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Environmentally sustainable tourism development in mountain regions: A systematic literature review

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ABSTRACT

Background: This study was designed to integrate previous research findings and focus on comprehensive considerations regarding sustainable tourism development in ecologically vulnerable areas such as mountain peaks in Indonesia. This study aims to analyze and synthesize the development of sustainable tourism in Indonesia by reviewing thirteen key academic studies selected from thousands of publications based on inclusion and exclusion criteria. This research is significant from an academic perspective and is aimed at contributing to the development of literature on sustainable tourism by discussing the specific context of the mountainous region in Indonesia. **Methods**: This research uses the SLR or Systematic Literature Review method to provide a comprehensive review of how the tourism business affects the environment and to find an overview of the concept of sustainable tourism that is more environmentally friendly. The steps of the SLR method are described in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol framework guidelines. **Findings:** Based on a comparative analysis of thirteen reviewed studies, this research proposes a conceptual framework for Environmentally Friendly and Improved Sustainable Tourism (EFIST) Indonesia's mountainous regions. This conceptual model highlights that the future of sustainable mountain tourism in Indonesia depends on how effectively these four elements—ecology, community, technology, and governance—are synchronized. **Conclusion**: The synthesis of this systematic literature review analysis culminates in the EFIST conceptual framework, which positions sustainable tourism in mountain areas as an integrated system, rather than a segmented practice. **Novelty/Originality of this article:** This study offers the EFIST model as a framework for policymakers, researchers, and practitioners to implement more cohesive and future-oriented tourism strategies in Indonesia and around the world.

KEYWORDS: environment; mountain; sustainable tourism.

1. Introduction

Indonesia is a country in Southeast Asia located between the continents of Asia and Australia/Oceania and between the Indian Ocean and the Pacific Ocean. Because it is located between two continents and two oceans, Indonesia is also called “Nusantara” (archipelago between) and consists of more than seventeen thousand islands, including Sumatra, Java, Sulawesi, Kalimantan, and Papua (ASEAN Intellectual Property Portal, 2024). In The Travel and Tourism Competitiveness Index Report 2019, Indonesia was ranked in the top 20 for the Natural and Cultural Resources sub-index. Indonesia ranked 17th for the Natural Resources sub-index with a score of 4.5 out of 6.0 (World Economic Forum, 2019). As an archipelagic country, Indonesia has a variety of natural beauties such as valleys, slopes, mountains, and other highland areas that can be used as tourist destinations. Mountain peak

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nature tourism areas have various advantages, such as beautiful natural panoramas and rich flora and fauna. However, this also has various negative impacts, especially on environmental sustainability, which in this case requires environmental conservation policies and sustainable tourism development (Hidayat et al., 2023). The impact of tourism on the environment can be direct, such as destruction of plants, trampling of trails, noise, synanthropization of animals, scaring of animals, introduction of large-scale development to mountain landscapes, littering, and so on. Meanwhile, indirect impacts can increase or decrease the likelihood of certain phenomena, such as increased erosion or reduced reproduction or survival of various animal species (Malec et al., 2024).

Fig. 1. Indonesia travel map
(Indonesia Point, 2025)

Sustainable tourism is defined as a social and cultural activity that emphasizes the protection of the natural ecological environment while promoting economic development in tourist destinations (Stronza et al., 2019). From the perspective of tourism development, sustainable tourism has become the fastest-growing segment of the global tourism industry, with annual growth rates of 25–30%. For example, in 2024 the contribution of Travel & Tourism to global GDP is estimated at US$10.9 trillion, representing around 10% of the global economy (World Travel and Tourism Council, 2024). It is undeniable that sustainable tourism has become a global trend and is increasingly important in the context of global environmental change (Andronache et al., 2019). In mountainous regions in particular—because of their fragile ecosystems, unique cultural landscapes, and often under-developed infrastructure—the challenge is heightened (Herman et al., 2021). Tourism—even in Indonesia's mountainous regions—can provide significant economic opportunities for local communities, but only if it is managed in a sustainable way that balances environmental conservation with economic growth and social welfare. Globally, sustainable tourism in mountainous regions is recognized as a key strategy for ensuring long-term environmental sustainability and preserving cultural heritage (Herman et al., 2021). Although mountain tourism offers substantial economic benefits, if mismanaged it can cause serious environmental challenges (Sánchez-Cañizares et al., 2018).

Given these dynamics, this paper presents a systematic literature review of thirteen peer-reviewed studies focusing on sustainable tourism in mountainous regions, with the aim of developing an integrated conceptual framework for the context of tourism in Indonesia. This analysis revealed four inter-related pillars—Ecology, Community, Technology, and Governance—that form the foundation of the proposed Environmentally Friendly and Improved Sustainable Tourism (EFIST) model. These pillars emerged from a thematic synthesis of the literature and encapsulate the multi-dimensional nature of

sustainable tourism development in mountain destinations. From the ecological standpoint, the reviewed studies emphasised the critical role of biodiversity conservation, watershed protection and trail management for maintaining mountain ecological integrity. On the social side, community participation and economic inclusivity were identified as essential to ensuring that tourism benefits are equitably shared and culturally-sensitive. Technological innovation (e.g., e-biking, digital interpretive tools, environmental monitoring) emerged as an enabler of low-impact tourism and visitor engagement. Meanwhile, governance mechanisms—including policy integration, stakeholder coordination and continuous monitoring—underpin the sustainable management of mountain tourism systems.

By applying the EFIST framework to mountainous regions in Indonesia, this study argues that environmentally friendly and improved sustainable tourism must be conceived as a holistic system rather than a set of isolated practices. In other words, rather than merely reducing negative impacts, sustainable tourism in such sensitive ecosystems must actively promote environmental regeneration, technological adaptation, community resilience and adaptive governance. Consequently, this paper's contribution lies not only in synthesising existing knowledge, but also in articulating context-specific models that can guide tourism policy, planning, and practice in Indonesia. In the context of Indonesian tourism—characterised by popular alpine tourism destinations, high visitor pressure, fragile ecosystems, and evolving infrastructure—the EFIST framework offers a promising pathway for reconciling tourism growth with ecological and social commitments. The findings underscore that success in mountain tourism depends on the contemporaneous integration of ecological restoration, community-based development, digital innovation, and institutional governance. With this integrated approach, tourism in Indonesia can progress towards long-term sustainability, resilience to climate change, and positive contributions to local livelihoods and ecological integrity.

Following up on this, this study was designed to integrate previous research findings and focus on comprehensive considerations regarding sustainable tourism development in ecologically vulnerable areas such as mountain peaks in Indonesia. This is to maintain the preservation, safety, and comfort of mountain peak tourist destinations that are more environmentally friendly. Although there is an increasing number of studies on sustainable tourism, research that specifically discusses how sustainable practices in mountain peak areas prioritize environmental aspects is still limited. Furthermore, although many studies focus on sustainability in tourism at the global or national level, few examine the uniqueness of sustainable tourism from mountain peaks in Indonesia, especially through a systematic literature review that combines and compares various existing findings to produce a more focused result. This research is significant from an academic perspective and is aimed at contributing to the development of literature on sustainable tourism by discussing the specific context of the mountainous region in Indonesia.

2. Methods

This research uses the SLR or Systematic Literature Review method to provide a comprehensive review of how the tourism business affects the environment and to find an overview of the concept of sustainable tourism that is more environmentally friendly. By using the SLR method, researchers can identify, evaluate, and review relevant studies to investigate the specified research topic or question (Nowak & Bertsch, 2025). This method allows researchers to go through systematic steps in searching, evaluating, and synthesizing existing information (Bellanger et al., 2025). The steps of the SLR method are described in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol framework guidelines, which ensure consistency and transparency in the research process (Nichols et al., 2025). Researchers systematically searched for studies related to more environmentally friendly sustainable tourism in the Scopus and WoS databases. Literature was found using predefined keywords, and only literature that met the inclusion criteria was selected (Klein, 2025). The data was then manually exported to

an MS Excel spreadsheet. After that, the titles and abstracts of the selected studies were filtered again according to the inclusion and exclusion criteria (Chen et al., 2025). The PRISMA framework flowchart was used as a guide in this process (Li et al., 2025).

2.1 Search strategy and eligibility criteria

The databases used to achieve the review objectives and search for published studies were Scopus and WoS between 2021 and 2025. Furthermore, the search keywords were combined using the Boolean logic AND operator. The search focused on studies with the keywords tourism AND environment AND mountain.

A systematic approach to literature selection is essential to ensure the validity and reliability of the findings. It is necessary to consider inclusion and exclusion criteria to achieve the research objectives. This is done to filter out search results that are less relevant to the topic being discussed, so that the study results do not deviate from the main points and issues being discussed (Alkhuzaimi et al., 2025).

Table 1. Inclusion and exclusion criteria

Criteria	Inclusion criteria	Exclusion criteria
Publication year	Publications published between 2021 and 2025	Publications published before 2021 or after 2025
Language	Publications written in English	Publications written in languages other than English
Document type	Article	Document types other than articles
Access type	Open access publications	Non–open access publications
Source type	Journal publications	Sources other than journals

2.2 Limitations

This study uses a selective search strategy to limit the scope of the review. Due to the large number of studies related to environmentally friendly tourism, studies were selected based on predetermined inclusion and exclusion criteria. This study also limited the perspective taken to be the focus of the research, namely the environment. Studies not related to tourism policy in this mountain peak area will be excluded from the analyses. Research that is not published in journal form or is not available in English will also be excluded from this study.

2.3 Selection process and reliability of assessment

The literature screening process according to the PRISMA framework consists of five stages. The first stage of information search used the specified keywords and produced 2,238 articles, namely 1,421 articles from Scopus and 817 articles from WoS. The second stage involved screening the literature based on inclusion and exclusion criteria such as language (English), year (2021-2025), document type (articles), source type (journals), and open access status. This reduced the number of articles to 319, consisting of 213 articles from Scopus and 178 articles from WoS. In the third stage, screening was conducted based on titles, which resulted in a total of 39 articles from Scopus and WoS. In the fourth stage, screening was conducted based on abstracts, which resulted in 18 articles. In the fifth stage, duplicate and full-text screening was conducted between Scopus and WoS, resulting in 13 articles. The metadata from these selected studies were then tabulated using a spreadsheet and reviewed in depth.

2.4 Data extraction and analysis

The final selection of studies was examined to extract studies that were relevant to the study objectives. The metadata included the title, year, author's name, and research results

related to data on sustainable tourism in environmentally friendly mountainous areas. This process ensured a structured synthesis of key findings and improved the accuracy of the analysis.

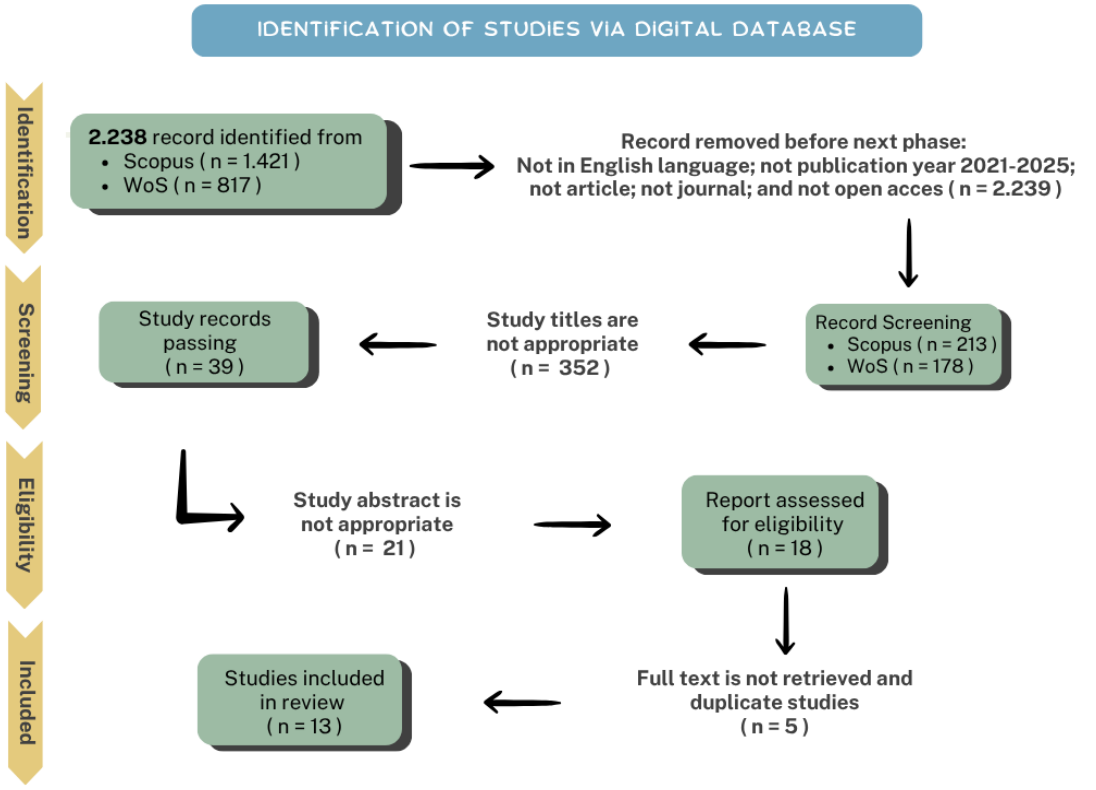

Fig. 2. PRISMA flowchart

3. Results and Discussion

3.1 Overview of reviewed studies

A literature review was conducted on the Scopus and WoS databases using keywords and applying inclusion and exclusion criteria, then compiled beginning with independent theme identification. Next, the lists were compared and a combined keyword classification was compiled, followed by theme comparison and consolidation. Discussions were held to establish a coherent framework that was visualized to help summarize the relationships between existing literature. The framework development was then presented before synthesizing the findings and checking the quality with other experts. The final list of keywords related to each article is presented in Table 2. There are thirteen articles that can be used as references before being developed as a formula in finding answers related to environmentally friendly sustainable tourism in Indonesia.

Table 2. Literature review

Researcher names (Years)	Titles	Methods	Results
Gherdan, A. E. M., Bacter, R. V., Maerescu, C. M., Iancu, T., Ciolac, R., & Ungureanu, A. (2025)	Sustainable tourism development in mountain regions: A case study of peştera village, brasov county, applying the analytic hierarchy process	Integrated bibliometric analysis, structured questionnaire, and the Analytic Hierarchy Process (AHP)	The AHP analysis shows that environmental sustainability emerges as a top priority, emphasizing the need for tourism practices that preserve the natural environment and village ecosystems. This indicates a clear alignment between ecological preservation and fundamental economic aspirations to achieve long-term sustainable development.

Huang, L., Zheng, L., Zhang, L., Chen, J., Chen, Y., Fang, J., Zheng, R., & Liu, H. (2025)	Landscape design and sustainable tourism at the wuyistar chinese tea garden, a world heritage site in Fujian, China	Extensive field & biodiversity surveys, and geographic information system (GIS) analysis	Planning principles prioritize environmental development, mountain reforestation, soil and water conservation, dam construction, and water storage with the development of roads and surrounding facilities.
Li, J., Feng, X., Li, T., Yang, X., Jing, W., & Cao, X. (2025)	Seasonal dynamics of hiking activities in mountainous areas: a topography-aware sequential network modeling approach using crowdsourced trajectories	Complex network analysis method	The balance of mountain ecological conservation is achieved through the development of hiking tourism, including the management of main trails, the regulation of seasonal visitor flows, and evidence-based transportation infrastructure planning. Sustainable tourism contributes to a framework that promotes human-nature coexistence in mountain ecosystems.
Senese, A., Pelfini, M., Belotti, P., Grimaldi, L., & Diolaiuti, G. (2025)	Soft mobility and geoheritage: E-biking as a tool for sustainable tourism in mountain environments	Field surveys, remote sensing analyses, and GIS (Geographic Information System)	E-biking facilitates low-impact exploration of geosites, raising public awareness of environmental challenges while minimizing the ecological footprint. Innovative digital tools (QR-coded virtual guides) enhance visitor education and engagement.
Vishaj, B. & Kuqi, B. (2025)	The natural and cultural assets for preserving the natural environment in Nemuna Mountains National Park	Quantitative methodology	High mountains rich in water, grasslands, and trees can be utilized for tourism. Mountain water is vital for residents and can be used for hydroelectric power generation, water supply, and agricultural irrigation. Poor mountain conditions such as illegal buildings, uncontrolled exploitation, damaged river flows, and inadequate supervision can be addressed with concrete steps to promote mountain and forest protection and conservation.
Du, Q., Guan, Q., Sun, Y., & Wang, Q. (2024)	Assessment of ecotourism environmental carrying capacity in the Qilian mountains, Northwest China	EECC evaluation indicator	It was found that ecological environmental support is under pressure from tourism activities. From a temporal perspective, most indicators from various subsystems show an upward trend.
Malec, M. M., Wojtaszek, A. Z., & Kędzior, R. (2024)	Can tourists' preferences determine the direction of sustainable development in mountain landscapes?	Main hiking trail survey	This allows for a balance between the use of tourist routes and the protection of the natural and cultural environment. This is in line with the principles of sustainable tourism to minimize negative impacts on the environment, while at the same time developing the region economically and satisfying tourists. The development of the tourism sector is linked to tourist satisfaction, which is increasingly driven by the quality of the natural and social environment.
Negri, A., Storta, E., Khoso, R. B., Colizzi, A. M., Acquaotta, F., Palomba, M., &	Sustainable geotourism in the Chiusella Valley (NW Italian Alps): A tool for enhancing alpine geoheritage in the	Field surveys, educational activities and scientific literature analysis, and	It reveals memories of past and present climate change, while supporting the development of targeted geotourism activities in the area. In addition, a specific location has been identified for indoor

Giardino, M. (2024)	context of climate change	assessment of geosites	activities that showcase climate change action.
Aldossary, N. A., Alzahrani, A. A., Alghamdi, J. K., Alqahtany, A., Jamil, R., & Alyami, S. H. (2023)	A procedural framework to identify critical indicators for the protection of environment and ecosystem during sustainable urban development in South-Western Saudi Arabia	Focus group approach (qualitative method)	It is important to focus on developing smaller settlements and minimizing urban expansion to protect wildlife habitats and the plant environment. Protection of local wildlife habitats and consideration of environmental responsibility are key to developing environmentally friendly sustainable tourism.
Chylińska, D. & Kołodziejczyk, K. (2023)	Wounded landscape: Environmental and social consequences of (illegal) motor tourism in forests on the example of worek okrzeszyna (the central sudetes on the polish-czech borderland)	Quantitative methodology	Motorcycle routes that are legally separated from routes intended for hikers and cyclists can resolve potential conflicts between various users of forest tourism and recreation areas, but they will not eliminate the environmental impacts inherent in motorcycle tourism, such as increased erosion, noise, and pollution.
Dax, T. & Tamme, O. (2023)	Attractive landscape features as drivers for sustainable mountain tourism experiences	Qualitative methodology	The focus is not only based on the idea of mountain landscapes, but also includes a vision of small-scale structures in tourist destinations and excludes municipalities that are too focused on tourism growth, which can have a negative impact on the environment. Thus, only small municipalities and municipalities that are not located in tourist centers are allowed to participate.
Wang, V. & Zhang, X. (2022)	Study on the coordinated development of economy, tourism, andeco-environment in Sanjiangyuan	Quantitative analysis	The results show that the economic index of Sanjiangyuan National Park has changed from increasing to slowing down, the tourism index shows a stable upward trend, and the ecological environment index has experienced significant fluctuations. Improvements in the ecological environment promote high-quality economic development and ensure the stable development of the tourism industry. It is urgent to improve the local basic ecological environment. However, the economic index is still much higher than the tourism index and the ecological environment index.
Zeng, T., Ma, L., Li, Y., Abuduwaili, J., Liu, W., & Feng, S. (2022)	Source apportionment of soil heavy metals with PMF model and Pb isotopes in an intermountain basin of Tianshan mountains, China	Pearson correlation analysis and ecological risk assessment methods	The values indicate that the ecological risk in this study area is low. Three sources of soil heavy metals (HMs) were identified and proportioned, namely 27.2% from traffic sources, 38.5% from natural sources, and 34.3% from mixed sources of tourism waste and atmospheric deposition.

This study conducted a systematic literature review of thirteen selected papers focusing on the development of environmentally friendly sustainable tourism in mountainous regions. The studies reviewed covered various contexts, including Asia and Europe, but shared a common focus on conservation issues such as the environment,

ecological stability, community-based tourism, and sustainable infrastructure development. Through thematic analysis, four main themes emerged, namely environmental sustainability and conservation practices, sustainable infrastructure and technological innovation, economic and social dimensions of sustainability, and policy, governance, and environmental risk management. Collectively, these themes contribute to understanding how environmentally friendly tourism can be implemented in Indonesia's mountainous regions.

Table 3. Summary table of key themes

Theme	Key findings	Relevant studies	Implications for Indonesia
Environmental conservation	Reforestation, regulation of visitor flow	1, 2, 3, 5, 7	Ecosystem protection and regulated tourism zones
Eco-infrastructure	E-biking, digital guides, green roads	2, 4, 10	Promote low-emission transport and tech-based learning
Economic-social balance	Small-scale tourism, local satisfaction	1, 7, 11, 12	Empower local communities
Policy & risk management	Supervision, risk mapping	5, 6, 12, 13	Strengthen regional policies and monitoring

Environmental protection and ecological balance are central themes in most of the studies reviewed. The Analytic Hierarchy Process (AHP) in one study highlights that environmental sustainability emerges as a top priority in mountain tourism planning, emphasizing the alignment between ecological conservation and long-term economic aspirations (Gherdan et al., 2025). Several further studies emphasize the importance of reforestation, soil and water conservation, and appropriate land use management as key strategies for preserving mountain ecosystems. For example, one study proposes integrating reforestation programs with water conservation and dam construction to ensure sustainable hydrological management in mountainous areas (Huang et al., 2025). Furthermore, maintaining a balance between tourism development and ecological integrity is achieved through regulated hiking trails, seasonal visitor management, and environmentally conscious infrastructure planning (Li et al., 2025). These approaches ensure that tourism expansion does not harm biodiversity or the landscape. The study also emphasizes that the development of tourism routes must minimize erosion, illegal construction, and uncontrolled exploitation of natural resources (Malec et al., 2024). The ecological risk analysis presented in a paper shows relatively low levels of heavy metal pollution in tourist areas, indicating that with proper environmental monitoring, tourism activities can coexist with environmental safety (Zeng et al., 2022). In the context of mountainous regions in Indonesia—such as mount Gede Pangrango, mount Rinjani, mount Semeru, mount Bromo, mount Ijen, mount Merbau, and so on—these findings underscore the need to prioritize ecological restoration, visitor management, and environmental monitoring. These strategies can be directly applied to local conditions where high tourist numbers and land use change often threaten ecological sustainability.

The development of infrastructure that supports sustainable tourism must consider the environmental impact and long-term ecological resilience. Several studies highlight the importance of building environmentally friendly infrastructure such as water storage systems, eco-friendly roads, and low-emission transportation routes (Vishaj & Kuqi 2025). Technological innovations, particularly in digital-based ecotourism, also play an important role in minimizing environmental degradation. One important example is the integration of e-biking systems for low-impact geosite exploration (Senese et al., 2025). This approach not only reduces carbon emissions but also raises public awareness of environmental issues. Furthermore, the use of digital devices such as QR-coded virtual guides increases visitor engagement and environmental education. Meanwhile, a study shows that separating motorcycle routes from hiking and cycling trails can reduce conflicts between users and reduce physical degradation of natural trails, although residual impacts such as erosion and

noise pollution remain (Chylińska & Kołodziejczyk, 2023). In Indonesia, mountain tourism destinations often rely on heavy visitor traffic and motorized transportation. The implementation of similar sustainable infrastructure and digital innovations can significantly reduce the environmental footprint of these areas. The implementation of environmentally friendly transportation systems and educational technologies can make mountain tourism both attractive and environmentally friendly (Senese et al., 2025).

Sustainable tourism development requires a balance between economic growth, community welfare, and environmental protection. Several studies reviewed emphasize that economic aspirations must be aligned with ecological preservation to ensure long-term sustainability (Wang & Zhang 2022). The papers reviewed collectively argue that the quality of the natural and social environment directly affects tourist satisfaction and, therefore, economic performance. One study highlights that small-scale tourism structures, rather than large-scale city-based development, are more effective in supporting community livelihoods while maintaining environmental quality (Aldossary et al., 2023). This perspective is very much in line with the idea of community-based tourism, which empowers local residents to participate directly in tourism activities and ensures that economic benefits are distributed evenly. Another study reveals that although economic indicators in mountain tourism areas often grow faster than ecological indicators, this imbalance threatens the long-term sustainability of the sector. Therefore, achieving a balance between economic growth and ecological preservation is essential. For Indonesia, this means prioritizing small-scale, community-based tourism projects that emphasize local participation, cultural preservation, and ecosystem protection.

Effective governance policies and mechanisms are essential for maintaining sustainable tourism in mountainous regions. Several studies reviewed indicate that weak oversight, illegal construction, and uncontrolled exploitation often accelerate environmental degradation (Vishaj & Kuqi, 2025). Therefore, a robust governance framework that integrates environmental monitoring and risk management is crucial. Research findings indicate that ecological indices tend to fluctuate significantly under tourism pressure (Du et al., 2024), highlighting the need for adaptive and sustainable monitoring policies. The identification of heavy metal sources in the soil—originating from traffic, natural processes, and mixed tourism waste—further underscores the need for evidence-based environmental regulation. In the case of Indonesia, establishing a local environmental monitoring system that monitors soil, water, and air quality can help reduce the negative impacts of tourism activities. Integrating ecological risk assessments into regional tourism planning will also ensure that environmental thresholds are not exceeded, thereby guaranteeing the long-term sustainability of the region's mountain ecosystems (Zeng et al., 2022).

From these thirteen studies, several consistent findings emerged. First, environmental sustainability remains the foundation for every tourism development model in mountainous regions. Second, technological innovations—such as electric bicycles and digital guides—serve as practical ways to reduce environmental impact while enhancing the tourist experience. Third, small-scale, community-based tourism approaches yield greater long-term benefits than mass tourism models. Finally, effective governance and regular environmental monitoring are necessary to prevent ecosystem degradation. However, there are also differences. Some studies emphasize technological and infrastructure strategies, while others focus on ecological restoration or socio-economic dimensions (Senese et al., 2025). A synthesis of these perspectives shows that a comprehensive approach combining environmental, economic, and social dimensions is needed. For mountainous regions in Indonesia, the implications are clear. Developing environmentally friendly sustainable tourism must involve protecting forest and water resources, implementing green transportation and digital innovation, empowering communities and ensuring fair economic participation, and implementing sustainable environmental monitoring and adaptive governance. By integrating these principles, Indonesia can develop a tourism model that not only attracts visitors but also preserves its ecological integrity for future generations.

3.2 Implications and comparative analysis

A synthesis of the thirteen studies reviewed provides a comprehensive understanding of the concept of environmentally friendly and improved sustainable tourism that can be adapted to the mountainous regions of Indonesia. This concept emphasizes an integrated framework that combines ecological preservation, community empowerment, technological innovation, and adaptive governance—all of which form the foundation for achieving long-term sustainability in tourism. From a comparative perspective, all studies share the understanding that sustainability in mountain tourism depends primarily on maintaining ecological balance while generating socio-economic benefits. The reviewed literature consistently points to interdependent pillars. Regarding ecological sustainability, the natural environment, including forests, rivers, wildlife habitats, and mountain landscapes, is an important asset for tourism in mountainous areas (Aldossary et al., 2023). The studies reviewed emphasize that without strong ecological protection measures, tourism poses a threat to the environment on which it depends. Several papers suggest the implementation of zoning systems, visitor management regulations, and reforestation programs to maintain the ecological integrity of mountain ecosystems. For Indonesia, this means developing strict land use controls in popular destinations such as mount Rinjani, mount Semeru, mount Bromo, mount Ijen, mount Merbau, mount Sumbing, mount Gede Pangrango, mount Lawu, mount Slamet, and so on, while promoting alternative tourist destinations to distribute visitor pressure evenly.

Regarding socio-economic sustainability, many studies reviewed agree that local participation and economic inclusiveness are at the heart of sustainable tourism. Community-based tourism, as described in the literature, enables residents to benefit directly from tourism revenues through small businesses, cultural performances, and local products. In the context of Indonesia, empowering local communities to manage homestays, eco-guided tours, and local food industries (such as traditional Sundanese culinary experiences) can foster a sense of ownership and pride in environmental management while improving economic resilience. Regarding technological and managerial innovation, the application of modern devices such as electric bicycles, virtual guides, and environmental monitoring technology represents the progressive dimension of sustainable tourism. Technology serves as an educational and management tool that reduces environmental impact while enhancing visitor experience (Senese et al., 2025). For example, QR code-enabled interpretive boards along hiking trails can convey environmental messages to visitors, raising awareness without requiring intensive labor. The implementation of digital booking systems that monitor visitor capacity also supports environmental carrying capacity management in mountain tourism areas.

Based on a comparative analysis of thirteen reviewed studies, this research proposes a conceptual framework for Environmentally Friendly and Improved Sustainable Tourism (EFIST) in Indonesia's mountainous regions. The framework integrates environmental conservation, community participation, and economic sustainability as its core dimensions. It is expected to provide practical guidance for policymakers and stakeholders in developing tourism strategies that balance ecological preservation with local economic benefits.

This framework integrates global best practices identified in the literature with Indonesia's specific ecological and sociocultural conditions. Based on ecological principles, the conservation of biodiversity, water systems, and forest cover are fundamental layers. Policies must ensure strict conservation measures in protected mountain areas, supported by ecological risk assessments and continuous monitoring (Zeng et al., 2022). Based on community integration and culture, local residents are key actors, not passive beneficiaries. Sustainable tourism in Indonesia must emphasize local wisdom, traditional environmental knowledge, and equitable economic participation to build a resilient and inclusive tourism economy. Based on technological advances, digital innovations such as smart ecotourism applications, low-emission transportation systems, and environmental data analytics need to be adopted to modernize management while ensuring a minimal ecological footprint (Senese et al., 2025). Indonesia's proximity to technology centers such as Bandung provides

opportunities to effectively integrate these innovations. Based on adaptive governance and policy coordination, strong coordination between government agencies, tourism operators, local communities, and environmental NGOs is necessary. Policies must be flexible and data-driven, enabling timely responses to ecological changes or tourism pressures. Governance must also include transparent environmental reporting and community accountability mechanisms.

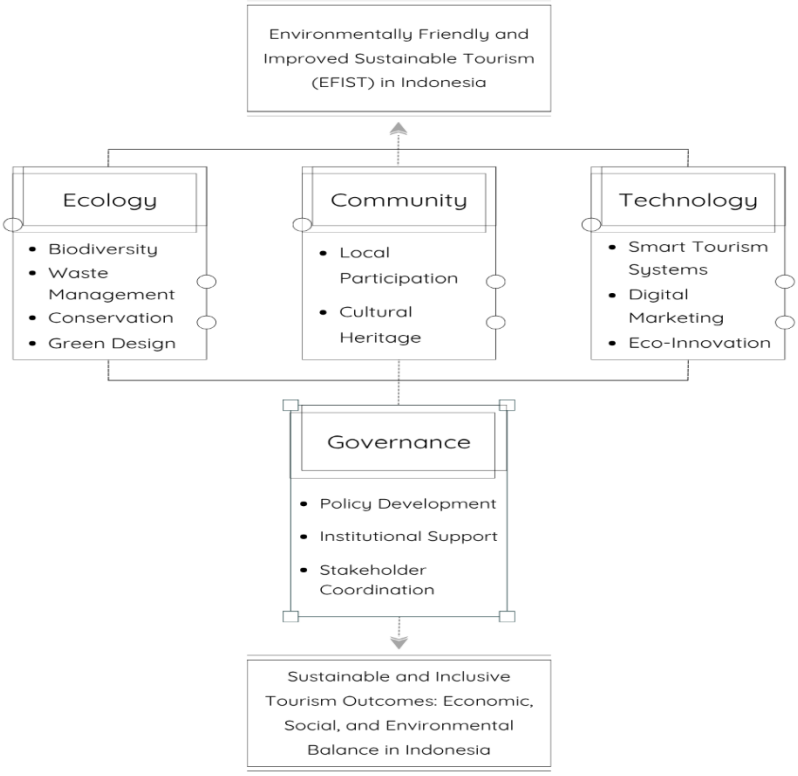

Fig. 3. Conceptual framework of EFIST in Indonesia

The inclusion of this conceptual framework adds new value to existing literature by contextualizing international findings within the regional landscape of Indonesia—particularly in mountainous areas. Unlike many previous studies that examine sustainability from a single perspective, such as the environment, this framework emphasizes multidimensional integration as a path toward greater sustainability. Furthermore, this document introduces the idea of better sustainable tourism—not as a static goal, but as a process of continuous adaptation and innovation. This means that sustainable tourism in Indonesia should not only aim to reduce damage, but also actively regenerate and improve the environment through eco-restoration, circular economy practices, and climate-conscious tourism design. Ultimately, this conceptual model highlights that the future of sustainable mountain tourism in Indonesia depends on how effectively these four elements—ecology, community, technology, and governance—are synchronized. This synergy represents the essence of environmentally friendly and better sustainable tourism, offering a strategic foundation for policymakers, researchers, and practitioners seeking to balance tourism growth with ecological preservation. Environmentally friendly sustainable tourism in mountainous areas must balance environmental conservation, technological adaptation, local community participation, and effective governance. This insight provides a strong empirical foundation for developing practical tourism policies in Indonesia that are in line with global sustainability standards.

Based on the findings of this systematic literature review analysis, local governments must carry out environmental restoration by prioritizing forest rehabilitation, strengthening soil conservation efforts, and managing water resources in all tourist areas. Conservation areas must be clearly defined to prevent illegal development and uncontrolled

land use (Vishaj & Kuqi, 2025). Reforestation and watershed protection programs must be integrated into regional tourism master plans, especially in vulnerable areas such as Mount Rinjani, Mount Semeru, Mount Bromo, Mount Slamet, and so on. There is a need to promote environmentally friendly infrastructure and low-impact transportation (Li et al., 2025). Sustainable infrastructure development should focus on low-emission mobility options, such as electric bicycles, pedestrian paths, and green transportation routes. Digital technologies, including QR code information boards and virtual tour guides, can increase visitor education while reducing physical damage to natural sites (Senese et al., 2025). Infrastructure planning should adopt environmental impact assessments as a mandatory step before construction begins.

This comparative study shows the need for efforts to strengthen environmental policies and monitoring. Local governments must implement stricter environmental regulations to control pollution, manage waste, and preserve biodiversity in tourist areas. Establishing an integrated monitoring system involving the government, local communities, and environmental NGOs will ensure accountability and sustainability of environmental protection efforts. There is a need to improve governance and cross-sector collaboration on sustainable tourism by adopting a multi-stakeholder approach that connects government agencies, the private sector, academics, and civil society. Clear policy coordination and effective communication mechanisms will ensure consistency in sustainability goals across all administrative levels and development sectors. Promoting evidence-based research and policy formulation in this regard is essential. Continuous academic and applied research on the socioeconomic and environmental impacts of tourism should form the basis for policy formulation. Collaboration between universities, tourism agencies, and local communities will generate data-driven insights for more adaptive and context-specific sustainability strategies. In this case, there is a need to develop the EFIST framework as a policy. The conceptual framework developed in this study (EFIST) needs to be further operationalized into measurable indicators and applied as guidelines for tourism planning, evaluation, and education. EFIST should be integrated into regional tourism and government programs so that it can encourage consistent and evidence-based sustainability practices.

Implementing continuous environmental monitoring and risk assessment is essential, especially in mountainous areas. Establishing an ecological monitoring system is necessary to track environmental changes caused by tourism. Indicators such as air and water quality, soil health, and biodiversity must be evaluated regularly. The use of GIS-based mapping and environmental data platforms can help policymakers identify ecological risks early on and take corrective action before significant degradation occurs (Zeng et al., 2022). There is a need to strengthen policy integration and multi-stakeholder governance. Effective governance requires coordination between government agencies, local communities, researchers, and the private sector. The Indonesian government needs to develop a comprehensive sustainable tourism framework that is aligned with Indonesia's national environmental policies. This framework should include clear standards for waste management, visitor capacity limits, and sustainable business certification for tourism operators. Sustainable tourism must prioritize community participation in decision-making processes. Training programs and educational initiatives focused on sustainable entrepreneurship, hospitality, and environmental awareness must be expanded to empower local residents as active partners, not passive beneficiaries. In addition, fostering environmental education and awareness also needs to be addressed. Public education and awareness are crucial to encouraging responsible tourist behavior. Programs such as environmental education workshops, eco-friendly certification for tour guides, and school-based ecotourism projects can foster a culture of sustainability among visitors and local residents. Digital campaigns highlighting conservation success stories can also encourage broader participation in environmental protection.

4. Conclusions

This study aims to analyze and synthesize the development of sustainable tourism in Indonesia by reviewing thirteen key academic studies selected from thousands of publications based on inclusion and exclusion criteria. Through comparative analysis, this study identifies mountain tourism in Indonesia, which collectively forms the foundation of Environmentally Friendly and Improved Sustainable Tourism (EFIST). These dimensions provide a holistic framework that links environmental management, community empowerment, technological innovation, and effective governance for the advancement of sustainable tourism. The studies reviewed also emphasize the important role of biodiversity conservation, environmental management, and green infrastructure in supporting tourist destinations. Environmental initiatives, such as waste reduction, adoption of renewable energy, and environmentally friendly accommodation design, emerge as important strategies to mitigate ecological degradation and enhance the attractiveness of natural tourist destinations. In addition, governance also plays a crucial coordinating role in harmonizing ecological, community, and technological efforts through policy, regulatory, and institutional collaboration. The existence of a clear policy framework, multi-level governance mechanisms, and transparent partnerships between the public and private sectors are essential to ensure the effective implementation of sustainability principles. The synthesis of this systematic literature review analysis culminates in the EFIST conceptual framework, which positions sustainable tourism in mountain areas as an integrated system, rather than a segmented practice. In this model, environmental protection in the mountain tourism sector forms the foundation, while community involvement ensures inclusivity, technology promotes innovation, and governance integrates these dimensions into a coherent strategy.

This research can contribute to achieving a balanced, environmentally conscious, and socially equitable tourism sector in Indonesia. Overall, these findings indicate that sustainable tourism development in Indonesia is progressing, but still requires stronger integration between environmental systems, technology, and governance. Thus, the EFIST model can serve as a reference framework for policymakers, researchers, and practitioners to implement more cohesive and future-oriented tourism strategies in Indonesia and around the world. The integration of ecological awareness, community empowerment, technological advancement, and good governance forms the foundation of the sustainable tourism paradigm in Indonesia. The Environmentally Friendly and Improved Sustainable Tourism (EFIST) model not only provides a theoretical framework but also a practical roadmap towards an inclusive, resilient, and environmentally conscious future for Indonesian tourism. Although this study successfully established the EFIST conceptual framework, further empirical validation is still needed. Subsequent research could conduct field-based case studies in various tourist destinations in Indonesia to test the application of EFIST indicators. Expanding comparative studies to other provinces in Indonesia to identify regional variations in sustainable tourism practices. Such studies would contribute to refining the framework and improving its generalization in Indonesia's national tourism development agenda.

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