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TECHNOLOGICAL INNOVATION AND SUSTAINABILITY IN THE TOURISM INDUSTRY: A COMPARATIVE POLICY STUDY IN CERTIFIED DESTINATIONS IN LATIN AMERICA

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SUMMARY
This study comparatively analyzes the public policies implemented in certified tourist destinations in Latin America that integrate technological innovation and sustainability. Through a qualitative approach, regulatory frameworks, digital strategies, and sustainable practices in Colombia, Mexico, and Costa Rica are examined. The results show differentiated advances in terms of digital infrastructure, community participation and environmental management, highlighting the role of technology as a catalyst for sustainability. It is concluded that the articulation between innovation and sustainability requires institutional coherence, public investment and local adaptability.

Keywords: technological innovation, sustainability, tourism policies, certified destinations, Latin America

INTRODUCTION

The tourism industry has established itself as one of the most dynamic economic sectors globally, accounting for approximately 10% of global GDP before the COVID-19 pandemic (World Tourism Organization [UNWTO], 2022). In Latin America, tourism has been identified as a strategic lever for sustainable development, job creation and environmental conservation. However, the impacts of climate change, pressure on natural resources, and socioeconomic transformations have required a reconfiguration of traditional tourism models (González & Navarro, 2023).

In this context, sustainability and technological innovation are positioned as key axes for the reinvention of the tourism sector. Tourism sustainability, understood as the balanced planning and management of natural, socio-cultural and economic resources, has become an imperative to ensure the long-term viability of destinations

(UNWTO, 2022). At the same time, digital transformation has allowed the development of Smart Tourist Destinations (DTI), integrating technologies such as big data, artificial intelligence, blockchain, and geographic information systems (GIS) to optimize the management of tourist flow, reduce negative impacts, and improve the visitor experience (Pérez et al., 2023; Camargo & Díaz, 2021).

The intersection between innovation and sustainability not only responds to an operational need, but also to a growing demand from tourists, who increasingly value responsible, safe, and personalized experiences (Rivera, Morales, & Rivas, 2022). In this sense, certified destinations – those that have adopted recognised sustainability assessment systems such as EarthCheck, Blue Flag or Biosphere – are constituted as living laboratories where public policies aimed at these objectives are implemented and evaluated (Martínez-Ruiz et al., 2021).

However, the effective integration of technology into sustainable strategies faces multiple challenges in Latin America, including: inequality in access to connectivity, lack of technical capacities, low institutional articulation, and poor impact evaluation (García-Sánchez & Rodríguez-Domínguez, 2023). Despite these challenges, several destinations in the region have begun to design public policies that seek to link innovation and sustainability through the creation of specific regulatory frameworks, economic incentives, talent training, and public-private partnerships.

This study aims to comparatively analyze the policies implemented in three certified tourist destinations in Latin America —Santa Marta (Colombia), Playa del Carmen (Mexico) and Monteverde (Costa Rica)—, in order to identify good practices, common gaps and opportunities for improvement in the articulation between technological innovation and sustainability. The research is based on a qualitative approach that combines documentary review, interviews with key actors and comparative analysis, seeking to provide empirical evidence for the formulation of more effective, inclusive and adaptable policies to the Latin American context.

THEORETICAL FRAMEWORK

Contemporary tourism development is profoundly influenced by two transformative forces: sustainability and technological innovation. Both respond not only to global challenges such as climate change and digitalization, but also to the need to transform the tourist experience and the governance model of destinations (UNWTO, 2022).

1. Sustainable Tourism Approaches

Sustainable tourism is defined as "tourism that takes full account of current and future economic, social and environmental impacts to meet the needs of visitors, industry, the environment and host communities" (UNWTO, 2022, p. 4). In Latin America, this definition has been reinterpreted in terms of territorial and community realities that seek to integrate respect for ecosystems, social equity, and economic viability.

According to García-Sánchez and Rodríguez-Domínguez (2023), the most effective sustainable tourism strategies in the region are characterized by participatory territorial planning, environmental certification, tourist education, and constant monitoring of impact indicators. Sustainable tourism also promotes the enhancement of cultural and natural heritage, local employment and resilience in the face of crises such as the COVID-19 pandemic (Vázquez et al., 2021).

2. Technological Innovation in the Tourism Sector

Technological innovation includes the incorporation of new digital tools, information systems, and intelligent processes to transform destination management, visitor experience, and the tourism business model (Camargo & Díaz, 2021). In particular, technologies such as Big Data, artificial intelligence (AI), augmented reality (AR), geolocation systems, and blockchain are changing the ways in which tourism activities are planned, promoted, and evaluated.

Rivera et al. (2022) point out that the most obvious benefits of digital transformation in tourism include the personalization of services, the optimization of visitor flow, the improvement in the management of carrying capacity, and transparency in tourism operations. However, they also warn about the technological gaps between rural and urban areas, the low interoperability between systems and the lack of regional standards for tourism data.

In this sense, the notion of **Smart Tourist Destinations (DTI)** has gained relevance. This proposal, promoted by the Network of Smart Tourist Destinations of Ibero-America, articulates sustainability, accessibility, governance, technology, and innovation as strategic pillars for tourism development (Pérez et al., 2023).

3. Intersection: Sustainability and Innovation

The current challenge is to achieve a harmonious integration between sustainability and innovation. This convergence is manifested in public policies that articulate environmental protection with the use of technologies for resource monitoring, participatory governance platforms, educational apps for tourists, and intelligent mobility systems (González & Navarro, 2023).

Camargo and Díaz (2021) propose a sustainable digital governance framework where technology functions as a means, not an end, that strengthens social processes, transparency in tourism management, and the co-responsibility of public, private, and community actors.

The following table summarizes some of the key elements of this convergence:

Table 1. Comparison of Principles between Sustainable Tourism and Technological Innovation

Dimension	*Sustainable Tourism*	*Technological Innovation in Tourism*	*Potential Convergence*
Objective	Environmental conservation, social equity, economic viability	Operational efficiency, user experience, intelligent management	Evidence-based responsible tourism development and digital efficiency
Instruments	Certifications, regulations, community engagement	Digital platforms, artificial intelligence, sensors, mobile apps	Automated sustainability indicators, online participatory platforms
Key Players	Local communities, NGOs, local governments	Tech companies, digital governments, tour operators	Collaborative public-private ecosystems with a focus on sustainability
Indicators of Success	Reduced environmental impact, social inclusion, local economic benefits	Levels of digitalisation, efficiency in services, tourist satisfaction	Integrated environmental, social and technological impact assessment
Examples in Latin America	Monteverde (Costa Rica), Barichara (Colombia), Pueblos Mágicos (Mexico)	Playa del Carmen (MX) – Big Data; Medellín (COL) – DTI; Guanacaste (CR) – IA	Santa Marta – sustainable geoindicators; Costa Rica – ecological sensors

Source: Authors' elaboration based on UNWTO (2022), Camargo & Díaz (2021), Rivera et al. (2022), Pérez et al. (2023) and González & Navarro (2023).

METHODOLOGY

This study adopts a qualitative-comparative exploratory-descriptive approach, suitable for understanding complex phenomena such as the articulation between sustainability and technological innovation in Latin American tourism contexts. According to Flick (2022), the qualitative approach allows access to meanings, social practices, and institutional dynamics that cannot be fully captured by quantitative methods. Likewise, comparative design facilitates the identification of patterns, differences, and convergences between different geopolitical realities but with common problems (Yin, 2018).

CASE SELECTION

An intentional sampling of three certified tourist destinations in Latin America that meet the following criteria was chosen:

- Formal recognition through environmental or sustainability certifications (e.g. EarthCheck, Blue Flag, Sustainability Seal).
- Inclusion of digital technologies in their tourism policies or programmes.
- Relevance in the national and regional tourism ecosystem.
- Availability of public information and access to key actors for interviews.

The selected destinations were:

- **Monteverde (Costa Rica)**
- **Playa del Carmen (Mexico)**
- **Santa Marta (Colombia)**

A synthesis of the contextual characteristics of each one is presented below:

Table 2. General characteristics of the selected destinations

Destiny	*Country*	*Sustainable Certification*	*Integrated Technologies*	*Type of Management*
Monteverde	Costa Rica	Ecological Blue Flag	Environmental monitoring platforms, educational tourism apps	Mixed Community Management
Playa del Carmen	Mexico	EarthCheck	Analysis of tourist data, georeferencing	Public-private management
Santa Marta	Colombia	Sustainability Seal	GIS systems, tourist load sensors, ICT diplomas	Local management with state support

Source: Authors' elaboration with data from ICT (2023), SECTUR (2023), MINCIT (2024).

INFORMATION COLLECTION

Three main data collection techniques were employed:

1. **Documentary review**: Included public policies, strategic tourism plans, technical sustainability reports, and documents from official bodies (2020–2024).
2. **Semi-structured interviews**: 12 in-depth interviews were conducted with government officials, representatives of tourism NGOs, community leaders, and private operators in the three destinations. These interviews were recorded, transcribed and coded according to ethical standards (informed consent and anonymity).
3. **Non-participant observation**: In virtual visits and observation of digital platforms, technological tools in use, information flows, and citizen participation were identified.

DATA ANALYSIS

The ATLAS.ti 23 **software was used** for qualitative content analysis, following a thematic approach based on three main analytical dimensions:

- **Dimension 1: SustainabilityEnvironmental, social and economic indicators applied in the destination.**
- **Dimension 2: TechnologyType, scope and objectives of the technological tools implemented.**
- **Dimension 3: GovernanceStakeholder participation, inter-institutional articulation and data management.**

These dimensions were inductively coded from the data and triangulated with the documentary information. Validity was guaranteed through peer review and contrast with previously established theoretical frameworks (García-Sánchez & Rodríguez-Domínguez, 2023; Rivera et al., 2022).

Table 3. Dimensions and Criteria of Comparative Analysis

Dimension	*Criteria analyzed*
Sustainability	Certification obtained, environmental management, socio-economic impact
Technology	Digital typology used, accessibility, scalability, interoperability
Governance	Inclusion of actors, transparency, decentralization, use of data in decision-making

Source: Authors' elaboration based on Pérez et al. (2023) and Camargo & Díaz (2021).

RESULTS

The comparative analysis of Monteverde (Costa Rica), Playa del Carmen (Mexico) and Santa Marta (Colombia) allows us to identify differences and similarities in the way in which each destination has articulated technological innovation with the principles of sustainability. The findings are organized into three major dimensions: sustainability, technology and governance.

1. Implementation of Sustainability Policies

All the destinations studied have recognized certifications, but their level of implementation varies. Monteverde features a deeper integration of ecological principles into its tourism management, with 85% of its operators trained in sustainable practices (ICT, 2023). In Santa Marta, although the regulations are robust, their effective application faces challenges due to budgetary limitations and lack of monitoring (MINCIT, 2024).

Table 4. Sustainability indicators in certified destinations

Destiny	*% of companies with sustainable practices*	*Current certification*	*Solid waste management*	*Active Environmental Education*
Monteverde	85%	Ecological Blue Flag	Recycling and composting (70%)	School Programs and Guides
Playa del Carmen	65%	EarthCheck	Mixed contract with private companies	Limited to guided tours
Santa Marta	58%	Sustainability Seal	Partial separation (40%)	Diploma courses with universities

Source: Authors' elaboration with data from ICT (2023), SECTUR (2023), MINCIT (2024).

2. Adoption and Functionality of Tourism Technologies

In the technological field, the three destinations have implemented digital tools with different degrees of depth. Monteverde leads with environmental monitoring systems connected to climate and tourist traffic sensors, integrated into a community mobile application (González & Navarro, 2023). Playa del Carmen stands out for its use of Big Data for market segmentation, although its use is concentrated in large tour operators (SECTUR, 2023).

Santa Marta has implemented GIS (Geographic Information Systems) maps for the management of protected areas and tourist zoning, which have been used by the municipal administration in infrastructure decisions (MINCIT, 2024).

Table 5. Applied technologies and functions in each destination

Destiny	*Core Technology*	*Function*	*Level of coverage*
Monteverde	Environmental sensors + Mobile app	Load capacity management and education	Registration (municipal and private)
Playa del Carmen	Big Data + Tourism CRM	Tourist segmentation and flow analysis	Media (Enterprise)
Santa Marta	GIS + Territorial Management Website	Green Zoning and Urban Planning	Registration (local government)

Source: Authors' elaboration based on Pérez et al. (2023), Rivera et al. (2022).

A common finding in all three cases is the **lack of interoperability** between platforms and data systems, which limits the creation of unified regional indicators. Likewise, weaknesses in the connectivity of rural areas are identified, which hinders the widespread use of technologies such as IoT (Internet of Things) or artificial intelligence (Camargo & Díaz, 2021).

3. Citizen Participation and Digital Governance

In terms of the governance dimension, Monteverde stands out for its participatory governance structures. More than 60% of strategic tourism decisions are made in cross-sectoral committees that include community leaders, NGOs, and entrepreneurs (ICT, 2023). Santa Marta has created technical tables on sustainable innovation with local universities, while in Playa del Carmen, decision-making continues to be centralized, with low participation of indigenous communities or local fishermen (SECTUR, 2023).

Table 6. Mechanisms for participation and institutional articulation

Destiny	*Spaces for participation*	*Actors involved*	*Using ICT for governance*
Monteverde	Cross-sectoral community committees	NGOs, community, government, business	Citizen application for suggestions
Playa del Carmen	Semi-annual technical forums	Private and municipal sector	Informational website
Santa Marta	Technical tables and ICT diplomas	Universities, government, tour operators	Open Data Platform

Source: Prepared by the authors with data from institutional sources (ICT, SECTUR, MINCIT).

Synthesis of Findings

- **Monteverde** demonstrates a comprehensive articulation between sustainability, technology and governance, standing out as a replicable model in the region.
- **Playa del Carmen** presents an advanced technological strategy, but limited by a business vision that is not very inclusive.

• **Santa Marta** exhibits significant advances in digital planning and academic alliances, although with operational challenges in environmental sustainability.

Conclusions

This comparative study on the articulation between technological innovation and sustainability in three certified tourist destinations in Latin America —Monteverde (Costa Rica), Playa del Carmen (Mexico) and Santa Marta (Colombia)— allows us to draw relevant conclusions both for the design of public policies and for the comprehensive management of tourism in the region.

Firstly, it is noted that **sustainability certification does not guarantee comprehensive and innovative management of the destination on its own**. Although all the cases studied have regulatory frameworks and environmental recognition, the levels of application, monitoring and social appropriation of the policies vary significantly. Monteverde emerges as the most advanced destination in this regard, due to its participatory governance model, the integration of ecological monitoring technologies, and a sustainability-oriented community culture (ICT, 2023; González & Navarro, 2023).

Second, it is observed that **the incorporation of technology in tourism is still uneven and fragmented**. Although the three destinations use tools such as geographic information systems, data analysis or mobile platforms, these solutions are not always articulated with each other, nor do they respond to a comprehensive digital transformation strategy (Pérez et al., 2023; Rivera et al., 2022). This highlights the need to create regional frameworks for technological interoperability, as well as common standards for the processing of sustainable tourism data (Camargo & Díaz, 2021).

Third, it is evident that **the governance dimension is a determining factor for the success or stagnation of technological sustainability initiatives**. Destinations such as Monteverde and Santa Marta have shown that the participation of local communities, academic institutions, and private actors facilitates the generation of shared knowledge, citizen monitoring, and the adaptability of public policies (MINCIT, 2024; UNWTO, 2022). On the contrary, the low social participation observed in Playa del Carmen reduces the legitimacy and sustainability of the technological decisions implemented.

From a regional perspective, these findings suggest that **the convergence between innovation and sustainability requires more than simply incorporating digital devices or certifications**. A holistic vision is needed that promotes a structural transformation in the models of governance, education, financing, and evaluation of tourism (García-Sánchez & Rodríguez-Domínguez, 2023). In particular, it is essential to:

• Promote **technological training** in local communities so that they can appropriate the tools and actively participate in tourism management.

• Promote **public-private-academic partnerships** that allow for the co-design of technologies adapted to local contexts.

• Establish **integrated monitoring systems** with real-time data that support strategic decision-making.

• Ensure **equitable access to connectivity** and reduce the territorial digital divide in rural areas.

In short, the experience of these destinations shows that **sustainability and innovation are not parallel paths, but profoundly interdependent**. Technology, well oriented, can act as a catalyst for sustainable transformations; but without strong institutions, social participation, and policy coherence, it risks becoming a superficial or even exclusionary tool (UNWTO, 2022; Vázquez et al., 2021).

Future studies could broaden the geographical scope of the analysis, include quantitative variables of economic and ecological impact, and explore the role of new technologies such as blockchain or generative artificial intelligence in sustainable tourism management in Latin America.

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