds, as recommended by Mclaughlin and Seabrook [32] in the concept of communities of practice.

Strategies such as continuous training in design thinking, ecotourism management, and digital literacy are also proposed to strengthen the dual role. The cross-generational co-design approach is considered effective for building a sense of shared ownership of ecotourism projects. Furthermore, the implementation of an evaluation system based on sustainability indicators adapted from the UNWTO Sustainable Tourism Indicators can help communities monitor social, economic, and ecological impacts measurably.

The results of this study show that, just like teachers in design learning in schools [74] Communities in the context of ecotourism also need knowledge, skills, and adaptive mindsets to flexibly switch roles between learners, designers, and movers. Their success in integrating design thinking with Indigenous Climate Education confirms that reflective collaboration across generations and sectors can be the key to sustainable ecotourism development in the digital age.

5.2. Collaboration as a Power of Local Social Innovation

An important foundation in the development of community-based sustainable ecotourism is cross-stakeholder collaboration. The collaboration between local communities, learning facilitators, local governments, MSME actors, and creative industries in this study has been proven to be able to overcome environmental, social, and technological challenges. This approach combines local knowledge with technical expertise, while optimizing the division of roles to support Digital-Social Agrotourism. This is in line with the results of research conducted by Ndhlovu and Dube [75] the active involvement of all parties allows the formation of more contextual and adaptive solutions to local needs.

The reflective learning process becomes a forum for the exchange of perspectives through co-teaching and co-design involving educators, Indigenous Climate Education practitioners, and design thought facilitators. This collaboration enriches learning strategies, integrates local wisdom with scientific knowledge, and equips communities with the ability to

manage digital tourist destinations that are responsive to climate change. This is in line with the research conducted by Rossi, et al. [76] where the co-design process can strengthen technical capacity and build a sense of shared ownership over the resulting program.

The sustainability of ecotourism programs cannot be separated from structured long-term support, both through horizontal networks between communities and vertical networks involving governments, universities, and NGOs. Environmentally friendly technology training, digital marketing management, and intensive assistance in tourism management based on sustainability principles are necessary to support the sustainability of the program. The research conducted [59] emphasizes that this kind of collaboration not only solves technical challenges, but also strengthens the social resilience of communities to global tourism dynamics.

Thus, the collaboration that exists within this scope serves as a driver of local social innovation. The synergy of various actors allows for the integration of digital technology, local wisdom, and sustainability principles, resulting in innovative community learning models. The resulting impact is not only limited to the economic aspect, but also strengthens cultural identity and preserves the environment. As emphasized by Galang, et al. [77] Participatory design collaboration can create social change that is sustainable and relevant to the needs of local communities.

5.3. Reflection as the Core of Social and Environmental Transformation

In literature reviews that discuss community-based learning and sustainability, critical reflection is often emphasized as key in linking field practice to the long-term goals of environmental conservation and social empowerment [78]. However, the understanding of how reflection is systematically carried out in the context of sustainable ecotourism—especially one that integrates design thinking and Indigenous Climate Education—is still very limited. In this study, reflections carried out in situ by facilitators, ecotourism actors, and community members play an important role in facilitating, leading, and redesigning the learning process. This process opens up opportunities to identify new themes, value contradictions, and future strategic ideas, which are relevant to the local socio-cultural context [32].

In line with research conducted by Lau, et al. [79] on reflective practitioners, reflection helps actors manage the complexities and uncertainties arising from challenges in the field, such as climate change, tourism market fluctuations, and digital technology transformation. However, the main obstacles faced are time constraints, the dominance of certain group perspectives, and the digital knowledge gap. For example, in the management of Digital-Social Agrotourism, a contradiction is found between maintaining the value of local wisdom and meeting the demands of the global market that relies on digital marketing technology [80] In addition, a strategic dilemma that often arises is to maintain a balance between voluntary community participation and the achievement of formal program targets.

Critical reflection on the practice and use of digital technology in ecotourism allows for the creation of social innovations and sustainable adaptation strategies [14]. Communities can strengthen their adaptive capacity in the face of climate change uncertainty through this process and ensure that the development of digital-social agrotourism remains grounded in ecological sustainability and local cultural values. Thus, reflection is not only an instrument of evaluation, but also the foundation of social-environmental transformation that connects technology, culture, and ecology in one dynamic community learning ecosystem.

5.4. Implications and Further Research Directions

The importance of developing community learning methods that integrate design thinking and Indigenous Climate Education in the context of sustainable ecotourism based on Digital-Social Agrotourism is an important focus emphasized in this study. More in-depth research needs to be done in designing curricula, learning strategies, and collaborative activities between facilitators, local communities, and other stakeholders. Participatory and reflection-based approaches should be the foundation of the learning design process to fit the socio-cultural dynamics and changing environmental conditions [81].

In addition, professional training for ecotourism facilitators and actors is very important to increase their capacity in managing digital technology while maintaining local wisdom, which is the foundation of sustainability. This capacity-building program should pay attention to the technical aspects and skills of adaptation and cross-sectoral collaboration that characterize the community learning model [52].

In this study, the application of reflection-in-action and reflection-on-action methods provides an authentic picture of the challenges and opportunities in the application of design-based learning in the field [46]. Reflection data collected sustainably and contextually helps to avoid retrospective bias, so the results provide important insights for designing more adaptive and sustainable ecotourism learning models and programs.

Furthermore, the role of facilitators as design process leaders who can manage uncertainty while facilitating collaboration across generations and sectors also needs to be emphasized to improve the community learning design model. The co-design approach and collective reflection are also key aspects to strengthen the program's sense of ownership and sustainability [76]. Effective time management in the context of reflection-based community learning also needs to be considered so that the process runs optimally without ignoring the participants' needs.

Therefore, further research is expected to develop learning frameworks and practices that are responsive to socio-ecological complexity, as well as strengthen the synergy between technology, local wisdom, and social innovation in the development of sustainable ecotourism.

5.5. Limitations

5.5.1 Study Limitations

The limitations in this study are influenced by the socio-cultural context and the specific conditions of the ecotourism community studied. Community learning designs that integrate design thinking and Indigenous Climate Education are heavily influenced by unique local wisdom values and practices, so the results may be less generalizable to communities with different characteristics [82].

Community participation in this reflective and collaborative process is limited to specific groups that have been actively involved, so the perspectives of broader community members are not yet fully represented. This can affect the breadth and depth of understanding related to social dynamics and digital technology challenges faced as a whole.

In addition, the limited time and resources in the reflective data collection process also limit the scope of analysis and the validity of the findings. This case study approach primarily focuses on the experiences and reflections of facilitators as well as core community members, making it difficult to draw broader conclusions about the effectiveness and long-term impact of the proposed learning model [46].

Nonetheless, this study provides valuable insights into reflection-based community learning practices in the context of sustainable ecotourism, which can serve as a foundation for further studies to expand the scope and methods of research to support the sustainability of digital-social ecotourism more comprehensively.

6. Conclusion

This research makes an important contribution to the development of reflection-based community learning designs for sustainable ecotourism by integrating design thinking and Indigenous Climate Education in the context of Digital-Social Agrotourism. Through continuous reflection from facilitators and community members, the learning process is not only well-structured and directed, but also continuously redesigned according to socio-cultural dynamics and environmental challenges faced.

This reflective process also increases the collective understanding of the principles of adaptive, participatory, and sustainable learning, which are relevant for the management of ecotourism based on digital technology and local wisdom. In addition, the integration between design thinking and Indigenous Climate Education strengthens the capacity of communities to develop innovative solutions that still adhere to cultural values and environmental sustainability [82].

This study recommends the need for greater emphasis on the role of communities as reflection facilitators, designers, and key actors in sustainable ecotourism learning, involving cross-sector collaboration as well as co-design on a sustainable basis. This approach is in line with the concepts of collaborative learning and participatory design that place the community as an active agent of change in the development of digital-social ecotourism [72].

Thus, this research opens up opportunities for the development of a more inclusive and adaptive community learning model in supporting the social, economic, and ecological sustainability of future ecotourism.

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