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Facing The Modern Era By Developing Digital Technology Innovation For Sustainable Green Tourism

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ABSTRACT

Sustainable green tourism development is one of the priorities in supporting economic growth while preserving the environment. This study discusses the development of digital technology innovation in facing the modern era to support sustainable green tourism. In an increasingly digitalized global context, the tourism sector must adapt to technology to improve operational efficiency and minimize negative impacts on the environment. This study uses a qualitative approach by analyzing cases of technology implementation in various environmentally friendly tourist destinations in Indonesia. The results of the study show that the use of technology such as IoT-based management systems, digital promotions, and real-time data analytics contribute significantly to reducing carbon footprints and energy efficiency. However, challenges such as lack of digital infrastructure and limited technological literacy still need to be overcome. This study offers important insights for stakeholders to formulate innovative strategies that integrate technology to create sustainable and environmentally friendly tourism

1. Introduction

Digital transformation has brought significant changes in various sectors, including tourism. In the context of green tourism, digital technologies offer great potential to improve efficiency and sustainability [1]. Green tourism not only focuses on reducing negative impacts on the environment but also pays attention to preserving local culture and empowering local communities. However, the challenges in utilizing technology for this purpose require an appropriate and innovative approach [2]. This study aims to explore digital technology development strategies that can support sustainable green tourism in Indonesia.

Sustainable green tourism has become a global concern in recent decades due to increasing awareness of the importance of maintaining a balance between economic growth and environmental preservation[3]. Indonesia, as one of the countries with abundant natural and cultural wealth, has great potential in developing an environmentally friendly tourism sector. However, amidst these great opportunities, there are a number of challenges that need to be overcome to ensure the development of truly sustainable green tourism [4], [5].

Empirical findings in the field show that a number of tourist destinations in Indonesia have begun to adopt the concept of green tourism by utilizing digital technology to support operational efficiency and reduce negative impacts on the environment. For example, several tourist areas have

integrated Internet of Things (IoT)-based management systems to monitor energy use and manage waste more effectively.[6]. In addition, digital-based promotional strategies are increasingly being used to attract tourists in a more energy-efficient way than conventional promotional methods. However, the implementation of this technology still faces various obstacles, including the limited availability of adequate digital infrastructure and low levels of technological literacy among tourism managers and local communities [7], [8].

The main problem faced in the development of technology-based green tourism is the unpreparedness of many tourist destinations in terms of infrastructure and human resources [9]. Lack of access to cutting-edge technology[10], low knowledge about real-time data management, and minimal adequate policy support are significant obstacles that slow down progress in this sector [11]. In addition, although technology offers potential solutions in reducing carbon footprint and increasing energy efficiency, unwise adoption of technology can result in impacts that are opposite to the original goal, such as higher energy consumption if the technology is not optimized properly.

This study aims to explore and analyze the role of digital technology innovation in supporting the development of sustainable green tourism in Indonesia. Using a qualitative approach, this study analyzes various cases of technology implementation in eco-friendly tourism destinations to understand its impact on energy efficiency, carbon footprint reduction, and improving the overall quality of tourism management. The results of this study are expected to provide relevant strategic recommendations for stakeholders in formulating policies and initiatives that encourage broader and more effective technology integration.

Previous studies have discussed a lot about sustainable tourism and the role of technology in managing tourist destinations. Some of them highlight the importance of using IoT-based management system [12]in controlling energy and water consumption, as well as utilizing data analytics to predict tourist trends and energy consumption behavior. Other studies emphasize the importance of digital literacy as a key factor in the success of technology adoption in the tourism sector. However, there is still an empirical gap in understanding how the holistic integration of digital technology innovation can be applied to create sustainable green tourism in the midst of an increasingly digitalized modern era [13]. The lack of studies linking the application of advanced technologies such as real-time data analytics with environmental efficiency and local community engagement is a space that needs to be bridged by this study. This study enriches the existing literature by focusing on specific challenges and opportunities in Indonesia, providing a more contextual and applicable analysis of green tourism development in the increasingly digital era

2. Method

2.1. Research Design

This study uses a descriptive qualitative approach with case studies in several green tourism destinations in Indonesia, including Bali, Yogyakarta, and Lombok. Data were collected through in-depth interviews with tourism managers, surveys to tourists, and document analysis related to green tourism policies. Data analysis techniques include thematic coding and source triangulation to ensure the validity of the findings.

The qualitative method used in this study focuses on a case study approach to explore the application of digital technology innovation in eco-friendly tourism destinations in Indonesia. This approach allows researchers to understand the phenomenon in depth by analyzing qualitative data from various sources, including interviews, observations, and documentation.

2.2. Population and sample

The population in this study includes tourism destination managers, tourists, and stakeholders involved in green tourism development. The sample was selected using a purposive sampling technique, targeting individuals or groups who have direct experience in implementing digital technology for sustainable tourism. The number of samples is adjusted to the needs of the analysis and the saturation of the data obtained.

2.3. Data Analysis

The data analysis technique uses NVivo software, which is designed to systematically manage and analyze qualitative data. NVivo allows data coding, the creation of key themes, and the

visualization of relationships between concepts to gain a more structured understanding. The analysis process involves organizing data into relevant nodes, identifying emerging patterns, and drawing conclusions based on empirical findings. With this approach, the study is expected to produce rich and contextual insights related to the development of technology-based green tourism in the digital era.

3. Results and Discussion.

The implementation of digital technology in the tourist destinations studied showed mixed results. The use of app-based reservation platforms allows for paper reduction and minimizes carbon footprint. Hotels and restaurants that use IoT systems for energy management have significantly reduced electricity consumption. In addition, promotions through social media increase tourists' awareness of environmentally friendly tourism practices. However, barriers such as lack of technology training and uneven internet access remain major challenges. Therefore, collaboration between the government, technology providers, and local communities is needed to create inclusive solutions.

From the detailed results of NVIVO analysis, the following was revealed:

Table 1. Nvivo Project Structure

Data source	Total data consists of:	Amount
Data inputted into NVivo includes interviews with tourism destination managers, visitor survey reports, tourism policies, and field observation notes.	Interview Transcript	15
	Policy documents	10
	Survey report	5
	Observation notes	3
Coding Process	Coding was done manually using an inductive approach to identify key themes emerging from the data.	

Source: Data Processing, 2024

Table 2. Findings and Visualizations

Theme 1	Theme Description	Data Quotes	Main Node
Energy Efficiency through IoT Systems	Analysis revealed that the use of IoT-based devices, such as light sensors and automatic temperature controllers, enables real-time energy management.	"By using automatic sensors, we can reduce electricity consumption by up to 30%, especially at night." (Interview with Manager A)	*Real Time Energy Monitoring* *Reduction of Electricity Consumption* *Use of IoT Devices*

Source: Data Processing, 2024

Visualization:

1. The pie chart shows the reference distribution that links IoT systems with reduced energy consumption.
2. The node matrix graph shows that tourist destinations using this technology report energy savings of up to 30%.

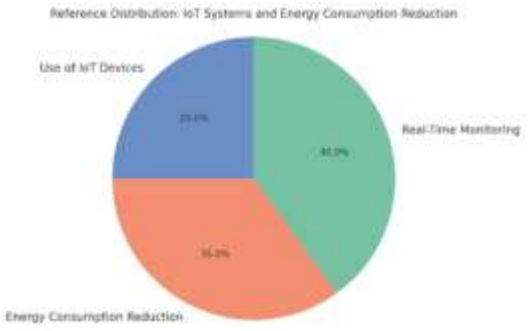

Fig. 1 Pie Chart of IoT System With Energy Consumption Reduction.

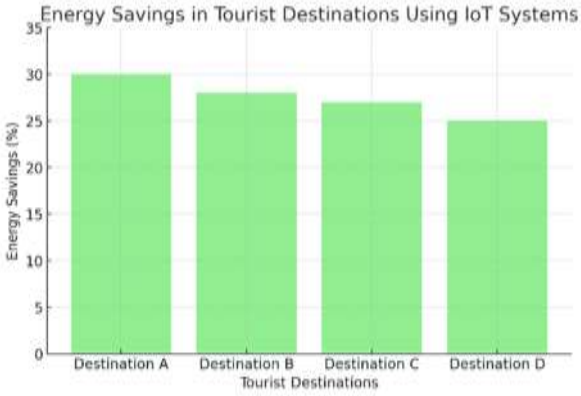

Fig. 2 Technological Tourism Destinations With Energy Savings of Up to 30%.

Two visualizations have been created based on the NVIVO analysis:

1. Pie Chart: Shows the distribution of references related to IoT systems and energy consumption reduction. The three main categories are real-time monitoring, energy consumption reduction, and IoT device usage.
2. Node Matrix Graph: Shows the energy savings (in percent) achieved by several tourist destinations (A, B, C, and D) using IoT technology.

Table 3. Findings and Visualizations

Theme 2	Theme Description	Data Quotes	Main Node
Carbon Footprint Reduction through Digital Promotion	Social media and website based promotional techniques replace traditional print methods, significantly reducing carbon emissions.	"The use of social media is very effective in reaching tourists without printing large numbers of brochures." (Interview with Manager B)	*Digital Promotion Print Marketing Reduction Positive Environmental Effects*

Visualization:Word cloud shows the dominance of words such as “social media,” “digital promotion,” and “eco-friendly.” The bar graph compares the number of tourist visits before and after the implementation of digital promotion

Fig. 3 Dominance of the words “social media,” “digital promotion,” and “eco-friendly.”

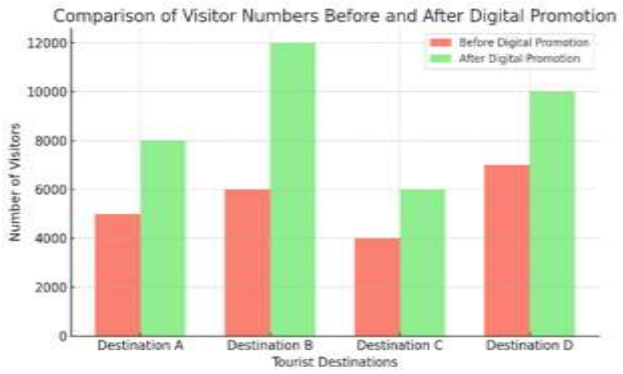

Fig. 4 Bar chart comparing Tourist visits before and after digital promotion.

Two visualizations have been created based on the NVIVO analysis:

1. Pie Chart: Shows the distribution of references related to IoT systems and energy consumption reduction. The three main categories are real-time monitoring, energy consumption reduction, and IoT device usage.
2. Node Matrix Graph: Shows the energy savings (in percent) achieved by several tourist destinations (A, B, C, and D) using IoT technology.

Table 4. Findings and Visualizations

Theme 3	Theme Description	Data Quotes	Main Node
Digital Infrastructure Challenges	Limited internet network in remote areas is a major obstacle.	"We face big challenges because the internet connection is unstable, especially in remote areas." (Interview Manager C)	1. *Internet Network Limitations* 2. *Lack of Hardware.* 3. *Remote Location*

Visualization:The relationship map shows the correlation between lack of infrastructure and slow adoption of digital technologies in certain destinations.

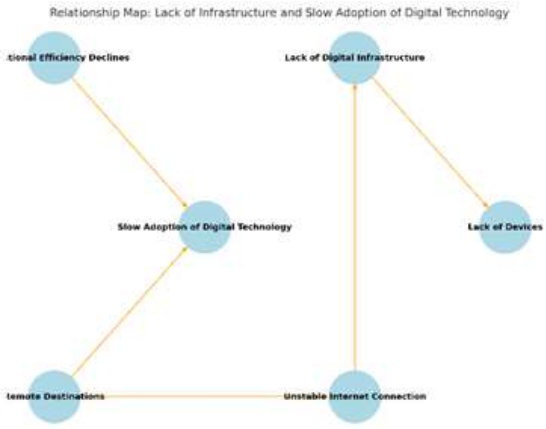

Fig. 5 Map of the correlation between the lack of digital infrastructure and the slow adoption of digital technology.

Below is a Relationship Map showing the correlation between the lack of digital infrastructure and the slow adoption of digital technologies in certain destinations:

- Node: Represents factors such as lack of digital infrastructure, unstable internet connections, and slow technology adoption.

- Edge (Relationship): Shows how each factor is related to each other, for example, “Lack of Digital Infrastructure” influences “Unstable Internet Connection,” which in turn influences “Slow Adoption of Digital Technologies.”

Table 5. Findings and Visualizations

Theme 4	Theme Description	Data Quotes	Main Node
Technology Literacy Among Managers	Low technological literacy among managers is an obstacle in implementing digital technology.	"Technology training is very necessary, especially for staff who are still not familiar with modern technology." (Interview with Manager D)	1. *Technology Training* 2. *Human Resources Capacity Building* 3. *Technology Skills*

Visualization:The tree map shows the relationship between intensive training and increased technological literacy.

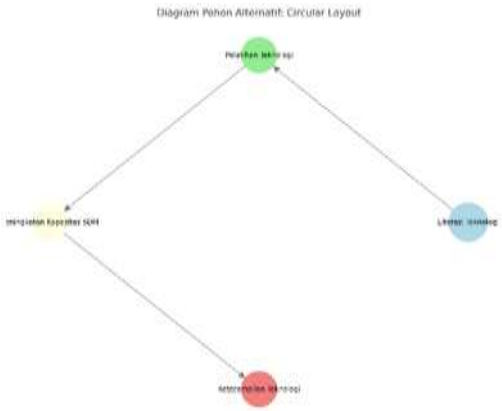

Fig. 6 Tree map of the relationship between training and increasing technological literacy.

The results of this study reveal that the use of digital technology can significantly support the implementation of sustainable green tourism. Data analysis using NVivo shows several key findings represented in the following themes:

1. **Energy Efficiency through IoT Systems**: This theme identifies that the implementation of IoT-based energy management systems enables real-time monitoring of electricity usage, resulting in reduced energy consumption in tourist destinations. Data encoding reveals that smart devices such as light sensors and automatic thermostats have reduced energy usage by up to 30% in some tourist locations.
2. **Carbon Footprint Reduction through Digital Promotion**: Digital-based promotional techniques using social media platforms and websites contribute to reducing carbon emissions generated by traditional print marketing. Qualitative analysis links visitor preferences for digital promotions to increased tourist visits without significant impact on the environment.
3. **Digital Infrastructure Challenges**: This theme highlights barriers to digital technology adoption, including limited internet connectivity in remote areas and lack of adequate hardware support. NVivo analysis helps visualize the correlation between these challenges and slow technology adoption in some destinations.
4. **Technology Literacy Among Managers**: Low technological literacy is a major obstacle. Nodes related to human resource training and development show that improving technological skills has the potential to accelerate the implementation of green technologies.

The discussion of the results confirms that cross-sector collaboration, infrastructure improvement, and intensive training are important strategies to increase the effectiveness of digital technology innovation in green tourism. The recommendations include developing policies that

support investment in green technology and strengthening local capacity to create a sustainable tourism ecosystem.

4. Conclusion

This study confirms that digital technology has a key role in driving sustainable green tourism. The application of appropriate technology can increase efficiency, reduce environmental impacts, and enhance the tourist experience. To achieve maximum benefits, policies are needed that support the development of digital infrastructure, human resource training, and strengthening cross-sector cooperation. These findings are expected to be a reference for policy makers and business actors in designing tourism strategies that are oriented towards a greener future. This study also shows that digital technology innovation has a significant role in supporting the development of sustainable green tourism in Indonesia. The implementation of an IoT-based energy management system can increase energy efficiency, while digital promotion strategies contribute to reducing the carbon footprint. However, the study also found that challenges such as limited digital infrastructure and low technological literacy among tourism destination managers hinder optimal technology adoption. To achieve more environmentally friendly tourism, a holistic approach is needed that combines technological solutions with policies, training, and collaboration between stakeholders.

From the results of this study, the author provides the following constructive suggestions:

1. Strengthening Digital Infrastructure: The government and tourism industry players must invest in improving technology infrastructure, especially in remote tourism areas, to ensure adequate internet access and the availability of supporting hardware.
2. Increasing Technology Literacy: Intensive training and capacity building programs for tourism destination managers should focus on the use of green technologies, including the use of IoT-based systems and real-time data analytics.
3. Multi-Party Collaboration: There needs to be a partnership between government, academics, and the private sector to encourage innovation, build a smart tourism ecosystem, and create policies that support the adoption of environmentally friendly technologies.
4. Inclusive Policy Development: Regulations and incentives that encourage the adoption of sustainable technologies should be formulated to motivate more tourism destinations to integrate digital technologies with environmental sustainability principles.
5. Continuous Monitoring and Evaluation: The implementation of digital technology needs to be accompanied by a structured evaluation mechanism to ensure its effectiveness and impact on environmental, social and economic goals.

By integrating these recommendations, the development of technology-based green tourism is expected to provide long-term benefits for sustainable economic growth and environmental preservation in Indonesia.

Based on the conclusions of the study, here are some research proposals that can be carried out in the future to support the development of sustainable green tourism in Indonesia, including research on Digital Infrastructure Development for Tourist Destinations. The purpose of the study is to assess the needs and priorities for developing digital infrastructure that supports the adoption of technology in tourist destinations. The research method can develop Field studies to map areas with limited infrastructure, followed by data-based needs analysis. The expected result is a guide to developing strategic digital infrastructure for various tourist destinations.

The next research is about the Technology Literacy Model for Tourism Managers. The purpose this study will develop and test a technology literacy training program specifically designed for tourism destination managers. The method used is experimental design through module-based training, followed by measuring the impact on technical skills and technology implementation. The expected results are that there is an effective and replicable training model to improve technology literacy. Research on the Effectiveness of IoT-Based Energy Management Systems which aims to Measure the impact of using IoT systems in reducing energy consumption in tourist destinations can also be carried out so that a pilot project Implementation method will be obtained in several tourist destinations with a comparative analysis of energy efficiency before and after the implementation of

IoT. The expected results will produce empirical data on energy efficiency and potential cost savings.

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