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Analysis of Pine Forest-Based Ecotourism Management Strategies to Support Landscape Sustainability in Purworejo Regency, Indonesia

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Abstract. *Pine forest-based ecotourism has significant potential to support sustainable landscape management and rural development. This study aims to formulate strategic management directions for pine forest-based ecotourism in Kalilo Pine Forest, Purworejo Regency, using an integrated SWOT-based landscape sustainability approach. The research employed a descriptive, qualitative, and quantitative case study design involving 30 respondents, including tourism managers, local community members, and village officials. Data were collected through field observations, interviews, and questionnaires using a Likert scale (1-4). Data analysis was conducted using Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS), followed by a SWOT matrix and strategy prioritization. The results indicate that Kalilo Pine Forest achieved an IFAS score of 2.70 and an EFAS score of 2.82, placing it in Quadrant I, which indicates strong internal capacity and favorable external opportunities. Priority strategies include the development of conservation-based educational ecotourism programs, strengthening community management capacity, and implementing environmental carrying capacity controls. This study contributes to sustainable tourism planning by integrating SWOT strategic analysis with ecological, social, and economic landscape sustainability considerations. The findings provide practical policy directions for improving ecotourism governance through the development of standard operating procedures and visitor management systems to support long-term sustainability.*

Keywords: *ecotourism management, pine forest, landscape sustainability, SWOT analysis, Purworejo.*

1. Introduction

Sustainable management of natural resources has become a critical issue in rural development, particularly in forest-dominated landscapes where ecological integrity must be balanced with socio-economic needs (Saarinen, 2020; Weaver, 2020; Tervo-Kankare, 2021). Forest ecosystems, especially pine forest landscapes, provide multiple ecological services such as biodiversity conservation, climate regulation, and soil protection, while also offering economic opportunities through nature-based tourism development (Lawasi *et al*., 2025; Rahmawaty *et al*., 2025). In recent years, ecotourism has been widely recognized as a strategic approach to promote sustainable natural resource utilization without compromising environmental sustainability (Wu,

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2021; Wu *et al*., 2025). Landscape ecology principles emphasize spatial interactions between ecological processes and land use patterns (Turner & Gardner, 2015).

Pine forests play an important role not only as ecological buffers but also as potential economic resources when managed appropriately through conservation-oriented approaches (Priatmoko *et al*., 2021). Ecotourism emphasizes conservation, environmental education, and community participation as key principles that distinguish it from conventional tourism practices (Asadpourian *et al*., 2020; Hariyadi *et al*., 2024). The development of forest-based ecotourism has been shown to support rural livelihoods while simultaneously enhancing environmental awareness and landscape protection. Community-based tourism models, particularly those involving collaboration between government institutions and local communities, have demonstrated effectiveness in promoting sustainable tourism management and local empowerment (Oka *et al*., 2021; Juliana *et al*., 2023).

Within the Indonesian context, many forest areas are managed under collaborative schemes involving state forestry institutions and local community organizations**,** such as the partnership between Perhutani and Forest Village Community Institutions (Lembaga Masyarakat Desa Hutan/LMDH). This collaborative management model plays an essential role in ensuring that forest utilization activities align with conservation objectives while supporting local socio-economic development. Kalilo Pine Forest, located in Kaligesing District, Purworejo Regency, Central Java, represents a forest landscape that has been managed under such a collaborative framework. The forest area has been under the management of Perhutani, in cooperation with LMDH Rukun Lestari, since 1971, and functions as part of the national forest system aimed at maintaining ecological stability and environmental sustainability.

Figure 1. Landscape Documentation of Kalilo Pine Forest Ecotourism Site.

Kalilo Pine Forest possesses several characteristics that support the development of forest-based ecotourism. Field observations conducted in 2024 indicate that the area exhibits high visual landscape quality, favorable microclimate conditions, and relatively well-preserved forest

ecosystems. These characteristics provide strong ecological and aesthetic value, making the area suitable for educational and conservation-based ecotourism development (Figure 1). Furthermore, the involvement of local communities through LMDH activities indicates the presence of social capital that can support sustainable tourism initiatives.

Previous studies have identified various factors influencing ecotourism feasibility and sustainability, including natural attractiveness, accessibility, management capacity, and stakeholder participation (Nugroho *et al*., 2018; Irmawati & Hasnawati, 2024; Kamaluddin *et al*., 2025). Other research conducted in forest landscapes highlights that destinations with distinctive ecological characteristics and strong community participation demonstrate greater potential for sustainable ecotourism development (Kamaluddin *et al*., 2025; Triwahyuningsih *et al*., 2025). However, many of these studies primarily focus on feasibility assessments or descriptive evaluations without integrating ecological landscape sustainability considerations into strategic planning.

Despite the growing body of literature on ecotourism development, several important research gaps remain. First, most previous studies apply SWOT analysis as a general strategic tool without explicitly linking it to measurable indicators of landscape sustainability. Second, limited research has examined how forest-based ecotourism strategies can be formulated within collaborative forest management systems involving institutions such as Perhutani and LMDH. Third, specific studies addressing strategic ecotourism planning in Kalilo Pine Forest from a landscape sustainability perspective are still lacking.

Therefore, this study introduces an integrated analytical approach that combines SWOT strategic analysis with landscape sustainability considerations, emphasizing ecological conservation, community participation, and long-term resource management. The integration of these components represents the novel contribution of this study, as it extends the application of SWOT beyond conventional tourism planning toward a sustainability-oriented landscape management framework.

Based on these considerations, this study aims to formulate strategic management directions for pine forest-based ecotourism in Kalilo Pine Forest, Purworejo Regency, using a structured analysis of internal and external factors. The results of this study are expected to contribute not only to practical management strategies but also to the theoretical development of sustainable forest-based ecotourism within collaborative forest governance systems.

Based on the identified research gap and theoretical considerations, a conceptual framework was developed to illustrate the relationship between internal and external factors, strategic

formulation, and landscape sustainability outcomes. The conceptual framework of this study is presented in Figure 2.

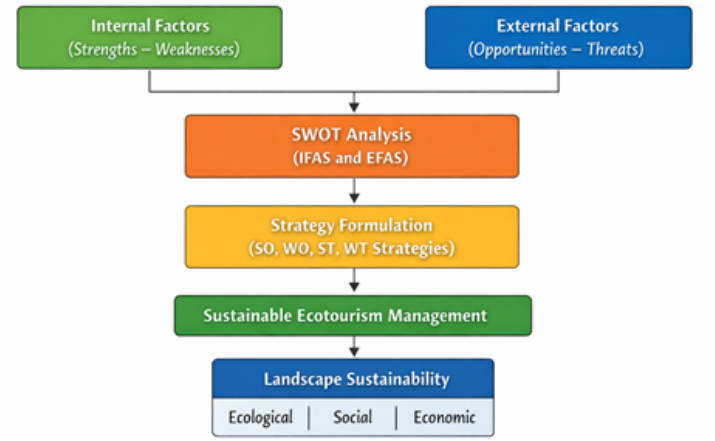

Figure 2. Conceptual Framework of Pine Forest-Based Ecotourism Management for Landscape Sustainability.

2. Materials and Methods

2.1. Study Area

The study was conducted at Kalilo Pine Forest, located in Kaligesing District, Purworejo Regency, Central Java, Indonesia (Address: 64XC+V97, Kalilo, Tlogoguwo, Kec. Kaligesing, Kabupaten Purworejo, Jawa Tengah 54175) as shown in Figure 3. The study area is characterized by pine forest vegetation, hilly topography, and a relatively cool microclimate, which supports the development of nature-based tourism activities. The area also possesses visual landscape attractiveness and ecological value that are relevant to sustainable ecotourism development.

Figure 3. Study Location of Kalilo Pine Forest in Kaligesing District, Purworejo.

2.2. Research Design and Data Collection

This study employed a descriptive, qualitative, and quantitative research design using a case study approach. Primary data were collected through field observations, semi-structured interviews, and questionnaires.

Field observations were conducted to evaluate the physical condition of the landscape, availability of tourism facilities, accessibility, environmental quality, and supporting infrastructure. Semi-structured interviews were carried out with tourism managers, local community representatives, and village officials to obtain in-depth information related to management practices, development challenges, and conservation efforts.

Questionnaires were distributed to selected respondents using a purposive sampling technique, targeting individuals who were directly involved in or knowledgeable about the management and development of Kalilo Pine Forest ecotourism. The selection criteria included tourism managers, members of local community groups, and village officials who actively participated in tourism-related activities. A total of 30 respondents participated in the survey, and all completed questionnaires were included in the data analysis. The questionnaire instrument was developed using a Likert scale ranging from 1 to 4, where:

1 = Very Low

2 = Low

3 = High

4 = Very High

The use of a four-point Likert scale was intended to reduce neutral responses and encourage clearer respondent preferences in evaluating internal and external factors.

To verify the content validity of the questionnaire, we sought expert judgment from academic specialists in ecotourism and landscape management. The items in the instrument were evaluated for their relevance, clarity, and alignment with the objectives related to forest-based ecotourism and landscape sustainability analysis.

Although formal statistical reliability testing, such as Cronbach's alpha, was not performed, the reliability of the instrument was bolstered through a structured questionnaire design, consistent formulation of indicators, and cross-validation of responses obtained from interviews and field observations. This triangulation approach enhanced the credibility and consistency of the collected data.

2.3. Data Analysis

Data analysis was conducted using a SWOT (Strengths, Weaknesses, Opportunities, Threats) framework to formulate strategic directions for sustainable forest-based ecotourism management. The SWOT method has been widely applied in ecotourism and natural resource management studies due to its ability to systematically evaluate internal and external conditions (Asadpourian *et al*., 2020; Benzaghta *et al*., 2021; Hossain, 2025).

Internal factors were analyzed using the Internal Factor Analysis Summary (IFAS), while external factors were evaluated using the External Factor Analysis Summary (EFAS). Each factor was assigned:

- A weight that represents its relative importance (ranging from 0.00 to 1.00).
- A rating that indicates the condition or response level (ranging from 1 to 4).

The determination of weights and ratings was based on expert consideration and respondent evaluation, supported by field observations and interview findings. The weighted scores were calculated by multiplying the assigned weight and rating for each factor.

The total IFAS and EFAS scores were subsequently used to determine the strategic position of Kalilo Pine Forest within the SWOT quadrant matrix. Based on this position, strategic alternatives were formulated using the SO, WO, ST, and WT strategy combinations.

To improve the robustness of strategic formulation, the SWOT results were further interpreted using a priority-based evaluation approach, considering ecological sustainability, community participation, and feasibility of implementation. Future studies are recommended to integrate multi-criteria decision-making methods such as the Analytical Hierarchy Process (AHP) to enhance the robustness of strategy prioritization (Ragheb, 2021). Multi-criteria decision-making methods such as AHP are widely used to support strategic prioritization in complex decision environments (Saaty & Vargas, 2012).

3. Results and Discussion

The internal and external factors were identified through field observations, interviews, and questionnaire responses. These factors reflect the empirical conditions that influence forest-based ecotourism management in Kalilo Pine Forest. They were analysed using the Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) frameworks.

The application of IFAS and EFAS provides a structured understanding of internal and external conditions influencing forest-based ecotourism management, as also demonstrated in previous studies on sustainable forest and ecotourism development (Widayati *et al*., 2024; Rahmawaty *et al*., 2025).

3.1. Internal and External Factor Analysis

The internal factors included in the IFAS were identified through field observations, interviews, and questionnaires. The wording of each factor was subsequently adjusted to emphasize forest-based ecotourism management and landscape sustainability, without altering the underlying empirical conditions represented by the data.

Based on the internal factor identification process described above, the strengths of Kalilo Pine Forest were evaluated using the IFAS framework, as presented in Table 1.

Table 1. Internal Factors Analysis Summary (IFAS) – Strengths.

	Statement	Weight	Rating	Score (W×R)
1	The visual quality and ecological value of the pine forest landscape	0.10	4	0.40
2	Favorable microclimate conditions supporting forest-based ecotourism	0.07	4	0.28
3	Distinctive forest landscape features and natural attractions	0.09	4	0.36
4	Potential of pine forest areas for environmental education and conservation-based ecotourism	0.07	3	0.21
5	Relatively well-preserved forest ecosystem condition	0.09	3	0.27
6	Initial involvement of local communities in forest-based ecotourism management	0.04	3	0.12
7	Affordable access supporting community-based forest ecotourism	0.04	3	0.12
	Total	**0.50**		**1.76**

Source: Primary Data Analysis (2024).

In addition to internal strengths, several internal weaknesses that may constrain sustainable ecotourism management were also identified and evaluated. The summary of internal weaknesses is presented in Table 2.

The IFAS results indicate that the internal condition of Kalilo Pine Forest is relatively strong, as reflected by a total IFAS score of 2.70. Key strengths are associated with landscape quality, environmental conditions, and the potential for educational ecotourism, while major weaknesses relate to limited facilities, management capacity, and the absence of standardized management procedures.

Table 2. Internal Factors Analysis Summary (IFAS) – Weaknesses.

	Statement	Weight	Rating	Score (W×R)
1	Limited supporting facilities for forest-based ecotourism activities	0.12	2	0.24
2	Limited accessibility affects sustainable forest ecotourism management	0.10	2	0.20
3	Limited dissemination and promotion of the forest-based ecotourism potential	0.08	2	0.16
4	Limited management capacity and professional skills in forest ecotourism management	0.08	2	0.16
5	Absence of standard operating procedures for sustainable forest ecotourism management	0.06	1	0.06
6	Inadequate sanitation facilities affect environmental quality	0.04	2	0.08
7	Lack of structured ecotourism programs integrating conservation and education	0.02	2	0.04
	Total	**0.50**		**0.94**

Source: Primary Data Analysis (2024).

While the internal analysis provides insights into the existing management capacity and resource conditions, external factors also play a crucial role in shaping the sustainability of forest-based ecotourism. Therefore, an analysis of external opportunities and threats was conducted using the EFAS framework.

The external factors outlined in the EFAS were developed based on policy, environmental, and socio-economic conditions, specifically tailored to reflect considerations of forest-based ecotourism management and landscape sustainability. Following the identification of these external conditions, potential opportunities for managing forest-based ecotourism were evaluated and summarized in Table 3.

Table 3. External Factors Analysis Summary (EFAS) – Opportunities.

	Statement	Weight	Rating	Score (W×R)
1	Increasing demand for forest-based ecotourism and nature-based recreation	0.12	4	0.48
2	Supportive regional policies for forest and forest-based ecotourism management	0.10	3	0.30
3	Opportunities for multi-stakeholder collaboration in forest-based ecotourism management	0.08	3	0.24
4	Growing interest in nature appreciation and forest landscape photography	0.08	4	0.32
5	Digital platforms as tools for promoting sustainable forest ecotourism	0.07	3	0.21
6	Tourism village programs supporting community-based forest ecotourism	0.05	3	0.15
	Total	**0.50**		**1.70**

Source: Primary Data Analysis (2024).

Alongside external opportunities, several external threats that may hinder sustainable forest ecotourism management were also identified. These threats are summarized in Table 4.

Table 4. External Factors Analysis Summary (EFAS) – Threats.

	Statement	Weight	Rating	Score (W×R)
1	Competition from similar forest-based ecotourism destinations	0.12	3	0.36
2	Risk of forest ecosystem degradation due to increased visitation pressure	0.10	2	0.20
3	Extreme weather events affecting forest accessibility & visitor safety	0.08	2	0.16
4	Low visitor awareness of environmental conservation practices	0.08	2	0.16
5	Seasonal and climatic fluctuations in visitor numbers	0.07	2	0.14
6	Changes in tourism and forest management policies	0.05	2	0.10
	Total	**0.50**		**1.12**

Source: Primary Data Analysis (2024).

The EFAS results showed that external opportunities outweigh existing threats, as indicated by a total EFAS score of 2.82. Major opportunities are driven by increasing demand for nature-based tourism and supportive policy environments, while the main threats relate to competition, environmental risks, and fluctuating visitor patterns.

3.2 Forest-Based Ecotourism Management Strategy

Based on the integration of internal and external factor analyses, a SWOT matrix was developed to formulate strategic directions for sustainable pine forest-based ecotourism management (Table 5). The resulting strategies emphasize forest landscape conservation, management capacity, and community participation as key elements supporting landscape sustainability (Muda, 2025).

Table 5. SWOT Matrix and Strategy Formulation.

Strengths (S)	**Weaknesses (W)**
S1. High visual and ecological quality of the pine forest landscape	W1. Limited supporting facilities for ecotourism activities
S2. Favorable microclimate for forest-based ecotourism	W2. Accessibility still needs improvement
S3. Distinctive natural attractions and educational potential	W3. Inadequate promotion of forest-based ecotourism
S4. Good environmental conditions and conservation value	W4. Limited management capacity and professionalism
S5. Early community involvement in ecotourism initiatives	W5. Lack of formal SOPs for sustainable ecotourism management
	W6. Inadequate sanitation facilities
Opportunities (O)	**Threats (T)**
O1. Increasing demand for nature-based and forest-based ecotourism	T1. Competition from other forest-based ecotourism destinations
O2. Supportive regional policies and tourism village programs	T2. Risks of forest ecosystem degradation due to visitor pressure
O3. Potential collaboration with the government and private sectors	T3. Extreme weather is affecting accessibility and safety
O4. Digital platforms supporting the promotion of sustainable ecotourism	T4. Low visitor awareness of environmental conservation
O5. Rising interest in landscape photography and nature appreciation	T5. Seasonal fluctuations in visitor numbers
O6. Strengthening community-based development approaches	T6. Changes in tourism and forest governance policies

Source: Primary Data Analysis (2024).

Strategic Implications and Formulation Based on SWOT Analysis

SO Strategies (Using Strengths to Seize Opportunities)

1. Develop conservation- and education-based ecotourism programs utilizing the unique pine forest landscape - *(S1, S3, S4 × O1, O6)*
2. Strengthen the identity and branding of Kalilo as a sustainable pine forest ecotourism landscape - *(S1, S2 × O4, O5)*
3. Utilize digital media to promote environmentally responsible and nature-based ecotourism - *(S3 × O4, O5)*

WO Strategies (Overcoming Weaknesses through Opportunities)

4. Improve ecotourism facilities and infrastructure through tourism village programs and stakeholder collaboration - *(W1, W6 × O2, O3)*

5. Enhance local community management capacity through structured training and capability-building programs - *(W3, W4 × O3)*

ST Strategies (Using Strengths to Reduce Threats)

6. Apply conservation principles and carrying capacity controls to prevent forest ecosystem degradation - *(S4 × T2, T3)*
7. Develop landscape uniqueness and differentiation to strengthen competitiveness among forest-based destinations - *(S1, S3 × T1)*

WT Strategies (Reducing Weaknesses and Avoiding Threats)

8. Formulate and implement integrated SOPs for sustainable forest-based ecotourism management - *(W4, W5 × T2, T4, T6)*

Table 6. Strategy Priority Ranking.

No	Strategic Program	Strategy Type	Priority Level	Implementation Focus	Expected Outcomes
1	Development of conservation- and education-based ecotourism programs.	SO	**High Priority**	Environmental education activities, guided forest tours, and ecological interpretation programs.	Increased environmental awareness and visitor learning outcomes.
2	Improvement of local community management capacity through training programs.	WO	**High Priority**	Training in ecotourism management, hospitality, environmental conservation, and visitor services.	Strengthened human resources and improved service quality.
3	Implementation of environmental carrying capacity control.	ST	**High Priority**	Visitor limitation, zoning systems, designated trails, and waste management regulations.	Prevention of environmental degradation and improved ecological sustainability.
4	Improvement of tourism infrastructure and supporting facilities.	WO	Medium Priority	Development of sanitation facilities, signage systems, and visitor amenities.	Enhanced visitor comfort and environmental quality.
5	Development of digital promotion and branding strategies.	SO	Medium Priority	Use of social media platforms and digital campaigns.	Increased visibility and visitor attraction.
6	Formulation of integrated standard operating procedures (SOPs).	WT	Medium Priority	Development of formal management guidelines and operational standards.	Improved management consistency and governance effectiveness.

Source: Primary Data Analysis (2024).

Aggressive strategies emphasizing conservation-based ecotourism and community participation are considered effective in forest landscape management contexts (Asadpourian *et al*., 2020; Priatmoko *et al*., 2021; Lawasi *et al*., 2025).

The integration of internal and external factor analyses positions Kalilo Pine Forest in Quadrant I of the SWOT matrix, indicating a relatively strong internal condition and favorable external opportunities. This strategic position suggests that an aggressive management approach is appropriate, focusing on maximizing existing strengths to capitalize on available opportunities. The S–O strategies emphasize the development of conservation-based educational ecotourism programs that utilize the ecological and visual qualities of pine forest landscapes, as well as the strengthening of the area's identity as a sustainably managed forest landscape. These strategies are aligned with the growing demand for nature-based tourism and the increasing recognition of ecotourism as an instrument for sustainable forest landscape management.

In addition to opportunity-driven strategies, the formulation also incorporates risk mitigation and capacity-building considerations through S–T and W–T strategies. The implementation of conservation principles and controls on environmental carrying capacity is crucial for preventing landscape degradation and maintaining long-term ecological integrity. Meanwhile, improvements in management capacity, basic facilities, and the implementation of integrated standard operating procedures are crucial to addressing internal weaknesses and external threats. These strategies collectively emphasize the need to balance ecological conservation, effective management, and community involvement to promote sustainable ecotourism based on pine forests and ensure landscape sustainability.

To enhance the practical applicability of the formulated strategies, a priority ranking was developed to identify the most critical and feasible actions for sustainable forest-based ecotourism management. The prioritization was determined based on ecological importance, community involvement, and feasibility of implementation. The results of the strategy priority ranking are presented in Table 6.

Following the identification of priority strategies, an implementation roadmap was developed to guide the sequential execution of strategic actions over time. This roadmap provides a structured timeline to ensure systematic and sustainable implementation of ecotourism management strategies, as presented in Table 7.

To support effective monitoring and evaluation, measurable indicators were developed to assess the success of each strategic program. These indicators provide a basis for adaptive management and continuous improvement in forest-based ecotourism management. The indicators of strategy success are presented in Table 8.

Table 7. Implementation Roadmap of Priority Strategies.

Phase	Time Frame	Strategic Focus	Key Activities
Phase 1	Year 1	Capacity Building and Education	Training programs for local communities, development of environmental education modules
Phase 2	Year 2	Infrastructure and Visitor Management	Improvement of facilities, establishment of visitor zoning, and carrying capacity control
Phase 3	Year 3	Institutional Strengthening	Development of SOPs, monitoring systems, and partnership strengthening
Phase 4	Continuous	Promotion and Sustainability	Digital promotion, evaluation of ecological impacts, and adaptive management

Source: Primary Data Analysis (2024).

Overall, the formulated strategies demonstrate that forest-based ecotourism can function as an effective management instrument to balance conservation objectives, management capacity, and socio-economic benefits within pine forest landscapes.

3.3 Ecological Implications of Forest-Based Ecotourism Development

Forest-based ecotourism development in Kalilo Pine Forest presents both opportunities and environmental challenges. The high visual landscape quality and relatively well-preserved ecosystem provide strong ecological foundations for sustainable tourism development. However, increasing visitor numbers may lead to ecological pressures such as soil compaction, vegetation disturbance, and waste generation.

Table 8. Indicators of Strategy Success.

Strategy	Indicator	Measurement
Educational ecotourism development	Number of environmental education programs	Programs/year
Community capacity improvement	Number of trained local participants	Participants/year
Carrying capacity control	Visitor compliance rate	% compliance
Facility improvement	Availability of sanitation and infrastructure	Unit availability
Digital promotion	Online engagement rate	Views/month
SOP implementation	Availability of formal guidelines	Document status

Source: Primary Data Analysis (2024).

These findings align with previous studies indicating that unmanaged tourism growth may accelerate ecosystem degradation if environmental thresholds are not properly controlled (Rahmawaty *et al*., 2025). Therefore, the implementation of carrying capacity control, visitor

zoning, and designated trails is essential to maintain ecological integrity (Dente *et al*., 2025; Molin, 2025). The absence of formal SOPs and visitor limitation mechanisms further highlights the need for adaptive management strategies to balance tourism development and conservation priorities.

3.4 Social Implications and Community Participation

Community participation plays a critical role in supporting forest-based ecotourism management (Musavengane & Kloppers, 2020). The involvement of LMDH Rukun Lestari in Kalilo Pine Forest indicates strong local institutional support that facilitates tourism governance. Capacity-building programs, such as training in hospitality and environmental education, are necessary to enhance local competence and promote responsible tourism behavior.

These findings are consistent with previous studies showing that community-based tourism contributes significantly to local empowerment and long-term development (Hariyadi *et al*., 2024). Strengthening community roles not only improves management performance but also increases acceptance of conservation-oriented tourism policies. Similar findings have also been reported in Indonesian tourism contexts, where strong local participation supports sustainable tourism practices (Wiramatika & Suryawati, 2025).

3.5 Policy and Practical Implications for Sustainable Ecotourism Management

The results of this study highlight the importance of integrating policy frameworks with practical management actions to ensure effective ecotourism governance in Kalilo Pine Forest. The absence of formal Standard Operating Procedures (SOPs) and visitor limitation mechanisms indicates an urgent need for structured management policies to regulate tourism activities and maintain environmental quality (Stone *et al*., 2024).

Tourism activities such as camping and photography demonstrate the increasing diversification of visitor use within the forest landscape. Without proper regulation, these activities may intensify environmental pressure. Therefore, practical management measures such as designated camping zones, visitor flow regulation, and waste management systems are necessary to reduce environmental risks (Das & Chatterjee, 2015).

Institutional collaboration between Perhutani, local communities, and government agencies is also essential to strengthen governance capacity and ensure consistent implementation of conservation-oriented tourism policies. The integration of policy-level planning with field-level practices represents a key strategy to support long-term ecological sustainability.

3.6 Socio-Economic Potential of Community-Based Ecotourism

The development of ecotourism activities, such as camping services and photography tourism, presents opportunities for local economic participation. Although this study did not

directly quantify economic impacts, tourism activities provide potential income sources through guiding services, small-scale food vendors, and local product sales.

Community involvement through LMDH Rukun Lestari plays a strategic role in facilitating these socio-economic opportunities. Strengthening local institutional capacity may enhance the ability of communities to manage tourism services while maintaining environmental quality. Similar observations have been reported in previous studies, which highlight that community-based tourism contributes significantly to rural development and sustainable tourism governance (Krittayaruangroj *et al*., 2023; Lawasi *et al*., 2025).

This study extends previous research by incorporating a structured priority-based strategy formulation that integrates ecological, social, and economic sustainability dimensions, providing a practical framework for sustainable tourism management in collaborative forest systems. Overall, the integration of ecological protection, community participation, institutional governance, and socio-economic development highlights the multidimensional role of forest-based ecotourism in supporting landscape sustainability.

4. Conclusion

This study demonstrates that Kalilo Pine Forest has strong potential to be developed as a sustainable pine forest–based ecotourism destination based on SWOT analysis results, which positioned the study area in Quadrant I, indicating strong internal capacity and favorable external opportunities for conservation-based development. Theoretically, this study contributes to sustainable ecotourism research by integrating SWOT strategic analysis with ecological, social, and economic landscape sustainability dimensions. Practically, the findings highlight the urgent need to establish formal Standard Operating Procedures (SOPs), visitor limitation mechanisms, and environmental monitoring systems as mandatory management instruments to ensure consistent operations and prevent environmental degradation. Future research is recommended to incorporate quantitative ecological indicators and multi-criteria decision-making approaches such as the Analytical Hierarchy Process (AHP) to enhance the robustness of strategy formulation. Overall, the implementation of structured ecotourism management strategies in Kalilo Pine Forest has the potential to serve as a practical model for sustainable forest-based ecotourism development within collaborative forest governance systems in Indonesia.

Abbreviations

IFAS	the Internal Factor Analysis Summary
EFAS	the External Factor Analysis Summary
SWOT	Strengths – Weaknesses – Opportunities – Threats

Data Availability Statement

All data used in this study will be available upon request.

Contributions of Authors

Nike Triwahyuningsih: data collection, conceptualization, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing - initial draft, writing - review and editing. **Dhani Suryawan**: data curation, formal analysis, resources, writing, review, and editing.

Conflict of Interest Statement

The authors declare that they have no competing financial interests or personal relationships that could influence the research in this manuscript.

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References

Asadpourian, Z., Rahimian, M., & Gholamrezai, S. (2020). SWOT-AHP-TOWS Analysis for Sustainable Ecotourism Development in the Best Area in Lorestan Province, Iran. *Social Indicators Research*, 152(1), 289–315. https://doi.org/10.1007/s11205-020-02438-0

Benzaghta, M. A., Elwalda, A., Mousa, M., Erkan, I., & Rahman, M. (2021). SWOT analysis applications: An integrative literature review. *Journal of Global Business Insights*, *6*(1), 55–73. https://doi.org/10.5038/2640-6489.6.1.1148

Das, M., & Chatterjee, B. (2015). Ecotourism: A panacea or a predicament? *Tourism Management Perspectives*, *14*, 3–16. https://doi.org/10.1016/j.tmp.2015.01.002

Dente, S. M. R., Pamungkas, A. S., Le, T. V., & Hashimoto, S. (2025). Tourist Carrying Capacity for Sustainable Development of Gunung Gede Pangrango National Park Ecotourism. *Tourism and Hospitality*, *6*(5), 249. https://doi.org/10.3390/tourhosp6050249

Hariyadi, B. R., Rokhman, A., Rosyadi, S., Yamin, M., & Runtiko, A. G. (2024). The Role of Community-Based Tourism in Sustainable Tourism Village In Indonesia. *Revista de Gestão Social e Ambiental*, *18*(7), e05466. https://doi.org/10.24857/rgsa.v18n7-038

Hossain, M. S., Islam, M. S., Hussain, M. D., & Islam, P. (2025). Sustainable Ecotourism in Bangladesh: A SWOT Analysis of Ecotourism Destinations. *International Journal of Multidisciplinary Research and Growth Evaluation*, 6(2), 1146–1163. https://doi.org/10.54660/.IJMRGE.2025.6.2.1146-1163

Irmawati, I., & Hasnawati, H. (2024). Community-based Ecotourism Strategy for Local Economic Empowerment. *Journal of Education, Humaniora and Social Sciences (JEHSS)*, *7*(2), 395–404. https://doi.org/10.34007/jehss.v7i2.2359

Juliana, Sihombing, S. O., & Suwu, S. E. (2023). Community-Based Ecotourism in Sawarna Tourism Village. *Enrichment : Journal of Management*, 13(1), 258–269. https://doi.org/10.35335/enrichment.v13i1.1192

Kamaluddin, A. K., Hasyim, A. W., Ishak, L., & Haji, S. A. (2025). Ecotourism in Volcanic Regions: A Systematic Literature Review of Community Impact, Stakeholder Involvement, and Development Implications. *Society*, 13(1), 651–669. https://doi.org/10.33019/society.v13i1.881

Krittayaruangroj, K., Suriyankietkaew, S., & Hallinger, P. (2023). Research on sustainability in community-based tourism: A bibliometric review and future directions. *Asia Pacific Journal of Tourism Research*, *28*(9), 1031–1051. https://doi.org/10.1080/10941665.2023.2276477

Lawasi, M. A., Kenda, N., Yusnikusumah, T. R., Pratama, B. B., Pratiwi, D., Septina, A. D., & Asrawijaya, E. (2025). Forest-Based Ecotourism In Indonesia: A Comprehensive Review Of Policy Challenges, Diverse Practices, Stakeholder Engagement, Conservation Efforts, And Socioeconomic Aspects. *Geojournal of Tourism and Geosites*, 60(2), 1041–1056. https://doi.org/10.30892/gtg.602spl02-1478

Molin, L. U. (2025). Advancing visitor management research in protected areas: A sensory ethnographic approach. *Journal of Sustainable Tourism*, 1–23. https://doi.org/10.1080/09669582.2025.2558942

Muda, F. (2025). Community participation in Indonesian sustainable tourism: A systematic review of models, impacts, and gaps. *Priviet Social Sciences Journal*, *5*(8), 125–139. https://doi.org/10.55942/pssj.v5i8.462

Musavengane, R., & Kloppers, R. (2020). Social capital: An investment towards community resilience in the collaborative natural resources management of community-based tourism schemes. *Tourism Management Perspectives*, *34*, 100654. https://doi.org/10.1016/j.tmp.2020.100654

Nugroho, I., Negara, P. D., & Yuniar, H. R. (2018). The Planning And The Development Of The Ecotourism And Tourism Village In Indonesia: A Policy Review. *Journal of Socioeconomics and Development*, 1(1). https://doi.org/10.31328/jsed.v1i1.532

Oka, I. M. D., Murni, N. G. N. S., & Mecha, I. P. S. (2021). The Community-Based Tourism At The Tourist Village In The Local People's Perspective. *GeoJournal of Tourism and Geosites*, 38(4), 988–996. https://doi.org/10.30892/gtg.38401-735

Priatmoko, S., Kabil, M., Purwoko, Y., & Dávid, L. D. (2021). Rethinking Sustainable Community-Based Tourism: A Villager's Point of View and Case Study in Pampang Village, Indonesia. *Sustainability*, 13(6). https://doi.org/10.3390/su13063245

Ragheb, G. A. (2021). Multi-Criteria Decision Making of Sustainable Adaptive Reuse of Heritage Buildings Based on the A'WOT Analysis: A Case Study of Cordahi Complex, Alexandria, Egypt. *International Journal of Sustainable Development and Planning*, *16*(3), 485–495. https://doi.org/10.18280/ijsdp.160309

Rahmawaty, Aththorick, T. A., Harahap, R. H., Rauf, A., Ismail, M. H., Fujiwara, T., & Tedong, P. A. (2025). Management strategies for natural tourism and non-timber forest products support the protection of The Gunung Leuser National Park Buffer Area in mitigating climate change. *BIO Web of Conferences*, 155(06009). https://doi.org/10.1051/bioconf/202515506009

Saarinen, J. (2020). Tourism and sustainable development goals: Research on sustainable tourism geographies. In J. Saarinen (Ed.), *Tourism and Sustainable Development Goals* (1st ed., pp. 1–10). Routledge. https://doi.org/10.1201/9780429324253-1

Saaty, T. L., & Vargas, L. G. (2012). *Models, methods, concepts & applications of the analytic hierarchy process* (2nd ed). Springer. https://link.springer.com/book/10.1007/978-1-4614-3597-6

Stone, M., Stone, L., & Nyaupane, G. (2024). *Protected Areas, Sustainable Tourism and Community Livelihood Linkages* (1st ed.). Routledge. https://doi.org/10.4324/9781003508182

Tervo-Kankare, K. (2021). Book review: D. Weaver, Advanced Introduction to Sustainable Tourism (Edward Elgar Publishing, Cheltenham, UK and Northampton, MA, USA 2020) 168 pp. *Journal of Qualitative Research in Tourism*, *2*(1), 85–87. https://doi.org/10.4337/jqrt.2021.01.10

Triwahyuningsih, N., Noviastuti, N., & Hidayati, N. (2025). Feasibility Study of Ecotourism Development in Kali Talang, Mount Merapi National Park, Klaten, Central Java. *Media Wisata*, 23(2), 492–503. https://jurnal.ampta.ac.id/index.php/MWS/article/view/940

Turner, M. G., & Gardner, R. H. (2015). *Landscape Ecology in Theory and Practice: Pattern and Process*. Springer New York. https://doi.org/10.1007/978-1-4939-2794-4

Weaver, D. B. (2020). *Advanced introduction to sustainable tourism*. EE | Edward Elgar Publishing.

Widayati, A., Winanta, A., Widada, H., & Pratiwi, N. H. (2024). Initiating a Sustainable Community-Based Agritourism Model of Herbal Garden in A Rural Area of Indonesia: Perspectives From Community Members. *Cogent Social Sciences*, 10(1), 2347049. https://doi.org/10.1080/23311886.2024.2347049

Wiramatika, I. G., & Suryawati, D. A. (2025). Local Community Participation Manifests Sustainable Tourim in the Batur Geopark Tourism Area. *Proceedings International Conference on Marine Tourism and Hospitality Studies*, *2*(1), 111–122. https://doi.org/10.33649/iconmths.v2i1.798

Wu, J. (2021). Landscape sustainability science (II): Core questions and key approaches. *Landscape Ecology*, *36*(8), 2453–2485. https://doi.org/10.1007/s10980-021-01245-3

Wu, J., Addai, J., Consolata, M., Gao, Z., Martin, E., Yasutake, E. S., & Wang, Y. (2025). Landscape sustainability science and the Sustainable Development Goals. *Geography and Sustainability*, *6*(5), 100309. https://doi.org/10.1016/j.geosus.2025.100309