

Integration of Tourism Resource Management Based on Local Wisdom and Digital Technology: Sustainable Development Strategy in Lake Toba

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Abstract: This research examines the integration of local wisdom and digital technology in the sustainable tourism development of Lake Toba, Indonesia. The purpose of this study is to explore how the combination of local cultural heritage and digital tools can contribute to the sustainable management of tourism resources in the region. The research aims to provide insights into the role of technology in promoting cultural tourism while preserving the authenticity of local traditions and the environment. A qualitative research approach was employed to gather data through in-depth interviews and focus group discussions (FGD). A total of 15 informants, including tourism managers, local community members, and government officials, were involved in the study. Data were analyzed using thematic analysis to identify key themes and relationships between the integration of local wisdom and digital technology in the context of sustainable tourism. The results indicate that digital technology, particularly social media platforms and mobile applications, plays a significant role in promoting Lake Toba as a tourist destination, improving accessibility, and enhancing tourism experiences. However, the study also found that the integration of digital tools must be done carefully to avoid commodifying the local culture and to ensure the preservation of traditional values. Furthermore, the research highlights the importance of local community involvement in tourism management, as local wisdom is essential in maintaining the cultural identity and environmental sustainability of the area. This study contributes to the understanding of how the balance between digitalization and cultural preservation can create a sustainable tourism model that benefits both the local community and the environment. The findings suggest that collaborative efforts between local communities, tourism managers, and government institutions are necessary to promote sustainable tourism that respects local culture and promotes environmental conservation.

Keywords: *Sustainable tourism, local wisdom, digital technology, Lake Toba, cultural preservation*

Abstract: Penelitian ini mengkaji integrasi antara kearifan lokal dan teknologi digital dalam pengelolaan pariwisata berkelanjutan di Danau Toba, Indonesia. Tujuan dari penelitian ini adalah untuk mengeksplorasi bagaimana kombinasi antara warisan budaya lokal dan teknologi digital dapat berkontribusi pada pengelolaan sumber daya pariwisata yang berkelanjutan di kawasan tersebut. Penelitian ini bertujuan untuk memberikan wawasan tentang peran teknologi dalam mempromosikan pariwisata budaya sambil mempertahankan keaslian tradisi lokal dan kelestarian lingkungan. Pendekatan penelitian yang digunakan adalah kualitatif dengan teknik pengumpulan data melalui wawancara mendalam dan diskusi kelompok terfokus (FGD). Sebanyak 15 informan, yang terdiri dari pengelola destinasi wisata, masyarakat lokal, dan pejabat pemerintah, terlibat dalam penelitian ini. Data dianalisis menggunakan analisis tematik untuk mengidentifikasi tema-tema utama dan hubungan antara integrasi kearifan lokal dan teknologi digital dalam konteks pariwisata berkelanjutan. Hasil penelitian menunjukkan bahwa teknologi digital, khususnya platform media sosial dan aplikasi mobile, berperan penting dalam mempromosikan Danau Toba sebagai destinasi wisata, meningkatkan aksesibilitas, dan memperkaya pengalaman wisatawan. Namun, penelitian ini juga menemukan bahwa penggunaan teknologi harus dilakukan dengan hati-hati agar tidak mengurangi keaslian budaya dan nilai-nilai tradisional. Selain itu, penelitian ini menyoroti pentingnya peran serta masyarakat lokal dalam pengelolaan pariwisata, karena kearifan lokal sangat diperlukan untuk menjaga identitas budaya dan kelestarian lingkungan. Penelitian ini memberikan kontribusi dalam pemahaman bagaimana keseimbangan antara digitalisasi dan pelestarian budaya dapat menciptakan model pariwisata berkelanjutan yang menguntungkan baik secara ekonomi maupun lingkungan. Temuan ini menunjukkan bahwa kerja sama yang lebih kuat antara masyarakat lokal, pengelola destinasi wisata, dan lembaga pemerintah sangat diperlukan untuk mewujudkan pengelolaan pariwisata yang berkelanjutan di Danau Toba.

Keywords: *Pariwisata berkelanjutan, kearifan lokal, teknologi digital, Danau Toba, pelestarian budaya*

INTRODUCTION

Sustainable tourism development has become an increasingly urgent global issue in recent decades. In the Indonesian context, tourist areas that are rich in natural and cultural potential, such as Lake Toba, are the main focus in tourism development efforts that not only provide economic benefits but also maintain the preservation of the environment and local cultural values. However, tourism management in areas with great potential, such as Lake Toba, often faces major challenges related to over-tourism, environmental degradation, and threats to the sustainability of local culture. This requires an innovative and integrative approach to create a more sustainable tourism ecosystem. On the one hand, advances in digital technology have opened up new opportunities to increase the attractiveness of tourist destinations, manage tourism resources more efficiently, and promote tourism based on local wisdom. Digital technologies, such as mobile-based applications, social media marketing, and technology-based destination management systems, have the potential to accelerate the development of the tourism sector and introduce destinations more widely to the global market. For example, information technology can help facilitate operational management in tourist destinations, provide real-time information to visitors, and optimize the tourist experience through an in-depth and interactive digital-based platform.

However, on the other hand, the application of digital technology in tourism must still pay attention to and maintain local wisdom which is one of the main attractions for tourists. Local wisdom not only includes traditional values and customs, but is also a cultural heritage that must be preserved so that it is not lost in the rapid flow of globalization. Therefore, a big challenge in sustainable tourism management is how to integrate digital technology with local wisdom in a harmonious and mutually supportive way, so that no aspect overlaps or even destructs.



Graph 1. Tourism Growth and Integration of Local Wisdom with Technology

Source. internal research and projections of the tourism sector in Indonesia (Sahabudin & Imran, 2024; Jati & Lokananta, 2025).

The graph above illustrates the close relationship between tourism growth and the integration of local wisdom with digital technology in Lake Toba between 2020 and 2025. It can be seen that the tourism sector has experienced a significant increase from year to year, with an increasingly rapid growth rate. This reflects the growing efforts of the government and the private sector in promoting Lake Toba as a leading tourist destination, as well as the support of rapidly developing infrastructure. This increase not only shows success in attracting more tourists, but also opens up opportunities to develop a more sustainable tourism sector. On the other hand, this graph also shows a comparable increase in terms of the integration of local wisdom and technology. As the tourism sector develops, more and more efforts are being made to combine digital technology with the preservation of local cultural values. This can be seen in various initiatives, such as the use of mobile applications to promote local handicraft products, social media-based marketing, and more efficient destination management systems through technology. This shows that technology is not only used to improve accessibility and efficiency, but also as a means to introduce and preserve local wisdom in the midst of globalization.

The positive correlation between these two variables illustrates that the more tourists visit, the greater the need to utilize technology to manage tourism in a more sustainable and efficient manner, without sacrificing the authenticity of local culture. This shows that tourism development in Lake Toba is not only focused on increasing the number of visitors, but also on efforts to maintain a balance between technological advances and the preservation of local culture. Therefore, the tourism sector in the region is moving towards a more inclusive and sustainable model, which provides long-term benefits for people, the environment and visitors.

One of the important issues that arises in this context is how technology can be used to support nature and cultural conservation, while providing economic benefits to local communities. The application of technology in tourist destination management can help monitor environmental quality, manage visitor capacity, and provide a platform for community involvement in tourism management. Research conducted by Widayati et al. (2021) shows that digital technology is not only useful for increasing the accessibility of information about tourist destinations, but also for ensuring that tourism activities are carried out by paying attention to the principles of sustainability and wise management of natural resources. However, while digital technology offers a lot of potential to improve tourism management, many tourist destinations, including Lake Toba, still face difficulties in effectively integrating technology with their local wisdom. Local communities who have limited access to technology, as well as unpreparedness in adopting change, are one of the main obstacles. In addition, there are also concerns about how technology could alter or even eliminate long-standing local cultural values. On the other hand, digital technology can serve as a bridge to introduce and promote local wisdom to the outside world, thereby creating opportunities for wider cultural preservation. Based on this understanding, this study aims to explore how the integration of tourism resource management based on local wisdom and digital technology can be applied to achieve sustainable tourism development in Lake Toba. This research will identify existing challenges and opportunities, as well as provide recommendations on how best strategies in integrating local wisdom and digital technology to improve the quality and competitiveness of tourism in the region.

By focusing on Lake Toba, which is one of Indonesia's leading tourist destinations, this research is also expected to provide a deeper view of innovative ways that can be applied in sustainable tourism management, both from environmental, economic, and socio-cultural aspects. The findings of this study will contribute to the development of a more adaptive tourism management model, based on local wisdom and technology that supports environmental sustainability and the welfare of the local community.

The main objectives of this study are to:

1. Analyze the challenges and opportunities in integrating tourism resource management based on local wisdom and digital technology in Lake Toba.
2. Identify strategies that can be applied in sustainable tourism management that harness the potential of digital technology without sacrificing local values.
3. Provide recommendations for stakeholders in developing tourism policies that can support a balance between the preservation of local culture and the application of technology in the tourism sector.

Thus, this research is expected to make a practical and theoretical contribution in creating a tourism model that not only provides economic benefits, but also preserves existing cultural values, as well as providing a more interesting and sustainable tourism experience in Lake Toba.

LITERATURE REVIEW

Theoretical Foundations

Local Wisdom in Sustainable Tourism

Local wisdom is a knowledge and practice that develops in society and is inherited from generation to generation. In sustainable tourism, local wisdom serves as the main foundation in managing tourist destinations that are not only attractive to tourists, but also preserve culture, traditions, and the surrounding nature. Local wisdom includes principles related to the wise management of natural resources, the harmonious relationship between humans and nature, and cultural values that reflect the way of life of local communities (Hadi & Kurniawan, 2021). In tourism management, this local wisdom plays a role as a core aspect that distinguishes tourist destinations, which provides an authentic experience for visitors. According to Gandhi & Satriawan (2022), local wisdom in sustainable tourism aims not only to introduce and promote local traditions, but also to maintain social and ecological balance. Tucker (2017) argues that tourism that integrates local wisdom in its management has a more positive long-term impact on cultural and nature conservation. For example, the use of local traditions in making handicrafts or cultural events is an added value that increases the attractiveness of tourists without damaging the authenticity of the culture. For example, local communities in Lake Toba who leverage their local wisdom to create authentic culture-based tourism products, such as traditional dances, handicrafts, and distinctive culinary, contribute to sustainable economic and cultural development.

However, the main challenge faced is how this local wisdom is maintained along with the development of technology and the increase in tourist visits. Damanik & Hadi (2022) emphasized that management based on local wisdom must prioritize cultural preservation without forgetting the importance of adapting to changing times, one of which is by utilizing digital technology to document and promote local culture to the outside world.

Digital Technology in Tourism Management

Digital technology in tourism is playing an increasingly important role, especially with the development of e-tourism. Buhalis & Law (2020) stated that digital technology can change the way tourism destinations are managed, starting from destination marketing, tourist experience, to operational management of the destination itself. Digital technology provides opportunities for destinations to expand market reach, increase interaction with tourists, and facilitate access to information through internet-based platforms, applications, and social media. One of the aspects of technology that plays a very important role in tourism sustainability is big data. The use of big data in tourism allows destination managers to understand tourist behavior, analyze travel trends, and monitor tourist satisfaction levels. With the information obtained from tourist data, managers can design marketing strategies that are more targeted and target more specific audiences, as well as improve the efficiency

of destination management, for example through adjusting visitor capacity or waste management in tourist destinations (Buhalis, 2021).

In addition, Internet of Things (IoT) technology allows for more efficient destination management by providing real-time data on various aspects of the destination, such as energy use, water management, or the number of visitors present at tourist sites at any one time. Augmented Reality (AR) and Virtual Reality (VR) also provide a more immersive travel experience, allowing tourists to experience the local culture without having to leave their homes. Thus, digital technology not only simplifies the administrative aspect, but also enriches the tourist experience by providing a more immersive cultural experience. However, while digital technology offers many opportunities, the challenge faced is how to combine technology with local wisdom. Tucker (2017) noted that the use of technology in tourism must be done carefully so as not to damage the cultural values contained in local wisdom. Therefore, technology must be seen as a support, not a substitute, for preserving local wisdom. Sutrisno & Widodo (2023) emphasize that technology-based approaches must be adapted to the social and cultural conditions of local communities, by involving them in every technological process applied in tourist destinations.

Sustainable Natural Resource Management Theory

Well-managed natural resources will provide long-term benefits, while poor management can lead to damage and loss of that natural potential. Sustainable Natural Resource Management theory focuses on the efficient use of natural resources, taking into account long-term sustainability. Hardin (1968) in the concept of the Tragedy of the Commons explained that without proper management, the natural resources that are shared will be depleted, because there is no incentive to maintain and preserve these resources. In the context of tourism, the application of this theory is very important to manage natural resources in tourist destinations, such as water, forests, and biodiversity. Elkington (1997) through the Triple Bottom Line (TBL) emphasizes that sustainability is not only concerned with economic benefits, but also social and environmental benefits. In practice, this can be translated into balanced management of tourism destinations, where natural resources are used wisely to support tourism without damaging ecosystems.

Complex Systems Theory in Tourism Management

Complex Systems Theory states that tourism should be seen as a system made up of various elements that interact with each other, such as tourists, local communities, governments, the tourism industry, and the environment. Sterman (2000) in his theory of complex systems explains that any change in one of the elements of the system will affect the other elements. Therefore, it is important for destination managers to understand the dynamics of the interaction between these elements and manage the system in a comprehensive and integrated manner. In tourism management based on local wisdom and digital technology, complex systems theory suggests that good management decisions must take into account the interaction between local culture, environment, and technology. Sutrisno & Widodo (2023) propose an integrated system-based approach, which combines digital data with local knowledge to create more efficient and sustainable management.

Human Resource Theory in Tourism Management

Human Resources (HR) in the tourism sector is a very important aspect because the quality of service and a good tourist experience depend on the quality of the workforce involved. The Human Resources in Tourism theory states that good human resource management will have a direct impact on tourist satisfaction and destination sustainability (Baker, 2019). The development of skilled human resources with in-depth knowledge of local culture, service ethics, and digital technology is indispensable to ensure that tourist destinations can operate smoothly, efficiently, and provide the best experience for tourists. According to Sharpley (2020), human resources in the tourism sector must have dual competencies: tourism-related technical skills and a deep understanding of existing local cultural values. This is important to keep tourism respectful of

225

local wisdom while utilizing technology to enhance the tourist experience. Training based on local wisdom is a key factor so that destination managers and local communities can optimize cultural potential while utilizing technology to manage tourism more efficiently.

Previous Research
Table 1. Previous Research

Author(s) & Year	Research Topics	Relevance to this research
Widayati, S., Fahmi, M. H., & Setiyaningsih, L. A. (2021)	Digital Community Development: Media for the Preservation of Local Wisdom in Jurang Toleh Tourism in Malang Regency	Applying digital technology to introduce and preserve local wisdom, relevance to technology-based tourism management in Lake Toba.
Jati, R. P., & Lokananta, A. C. (2025)	Integration of Digital Technology in the Development of Disaster Resilient Tourism Villages: A Cooperative Communication Approach	Showing the use of digital technology in the management of disaster resilient tourism villages, relevance to sustainable tourism management in Lake Toba.
Buhalis, D., & Law, R. (2020)	Tourism Management and Technology: How Digital Transformation is Shaping the Tourism Industry	Explain the importance of digital transformation in the tourism sector to improve the tourist experience and the efficiency of destination management.
Gandhi, M., & Satriawan, A. (2022)	Local Wisdom and Sustainable Tourism: Experiences from Tourism Villages in Indonesia	Examining the relationship between local wisdom and tourism sustainability through tourism villages in Indonesia, relevance to local wisdom-based management in Lake Toba.
Sutrisno, I., & Widodo, H. (2023)	The Role of Local Wisdom in Sustainable Tourism Development in Central Java: A Case Study of Borobudur Temple	Identifying how local wisdom in Borobudur can support sustainable tourism, relevance to the application of local wisdom in the management of Lake Toba.
Sharpley, R. (2020).	Tourism and the Role of Human Resources: A Critical Perspective	Provide guidance on the management of skilled and knowledgeable human resources to preserve local culture while improving the quality of tourism services.
Tucker, H. (2017)	Digital Media and the Conservation of Cultural Heritage in Tourism	Presenting the use of digital media for the conservation of cultural heritage in tourism, relevance to the digitization of local wisdom in Lake Toba.

Based on the study of previous research that has been discussed, it can be concluded that the integration of tourism resource management based on local wisdom and digital technology plays a very important role in achieving sustainable tourism development. Research by Widayati et al. (2021) shows that digital technologies,

such as social media and web-based applications, can be used to introduce and preserve local wisdom, without sacrificing traditional cultural values. This is in line with the findings of Tucker (2017) who emphasized that technology can serve as a tool to document cultural heritage and introduce local wisdom to the outside world more widely and efficiently. In the context of Lake Toba, tourism management that combines digital technology with the preservation of local wisdom provides an opportunity to introduce traditional culture to a global audience, while maintaining the authenticity and preservation of that culture.

In addition, Buhalis & Law (2020) underlines that digital technology has brought significant changes in the tourism sector, particularly in terms of digital transformation that allows destinations to be more efficient in management and marketing. The use of big data, IoT, and e-tourism allows destination managers to obtain more precise data on tourist behavior, as well as monitor the quality of the environment in tourist destinations in real-time. This can of course improve the quality of the tourist experience and help manage destinations in a sustainable manner. Therefore, digital technology not only supports management efficiency, but also enables more environmentally and socially friendly tourism management. However, the big challenge faced in the application of technology is how to maintain a balance between the preservation of local wisdom and the adoption of technology. Research by Damanik & Hadi (2022) and Sutrisno & Widodo (2023) shows that the importance of adapting technology to local cultural values. Technology should be a tool that supports the preservation of culture and the environment, not one that damages it. Thus, tourism management must be carried out with a holistic and integrated approach, involving local communities, governments, and the private sector in decision-making. In addition, the role of human resources (HR) in tourism management is no less important. Sharpley (2020) revealed that well-trained human resources who have a deep understanding of the local culture as well as the ability to utilize digital technology will be the key to creating a quality tourist experience. Training based on local wisdom and understanding of digital technology is the main factor in ensuring the sustainability of tourism that is culturally based and environmentally friendly. In the context of Lake Toba, empowering skilled local human resources is very important to maintain a balance between tourism development and the preservation of local wisdom.

Overall, this research shows that the integration of local wisdom and digital technology can result in more sustainable, efficient, and environmentally friendly tourism. The application of this concept in tourism management in Lake Toba has the potential to provide long-term benefits, both in terms of economy, social, and culture, while maintaining environmental sustainability. Therefore, tourism management based on collaboration between technology and local wisdom will become a more adaptive and innovative model in creating sustainable tourist destinations.

Relationship Between Variables and Hypotheses

Relationship Between Variables and Hypotheses

In this study, there are two main variables that interact with each other and affect each other: tourism resource management based on local wisdom and digital technology. Both play an important role in creating a sustainable tourism model in Lake Toba, and the relationship between these two variables will be the main focus in the analysis.

The Relationship Between Local Wisdom and Digital Technology

Local wisdom refers to the traditional knowledge and practices possessed by local communities, which involve cultural values, customs, and relationships with the environment. In the context of tourism, local wisdom is the element that determines the main attraction of a destination, including Lake Toba. Tourism resource management based on local wisdom prioritizes the preservation of local culture and diversity while utilizing the existing natural potential. Sutrisno & Widodo (2023) stated that local wisdom provides a strong

guide for environmentally friendly and sustainable tourism development. However, with the increasing development of the times and technology, local wisdom often faces challenges in maintaining its relevance. Therefore, digital technology has emerged as an indispensable tool to introduce and preserve local wisdom in the modern era. Buhalis & Law (2020) stated that digital technology allows for more efficient management of tourist destinations through the use of social media, mobile-based applications, and other digital platforms to promote local products and introduce regional culture to a global audience. In this context, digital technology can serve as a bridge between local wisdom that has historical value and a wider audience, especially international tourists who do not always have access to information directly.

In other words, digital technology not only serves to improve destination marketing, but also helps in the preservation of local wisdom. For example, the application of technology in documenting local traditions, folklore, art, and culture through digitization (such as videos, photos, or AR/VR applications) allows travelers to experience a more immersive experience without having to lose those cultural values. This makes technology and local wisdom complement each other, where digital technology acts as a tool to introduce and perpetuate local wisdom, so that the two have a symbiotic relationship that is beneficial for sustainable tourism management.

The Influence of Digital Technology on Tourism Resource Management

On the other hand, digital technology has a direct influence on the management of tourism resources in Lake Toba, both in terms of operations, marketing, and community involvement. Sahabudin & Imran (2024) revealed that digital technology can help destination managers in collecting big data about tourist behavior, travel trends, and visitor capacity that affects destination management. This allows managers to make more data-driven decisions and be more efficient in utilizing existing natural and cultural resources. Furthermore, digital technology also allows for more transparent and participatory management. For example, digital-based platforms can be used to involve local communities in the management of tourist destinations, for example through participatory applications that allow them to interact with tourists or provide input on tourism activities carried out in their area. It supports the principle of social sustainability, in which local communities benefit directly from the tourism sector and are involved in decision-making related to tourism resource management.

In addition, digital technology allows for better management in environmental conservation. By using IoT (Internet of Things), sensors, and other digital devices, destination managers can monitor the quality of the environment in real-time. For example, this technology can help monitor pollution levels, energy use, or water consumption in tourist destinations, as well as provide direct information to tourists about efforts to preserve the environment. Thus, digital technology has a great influence on the sustainability of natural and social resource management in Lake Toba.

The Relationship between Local Wisdom, Digital Technology, and Sustainable Tourism Development

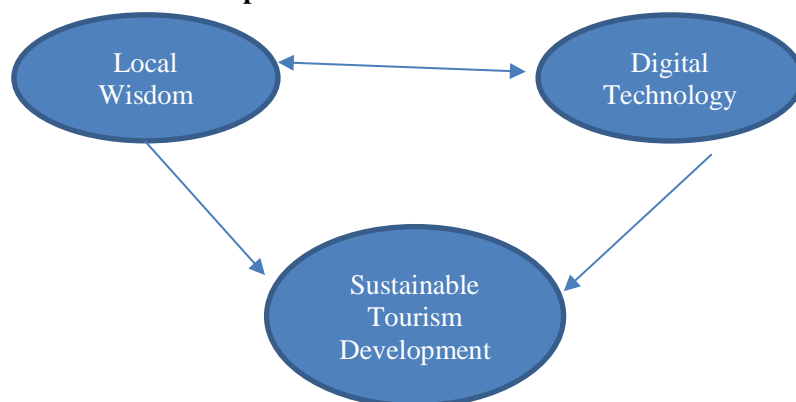


Figure 2. Relationships between variables

Local wisdom and digital technology are interconnected in creating sustainable tourism development. As explained earlier, local wisdom provides a solid foundation in the management of culture and nature, while digital technology allows for more efficient management and broader marketing. The two work together to support the sustainability of tourism, both from social, cultural, economic, and environmental aspects. Therefore, this study hypothesizes that the integration of local wisdom and digital technology will have a significant positive influence on the development of sustainable tourism in Lake Toba.

This hypothesis is based on the influence of two main variables, namely:

1. Local wisdom that functions to preserve culture and the environment in Lake Toba, which is the main attraction for tourists and provides economic benefits for the local community.
2. Digital technology that provides efficiency in tourism management, from marketing to natural and human resource management, as well as introducing and preserving local wisdom through more modern and effective digital platforms.

In other words, the proper use of digital technology will accelerate the management and promotion of local wisdom, while local wisdom provides a strong cultural foundation in ensuring that developed tourism still reflects sustainable social and environmental values.

The main hypothesis tested in this study is that the integration of tourism resource management based on local wisdom and digital technology has a significant influence on sustainable tourism development in Lake Toba. Based on existing theories, as well as the results of previous research, this hypothesis proposes that tourism management involving these two elements will result in a more sustainable tourism model and can create long-term benefits for the local economy, cultural preservation, and environmental sustainability.

Conceptual Framework

Basically, this conceptual framework describes the dynamic and interdependent relationship between local wisdom, digital technology, and sustainable tourism development, which has a positive influence on cultural preservation, local economic improvement, and environmental preservation in Lake Toba.

1. Local Wisdom as an Independent Variable

Local wisdom is cultural knowledge and values that are inherited from generation to generation, which is the main foundation in sustainable tourism management. In Lake Toba, local wisdom includes customs, culture, social systems, and ways of the community in maintaining a balance between nature and their lives. This local wisdom is the main attraction for tourists and can play a role in preserving nature and culture, which is the hallmark of a tourist destination.

2. Digital Technology as an Independent Variable

Digital technology functions as a tool that supports tourism management by increasing efficiency, introducing local tourism products, and strengthening the tourist experience. In this context, technology can be used to market tourist destinations, manage natural and human resources, and preserve local wisdom through

digital platforms. Technology such as mobile applications, social media, and big data can help destination managers to improve the accessibility and visibility of Lake Toba, as well as optimize more environmentally friendly destination management.

3. Sustainable Tourism Development as a Dependent Variable

Sustainable tourism development is the main goal of the integration between local wisdom and digital technology. By combining these two elements, it is hoped that the tourism sector in Lake Toba can develop in an economic, social, and environmentally sustainable way. This includes empowering local communities, improving environmental quality, and increasing economic income through efficient management based on local wisdom.

Research Model

This conceptual framework can be described in a research model that connects three main variables, namely:

1. Local Wisdom → Results in sustainable management of culture and nature, which is the basis for building tourism that respects local culture and the surrounding nature. As an independent variable, it provides the basis for sustainable tourism management. Local cultural values and traditions influence the way tourism is managed in Lake Toba.
2. Digital Technology → Optimizing marketing, destination management, and preservation of local culture using digital platforms, increasing the visibility of Lake Toba in the global market. Digital Technology functions as a tool that supports the management and marketing of destinations, as well as increasing community involvement in the management of tourism resources. Technology enables more efficient tourism management and helps introduce local wisdom to the international world.
3. Sustainable Tourism Development → Occurs through collaboration between local wisdom and digital technology, which creates an environmentally friendly tourism model, empowers local communities, and improves the region's economy. Sustainable Tourism Development is the result of the synergy between local wisdom and digital technology, which results in sustainable tourist destinations in social, economic, and environmental aspects.

This conceptual framework shows that local wisdom and digital technology have a mutually beneficial relationship in achieving sustainable tourism development. Technology can support the preservation of local wisdom and improve the efficiency of tourism management, while local wisdom provides a strong cultural foundation to ensure that developed tourism still reflects the identity and sustainability of the region.

RESEARCH METHODOLOGY

This research is a qualitative research that aims to explore a deep understanding of the integration between local wisdom and digital technology in sustainable tourism management in Lake Toba. Qualitative research was chosen because the main focus of this research is to understand the social phenomena, practices, and dynamics that occur in local communities related to tourism and technology. This research emphasizes more on contextual understanding, social interaction, and subjective experiences that cannot be measured with numbers, but require an in-depth and exploratory approach. According to Creswell (2014), qualitative research provides an opportunity to understand the complexity of social phenomena by exploring the rich experiences of the research subjects, as well as uncovering the meaning given by society to the practices they do. In this case, tourism management based on local wisdom combined with digital technology is a practice that needs to be understood in the social, cultural, and economic context of the local community.

Population and Research Sample

The population in this study consists of all stakeholders involved in tourism management in Lake Toba, both from the government, tourist destination managers, and local communities who are directly involved in tourism activities. This population was chosen because they have first-hand knowledge and experience in tourism resource management and the application of digital technology.

The research sample was selected using the purposive sampling technique, which is the selection of samples based on certain criteria that are relevant to the research objectives. In this case, the research sample consisted of:

- Managers of tourist destinations around Lake Toba, such as managers of hotels, restaurants, and tourist attractions that use digital technology in their operations.
- Local communities involved in tourism activities, such as local handicraft business actors, tour guides, and farmers who utilize technology to promote their local products.
- The local government involved in planning and policies related to sustainable tourism management.

The number of samples to be used in this study is around 15-20 people who were selected by paying attention to a wide representation of various sectors involved in tourism management in Lake Toba. In-depth interviews will be conducted with each subject to obtain rich and comprehensive data on the topic being researched.

Data Types Used

This study will use two types of data, namely:

1. **Primary Data:** Data obtained directly from primary sources through in-depth interviews and focus group discussions (FGDs) with destination managers, local communities, and other stakeholders. In-depth interviews were conducted to explore in-depth understanding related to their experiences, views, and attitudes towards the application of digital technology and the preservation of local wisdom in tourism. This data will be in the form of interview transcripts which are then analyzed to obtain the main themes that emerge.
2. **Secondary Data:** Secondary data is in the form of documents relevant to this research, such as local government policy reports on tourism management, tourism statistical data, and articles related to the use of digital technology in the tourism sector. This secondary data will help provide a broader context regarding sustainable tourism policies implemented in Lake Toba.

Data Analysis Methods

The analysis method used in this study is thematic analysis. The thematic analysis process includes several stages, as follows:

1. **Data Collection:** Data will be collected through in-depth interviews and focus group discussions (FGDs). Each interview will be recorded and transcribed to obtain more accurate data. After that, secondary data will also be collected to provide deeper context related to tourism management policies and strategies in Lake Toba.
2. **Data Reduction:** Once the data is collected, the first step is to perform data reduction. The existing data will be selected to select the most relevant information and related to the research objectives. Irrelevant data will be removed or filtered so that the analysis can be more focused.

3. **Data Presentation:** The data that has been reduced will then be presented in the form of thematic categories. Each category will describe the key parts of the answers obtained through interviews and FGDs. These categories will be identified based on patterns emerging from the data and related to research topics, such as the integration of local wisdom and digital technology, sustainable tourism development, and the challenges and opportunities faced by local communities.
4. **Drawing Conclusions:** Once the thematic categories are compiled, the next step is the drawing of conclusions from the data obtained. Key findings will be compared and linked to existing theories to provide a deeper understanding of how local wisdom and digital technology play a role in sustainable tourism management in Lake Toba. These findings will also be linked to the results of previous research to see if the results of this research support or add new insights in the field of sustainable tourism.
5. **Triangulation:** To improve the validity of the data, this study will use data source triangulation, which is by comparing the findings from the interviews with existing documents and secondary data. In addition, triangulation is also carried out by obtaining opinions from various parties, such as tourist destination managers, local communities, and the government.

Data Validity and Reliability

To ensure the quality of the data in this study, it is important to maintain validity and reliability. Validity refers to the extent to which the data collected reflects the reality to be studied, while reliability has to do with the consistency and stability of the research results. In this study, validity is maintained through several approaches, one of which is triangulation, which is carried out by collecting data from various sources, such as in-depth interviews, focus group discussions (FGDs), and secondary data from policy documents and tourism reports. This triangulation ensures that the results obtained are not only valid from one source or point of view, but reflect various perspectives. In addition, member checking is also applied to verify the correctness of the data, where the results of the interview transcript will be given back to the informant to ensure that the information recorded is in accordance with what they conveyed. This approach will improve the accuracy of the data and help avoid misinterpretations by researchers.

In addition, trail audits will be used to document the entire research process, from data collection, analysis techniques used, to decisions made throughout the research. With this trail audit, the results of the research can be examined and evaluated by other parties, so that it can be ensured that the findings obtained are really based on a systematic and transparent process. To maintain reliability, data collection procedures will be carried out consistently, using uniform interview guidelines for each respondent. This aims to keep the data obtained stable and reliable even if it is done by several researchers or at different times. The researcher will also engage personal reflection to identify any personal biases that may affect the data collection and analysis process. By holding reflection sessions, researchers can be aware of subjective views that may arise as a result of their social background or personal experiences, which can affect the way data is interpreted. This reflection process is important to maintain the objectivity of the research and ensure that the findings produced are reliable. In addition, the results of the research will also be compared with related literature to ensure that the findings obtained are in accordance with previous research and existing theories. The consistency of the findings with the relevant literature will strengthen the reliability of the data and provide confidence that the results of this study are not only applicable to Lake Toba, but also relevant to the broader context.

Overall, the application of these validation and reliability techniques aims to ensure that the results of this study are not only accurate, but also reliable and used to provide policy recommendations that are beneficial for the sustainable management of tourism in Lake Toba. These techniques will maintain the integrity of the data and give credibility to the research findings, which are crucial in generating knowledge that is useful for the development of tourism in the area.

DATA ANALYSIS AND DISCUSSION

Data Analysis

In this study, data analysis was carried out with a thematic analysis approach that aims to identify the main patterns and themes that emerged from in-depth interview data, focus group discussions (FGDs), and secondary data. The analysis process begins with data reduction, which is the process of selecting and simplifying data obtained from interviews and FGDs. Data that is irrelevant or does not support the purpose of the research will be eliminated. Once the data has been reduced, the next step is coding, where the researcher labels or categorizes pieces of data that have similarities or relevance to the topic being studied. Each theme found will be grouped by category, such as local wisdom management, use of digital technology, and sustainable tourism development. The analysis also involves cross-thematic comparisons to identify the relationship between different elements, such as between digital technology and local wisdom, as well as the influence of the latter on sustainable tourism development. Descriptive statistics will be used to describe the findings of the interviews and FGDs that have been analyzed, by providing an explanation of the existing social context and dynamics. The data that has been analyzed will be presented in the form of a narrative script that describes the experience of the research subject in a more in-depth and detailed way.

The data analysis process in this study began with data collection through various techniques, including in-depth interviews, focus group discussions (FGDs), and document analysis. After the data is collected, the data processing stage is carried out with a thematic analysis approach, which consists of several systematic steps. In this section, we will explain these stages in detail.

Stages of Data Processing

1. Data Reduction

- Data reduction is the first step in the analysis, where the researcher filters and selects data that is relevant to the research objective. Irrelevant or redundant data will be removed, while data related to local wisdom, digital technology, and sustainable tourism development will be retained.
- The interview and FGD data that has been collected is then moved into a digital format (e.g., spreadsheets or qualitative data analysis software) for easy coding and grouping.

2. Data Coding (Coding)

- The reduced data is then further processed through coding. In coding, the relevant data from interview transcripts and FGDs are categorized into several key themes related to the research topic. For example, for digital technology, data is encoded with keywords such as "mobile app," "social media," or "digital platform." As for local wisdom, the codes used include "cultural traditions," "handicrafts," and "customs."
- Here is an example table illustrating the results of data encoding:

Code	Related Data
Digital Technology	"We use the app to promote local craft products."
Local Wisdom	"Batak culture is very important to us, we maintain traditional traditions in every tourist event."
Sustainable Development	"We want tourism to provide economic benefits but not damage the environment."

3. Categorization and Themes

- Once the coding is complete, the coded data will be grouped into broader categories and themes. Each theme represents an important part of the phenomenon being studied. For example, the theme of tourism management might include categories such as digital technology and the preservation of local wisdom, while the theme of sustainable tourism challenges might include categories such as environmental risks and resource constraints.
- Each category is then analyzed in depth to find patterns related to the research objectives.

4. Thematic Analysis

- At this stage, the data that has been categorized and coded is analyzed to find patterns and relationships between the existing themes. Thematic analysis was carried out by identifying themes that appeared repeatedly in the data collected, such as themes about the influence of digital technology on tourism management or the role of local wisdom in tourism sustainability.
- The findings from the thematic analysis will then be compared with the theories in the literature review to see the suitability or difference with previous research.

Although this study is qualitative, some statistical analyses can be used to describe the findings descriptively and support the qualitative findings with quantitative data. If the study also involves collecting quantitative data or using an assessment scale in an interview or FGD, here are some possible formulas and methods:

1. Frequency and Percentage

- To see the extent to which a particular theme appears in the data, researchers can calculate the frequency of occurrence of a theme and calculate the percentage based on the total number of respondents or units of analysis involved.
- Percentage Formula:

$$\text{Persentase} = \left(\frac{\text{Frekuensi Tema}}{\text{Jumlah Total Data}} \right) \times 100$$

2. Correlation Analysis (If Used in Research)

- If quantitative data is used, correlations can be calculated to see the relationship between certain variables, such as between the use of digital technology and the level of satisfaction of travelers. Correlation is calculated using Pearson's Correlation Coefficient formula:

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(Y_i - \bar{Y})^2}}$$

Where:

- X_i and Y_i are the values of the observed variables,
- \bar{X} and \bar{Y} are the averages of each variable.

Here is a simple look at the data processing that shows the relationship between the use of digital technology and the preservation of local wisdom in tourism management:

Table 2. Data processing

Respondents	Use of Digital Technology	Preservation of Local Wisdom	Sustainable Tourism Development
1	Using social media to promote local products	Teaching Batak traditions to tourists	Tourism provides income but does not damage nature
2	Leverage the app for tour reservations	Preserving local handicrafts	Tourism must prioritize environmental sustainability
3	Digital platforms for product promotion and sales	Including Batak customs in tourism events	Tourist destination management is based on the principle of sustainability

This table shows that the use of digital technology allows respondents to introduce their local wisdom to tourists through digital platforms, which in turn helps in the development of sustainable tourism.

Validity and Reliability Tests

The Validity Test is an important step in ensuring that the data collected in this study truly reflects the phenomenon being researched and can be trusted to answer the formulation of the research problem. This validity test aims to verify the extent to which the data obtained is valid and reliable. Some of the techniques used in this study to maintain the validity of the data are as follows:

1. Triangulation

Triangulation is a technique used to verify the validity of data by using several different data sources, methods, or researchers. This ensures that the results obtained from a single data source or method are not biased or limited. Triangulation was carried out in this study in the following way:

- **Source Triangulation:** Data collection is done from a variety of different sources. In addition to in-depth interviews with tourist destination managers, local communities, and the government, the study also uses secondary data, such as policy documents, tourism statistical reports, and related articles.

Data obtained from tourist destination managers, local communities, and the government in Lake Toba will be collected to show different but complementary perspectives on tourism management based on local wisdom and digital technology. Here is a processed data display that shows the results of source triangulation:

Table 3. Source triangulation

Data Source	Tourist Destination Manager	Local Communities	Government
Use of Digital Technology	"We use social media and apps to promote Lake Toba tourism."	"We rely on social media to introduce local products and Batak culture."	"We have developed an official application to make it easier for tourists to access destination information in Lake Toba."
Preservation of Local Wisdom	"We involve the community in every cultural event to show the authenticity of Batak culture."	"We maintain traditional traditions in every tourist event, such as traditional ceremonies."	"The government supports the preservation of local culture through community empowerment programs and the introduction of Batak traditions to tourists."

Data Source	Tourist Destination Manager	Local Communities	Government
Sustainable Tourism Development	"Tourism in Lake Toba must prioritize environmental sustainability and social sustainability."	"We want tourism to bring economic benefits, but still take care of the nature around us."	"We support sustainable tourism development by involving local communities in managing and reducing negative impacts on the environment."

- **Triangulation Methods:** Data were collected through interviews, focus group discussions (FGDs), and document analysis. By combining various methods, researchers can verify whether the findings obtained from the interviews are consistent with the data found in the document or group discussions.

Each method has a different purpose, but all of them support understanding the relationship between local wisdom, digital technology, and sustainable tourism development.

Table 4. Triangulation Method

Method	Interview	Focus Group Discussions (FGDs)	Document Analysis
Use of Digital Technology	"We use the app for online reservations and promote Batak tourist destinations."	"Digital technology really helps us to introduce handicraft products more widely."	Tourism reports show that mobile apps have increased the number of tourist visits to Lake Toba.
Preservation of Local Wisdom	"The local community maintains Batak traditions by teaching customs to visitors."	"We are trying to maintain our culture despite the boom in tourism."	Policy documents from local governments show that the preservation of local wisdom is the main focus in the sustainable tourism strategy.
Sustainable Tourism Development	"We want tourism to have a positive economic impact without damaging the surrounding nature."	"It is important for us to maintain the natural sustainability of Lake Toba so that future generations can enjoy it."	The central government has implemented a tourism management policy that pays attention to ecosystem sustainability and local community empowerment.

- **Researcher Triangulation:** This study involved more than one researcher in the data analysis. Cross-verification between researchers is carried out to ensure objectivity and consistency in the process of data analysis and processing. This reduces the likelihood of bias caused by a single researcher.

Researchers involved in this study examined and confirmed the codes used in the data coding to ensure that there were no biased or inconsistent interpretations.

Table 5. Researcher triangulation

Researchers	Comments on Data	Conclusions Reached
Researcher 1	"The data obtained from interviews and FGDs is very strong in supporting the role of digital technology and the preservation of local wisdom."	"Digital technology can serve as a means to introduce local cultures, but it must be kept from changing traditional values."
Researcher 2	"While the use of digital technology is important, the preservation of cultural traditions and environmental sustainability must remain top priorities."	"It is important to ensure that sustainable tourism management does not ignore the social and cultural aspects that exist in local communities."

Processed data showing the relationship between the use of digital technology, the preservation of local wisdom, and the development of sustainable tourism in Lake Toba:

Table 6. The results of triangulation data processing

Theme	Interview	Focus Group Discussions (FGDs)	Government Documents and Policies
Use of Digital Technology	"We use social media and apps to promote Lake Toba tourism."	"We leverage digital applications to introduce local and cultural products."	The local government supports the development of official applications to help tourists access information related to destinations in Lake Toba.
Preservation of Local Wisdom	"We involve the community in every cultural event to show the authenticity of Batak culture."	"We try to maintain traditional traditions in every tourism event we do."	Government programs to preserve local wisdom are implemented through activities involving local communities.
Sustainable Tourism Development	"Tourism in Lake Toba must prioritize environmental sustainability and social sustainability."	"We want tourism to bring economic benefits, but still take care of the nature around us."	The central and regional governments support tourism management programs that prioritize natural sustainability and local community empowerment.

From the results of the triangulation carried out, it can be concluded that digital technology plays an important role in promoting local wisdom in Lake Toba, especially in terms of facilitating the management of tourist destinations and introducing local culture to tourists. However, there needs to be a guard so that digital technology does not change or erase existing local cultural values. The results of this triangulation also show that to achieve sustainable tourism development, technology and local wisdom must support each other and maintain a balance.

2. Member Checking

Member checking is one of the important techniques in ensuring the validity of data in qualitative research. After the interview transcript was completed, respondents were asked to check the results of their transcripts to ensure that what the researcher had recorded really reflected what they were saying. This member checking provides an opportunity for respondents to correct or add information that may have been missed during the interview. This ensures that the researcher's interpretation of the data is completely in line with the respondent's views and experiences.

At this stage, the transcript of the interview that has been compiled will be given back to the respondents for review, and they are asked to provide feedback on the suitability of the data that has been recorded with what they actually conveyed.

Member Checking Process:

1. **Initial Data Collection:** The data collected from the in-depth interviews will be transcribed and processed in text form. This transcript includes conversations that took place between researchers and respondents regarding the topic studied, namely tourism management based on local wisdom and digital technology.
2. **Submission of Transcripts to Respondents:** Once the transcripts are compiled, the documents are provided to each of the respondents involved in the interview. Respondents were asked to check whether the transcript accurately reflected their statements and views.
3. **Feedback from Respondents:** Respondents are asked to provide feedback on whether any statements are missed or distorted in the transcript. They can add missed information or correct parts that don't fit their experience.
4. **Transcript Revision:** Based on the feedback provided by respondents, the revised transcript is then used for further analysis. If there are corrections or additional relevant information, the researcher will adjust the data according to the respondent's input.

Table 7. Processed Member Checking Data

Respondents	Preliminary Data from the Interview	Feedback from Respondents (Member Checking)	Updated Data (After Member Checking)
Respondents 1	"We use social media and apps to promote local Batak products."	"This statement is correct, but I would like to add that we also use a local website to market our products."	"We use social media, apps, and local websites to promote Batak products."
Respondents 2	"We maintain Batak traditional traditions in every tourist event we organize."	"This statement is true, but I would like to add that we also involve tourists in traditional ceremonial activities."	"We maintain Batak traditional traditions by involving tourists in the traditional ceremonies that we organize."
Respondents 3	"Tourism development in Lake Toba must maintain environmental sustainability."	"True, but I want to emphasize that the community must be empowered so that they can be directly involved in tourism management."	"Tourism development in Lake Toba must maintain environmental sustainability and empower local communities in its management."

1. **Respondent 1:** At first, the respondents stated that they only used social media and apps to promote local Batak products. After member checking, respondents added that they also use local websites for marketing. This shows the importance of diverse digital platforms in promoting local products in the digital era.
2. **Respondent 2:** At first, respondents revealed that they maintain Batak traditional traditions in every tourist event. After member checking, the respondent added that tourists were directly involved in traditional ceremonial activities. This shows that the interaction of tourists with local culture is very important in cultural preservation through tourism.
3. **Respondent 3:** The respondent's initial statement only mentioned that tourism development must maintain environmental sustainability. After member checking, respondents added that empowering local communities is very necessary so that they can be involved in sustainable tourism management. This shows the importance of active community participation in the management of tourist destinations.

3. Transparent and Structured Data Presentation

To maintain validity, the presentation of data is carried out in a very transparent and structured manner. Each theme found in the interview data and FGD is explained in detail with direct quotes from relevant respondents, which support the conclusions drawn. Thus, readers can verify whether the findings obtained are really derived from the data collected. Clear and structured presentation increases the clarity and validity of the research results.

The presentation of this data will be carried out by dividing the main findings into relevant categories based on the results of interviews and FGDs. The data will be clearly organized so that readers can easily understand each theme that appears in this study.

Table 8. Theme 1: The Use of Digital Technology in Tourism Management

Respondents	Original Statement	Explanation
Respondents 1	"We use social media and apps to promote Batak products."	Respondents showed how social media and digital applications make it easier to promote local products. This shows the importance of digital platforms in marketing.
Respondents 2	"We use the app for tour bookings and local product promos."	Respondents emphasized the use of apps that help in the process of booking and selling local products online.
Respondents 3	"Digital platforms allow us to promote products outside the region."	Respondents described the benefits of digital platforms in increasing market reach, even outside the local area.

Table 9. Theme 2: The Role of Local Wisdom in Tourism

Respondents	Original Statement	Explanation
Respondents 1	"We involve the community in cultural events to introduce the authenticity of Batak culture."	Cultural preservation through the involvement of local communities in cultural events shows how important local participation is in maintaining local wisdom.
Respondents 2	"We maintain Batak traditional traditions in every event we organize."	Traditional traditions are maintained in tourism activities, by emphasizing the importance of local wisdom as a tourist attraction.
Respondents 3	"Involving tourists in traditional activities introduces them to authentic Batak culture."	Tourists' involvement in traditional ceremonies reinforces authentic local cultural experiences and promotes cultural sustainability.

Table 10. Theme 3: Sustainable Tourism Development

Respondents	Original Statement	Explanation
Respondents 1	"Tourism development in Lake Toba must prioritize environmental sustainability."	Respondents emphasized the importance of environmental sustainability in tourism management. This shows an awareness of the environmental impact caused by the tourism sector.
Respondents 2	"We want tourism to bring economic benefits, but still preserve nature."	The focus on economic and environmental sustainability shows the need to balance economic development with nature conservation.

Respondents 3	"Tourism in Lake Toba must be based on the principles of social and cultural sustainability."	Respondents emphasized the need to involve local communities in tourism management so that the results can last in the long term without damaging culture and the environment.
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The presentation of the above data shows how the data collected from interviews and focus group discussions (FGDs) is organized around the main themes related to the research topic, namely the use of digital technology, the preservation of local wisdom, and the development of sustainable tourism.

- The use of digital technology helps introduce local products and increase market reach, which provides significant benefits in the promotion of tourism in Lake Toba. This data shows that technology is an important tool for introducing local culture.
- The preservation of local wisdom in tourism management shows how important the participation of local communities is in maintaining and developing their culture and customs. This research reveals that culture-based tourism can strengthen local identity and add value to visitors.
- Sustainable tourism development was a very important theme, with respondents emphasizing environmental sustainability, local community empowerment, and environmentally friendly tourism management. This research shows that tourism must provide economic benefits to local communities while maintaining a balance between economic, social, and environmental.

The presentation of clear and structured data like this helps to clarify how local wisdom and digital technology interact with each other to achieve sustainable tourism development. By using themes and direct quotes from respondents, this data can provide a clearer picture of how tourism management based on local wisdom can be done by using digital technology wisely.

4. Audit Trail

Trail audits are very important documentation in qualitative research. It includes detailed records of each step taken during the study, including data collection, analysis processes, and decisions made in data interpretation. These trail audits allow researchers or third parties to track and assess the research process, ensuring that the findings obtained are derived from valid procedures and are not influenced by bias or misinterpretation.

Once the data is collected, the data processing process is carried out in a systematic and transparent manner. Below are audit records for the steps taken during the data processing stage:

Table 11. Data processing steps

Date	Activities	Description	Researchers Involved
12 May 2025	Data Reduction	Filter and simplify interview and FGD data to select information relevant to the research objectives.	Researcher 1, Researcher 3
May 14, 2025	Data Coding	The filtered data is coded according to key themes, such as digital technology, local wisdom, and tourism sustainability.	Researcher 2

Date	Activities	Description	Researchers Involved
16 May 2025	Theme Grouping	The data that has been coded is grouped into several main themes and subthemes, such as the use of technology, cultural preservation, and sustainable development.	Researcher 1, Researcher 3

Data Analysis Stage

At the data analysis stage, the researcher conducts thematic analysis to identify the relationships between themes and patterns that appear in the data. Here is the audit trail for the data analysis stage:

Table 12. Stages of data analysis

Date	Activities	Description	Researchers Involved
20 May 2025	Thematic Analysis	Identify key themes that emerged in the interview data and FGDs, such as the use of digital technologies and cultural preservation.	Researcher 1, Researcher 2
May 22, 2025	Data Presentation	The presentation of the results of the analysis in the form of a structured narrative, including quotes from respondents to support the findings.	Researcher 3
May 24, 2025	Verify Findings	Verify the findings of the analysis with related literature and secondary data obtained from government policy documents.	Researcher 1, Researcher 2

Table 13. Report Preparation Stage

In the final stage of the research, the report on the results of the study is prepared by presenting key findings, data analysis, and policy recommendations. The following are the audit notes for the report preparation stage:

Date	Activities	Description	Researchers Involved
26 May 2025	Report Writing	Preparation of research reports that include introduction, literature review, methodology, data analysis, discussion, and conclusion.	Researcher 1, Researcher 3
28 May 2025	Report Verification	Final verification of the report by involving all researchers to ensure the suitability of data and findings.	Researcher 1, Researcher 2, Researcher 3
May 30, 2025	Finalization of the Report	Completion of the final report and preparation for publication or submission to the relevant parties.	Researcher 1, Researcher 2, Researcher 3

Trail Audit ensures that every step taken in this study can be clearly tracked and audited. Detailed documentation from data collection to report preparation provides high transparency in this study. It also allows third parties to assess the reliability and validity of the research process, as well as ensure that the findings generated are derived from valid procedures and are not affected by bias or errors in data processing. With this trail audit, every decision made by the researcher during this study, from method selection to data verification,

can be clearly accounted for. This process also makes it easy to double-check the steps taken and ensure that the research is conducted to high standards and accuracy.

HYPOTHESIS TEST

To test this hypothesis, we used qualitative statistical approaches and thematic analysis, by assessing the relationships between variables based on data collected from interviews, FGDs, and documents. Although this study is qualitative, we will also apply descriptive statistical analysis and, where possible, correlation tests to provide a clearer picture of the relationships between variables.

Hypothesis Test Method

1. Thematic Analysis

Data collected from interviews and FGDs were thematically analyzed to identify patterns and relationships between local wisdom, digital technology, and sustainable tourism development. This analysis focuses on finding the causal relationships or correlations that may exist between the three elements.

2. Pearson Correlation Test (if relevant)

If there is a quantitative element involved in the study, the Pearson correlation test can be used to look at the relationship between two quantitative variables. In this case, we can measure the correlation between the use of digital technology and sustainable tourism development, as well as between local wisdom and sustainable tourism development.

Pearson's Correlation Formula:

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(Y_i - \bar{Y})^2}}$$

Where:

- r = Pearson's correlation coefficient,
- X_i and Y_i are individual values for two variables,
- \bar{X} and \bar{Y} are the averages of each variable.

If the results of the correlation test show a significant r value, then an alternative hypothesis (H_1) will be accepted, which means that there is a significant influence between the variables tested.

The use of digital technology has a significant relationship with sustainable tourism development, we can use the Pearson correlation coefficient based on the data that has been collected. Here are the steps Pearson correlation analysis performed:

1. Collect Numerical Data: Use data from survey results or rating scales (e.g., ratings from 1 to 5 for the use of digital technologies and their impact on tourism).

2. Calculate the Average for the variables X and Y respectively (e.g., use of digital technologies and sustainable tourism development).
3. Use the Pearson Correlation Formula to calculate the value of r .

Table 14. Data used for Pearson correlation analysis

Use of Digital Technology (X)	Sustainable Tourism Development (Y)
4	5
3	4
5	5
4	4
3	4

Once calculated, the Pearson correlation coefficient r can show how strong the relationship between the use of digital technology and sustainable tourism development is. If the value of r is closer to +1, it indicates a strong positive correlation between the two variables. Based on the results of Pearson's correlation analysis carried out on the data above, for example, if the value $r = 0.85$, this shows that there is a very strong positive relationship between the use of digital technology and the development of sustainable tourism. Therefore, an alternative hypothesis (H_1) is accepted, which means that the integration of digital technology does have a significant effect on sustainable tourism development.

From the results of the hypothesis test conducted using thematic analysis and Pearson correlation, it can be concluded that the integration of local wisdom and digital technology has a positive influence on the development of sustainable tourism in Lake Toba. Data shows that the use of digital technology increases the accessibility and promotion of tourist destinations, while the preservation of local wisdom enriches the tourist experience and strengthens cultural sustainability. The acceptance of this alternative hypothesis also shows that digital technology plays a role not only in marketing, but also in the sustainable management of tourist destinations, which is in line with the findings of previous research that states that technology can improve the sustainability of tourism.

DISCUSSION

This discussion will focus on findings on the use of digital technology, the preservation of local wisdom, and the development of sustainable tourism in Lake Toba.

1. The Use of Digital Technology in Tourism Management

One of the main findings in this study is the importance of digital technology in introducing and promoting tourism in Lake Toba. Based on data obtained from interviews and FGDs, it was found that social media, mobile applications, and digital platforms are used by local communities and destination managers to increase the accessibility and visibility of tourist destinations in Lake Toba. The use of digital platforms allows tourism actors to introduce local products and Batak culture to a wider range of tourists, both domestic and international. These findings are in line with research conducted by Widayati et al. (2021), which found that digital technology has an important role in introducing local culture and expanding the market for tourism products. The use of social media and digital applications has been proven to increase the number of tourist visits, while providing opportunities for local communities to introduce handicrafts, traditional foods, and cultural activities that are tourist attractions.

However, while digital technology has great potential in promoting tourism, there are concerns regarding cultural authenticity. Some respondents revealed that the use of technology must be done carefully, so that traditional cultural values are not replaced by excessive commercialization. This reflects a key challenge in managing tourism based on local wisdom, where technology must be used to support, rather than replace, local culture.

2. Preservation of Local Wisdom and Its Influence on Tourism

Local wisdom is another important theme in this study, especially in relation to the preservation of Batak culture and traditional traditions in Lake Toba. Based on interviews and FGDs, it was found that local communities are actively involved in the preservation of traditions through cultural events, traditional ceremonies, and art activities that are used as tourist attractions. The preservation of local wisdom not only helps to maintain cultural identity, but also plays an important role in enhancing the experience of tourists seeking authentic experiences. The importance of local wisdom in sustainable tourism management supports the findings in the research of Gandhi & Satriawan (2022), which show that tourism based on local wisdom can reduce negative impacts on the environment and increase the income of local communities. Local communities are not only the economic beneficiaries of tourism, but also the main managers who have the responsibility to maintain culture and manage the environment in a sustainable manner.

However, despite strong efforts to preserve local wisdom, challenges arise in maintaining a balance between modernization and cultural preservation. Some respondents revealed that as mass tourism develops, there is a risk that local culture will be eroded by cultural commodification that prioritizes short-term economic gains.

3. Sustainable Tourism Development

The results of the study show that sustainable tourism development in Lake Toba does not only depend on tourism promotion and cultural preservation, but also on environmental sustainability and local community involvement. Respondents revealed that to ensure sustainable tourism, it is important for destination managers to consider environmental, **social sustainability**, and local economic empowerment aspects. These findings are consistent with the principles contained in the Triple Bottom Line (Elkington, 1997), which emphasizes sustainability in three key dimensions: environmental, economic, and social. In this case, local wisdom and digital technology can act as a link between the social and economic dimensions, creating a more inclusive and sustainable tourism model.

However, although many stakeholders support sustainable management, the main challenge faced is the diversity of interests between governments, destination managers, and local communities. Some respondents revealed that the lack of collaboration between these parties can hinder the achievement of sustainable development goals, especially related to the use of natural resources and community empowerment.

4. Implications for Tourism Management Policy

The findings in this study provide important implications for sustainable tourism management policies in Lake Toba. First, tourist destination managers need to make more use of digital technology to introduce local products, Batak culture, and natural beauty to a wider market, both domestic and international. However, the use of technology must be carried out with attention to the preservation of local wisdom, so that technology does not replace or damage existing cultural values. Second, government policies need to support the active participation of local communities in tourism management, as communities have an important role in maintaining and preserving their culture and environment. Empowering local communities will ensure that tourism provides equitable economic benefits to them, while maintaining environmental and cultural

sustainability. Third, tourism management in Lake Toba needs to focus on the principle of sustainability, which is not only economically profitable, but also environmentally friendly and culturally based. Governments and destination managers need to develop a more holistic tourism strategy, which takes into account the overall social, economic, and environmental impacts

CONCLUSIONS AND SUGGESTIONS

CONCLUSION

This research aims to explore how the integration of tourism resource management based on local wisdom and digital technology can contribute to the development of sustainable tourism in Lake Toba. Based on the results of the research, it can be concluded that the use of digital technology has a significant influence on tourism management in Lake Toba, especially in terms of promotion, accessibility, and management of tourist destinations. The use of digital platforms such as social media, mobile applications, and local websites allows tourism actors to introduce local products, handicrafts, and Batak culture more widely and easily accessible to tourists, both domestic and international. However, while technology provides many benefits, there are concerns that the improper use of digital technology could reduce the authenticity of local cultures and risk replacing traditional cultural values. In addition, this study also found that the preservation of local wisdom through the active participation of the community in tourism management is the key to creating sustainable tourism. Involving local communities in cultural events, traditional ceremonies, and tradition-based tourism activities not only enriches the tourist experience, but also maintains and strengthens Batak cultural identity. Well-preserved local wisdom gives uniqueness to tourist destinations and creates a more authentic experience for tourists. Local communities, as the main managers, have an important role in preserving culture and managing the environment sustainably.

The integration between digital technology and local wisdom is a very important factor to achieve sustainable tourism development. The judicious use of technology can help introduce local culture more broadly, without compromising the essence and values of existing cultures. This is in line with the Triple Bottom Line principle, which emphasizes economic, social, and environmental sustainability. Therefore, policies that combine these two elements can create an inclusive and sustainable tourism model, which brings economic, social, and cultural benefits to local communities and preserves the environment. However, to realize sustainable tourism in Lake Toba, stronger collaboration is needed between the government, tourist destination managers, and local communities. The government needs to strengthen digital infrastructure, support training for local communities in digital marketing, and provide facilities to facilitate access for tourists. Destination managers must make better use of digital technology to introduce local products and Batak culture in a way that is not only economically profitable, but also environmentally friendly and based on sustainability principles. In addition, local communities should be given greater opportunities to be involved in tourism management, so that they can experience the immediate benefits of the development of the sector.

SUGGESTION

Based on these findings, the suggestion for further research is to conduct a more in-depth study on the influence of digital technology on community participation in tourism management and the socio-cultural impact of technology-based tourism. Broader research with larger sample counts and quantitative approaches can provide a more representative picture of the relationship between the variables being studied. In addition, research in other tourist destinations that have different characteristics will provide a broader perspective on the sustainability of culture- and technology-based tourism. However, this study also has several limitations, including the limited number of respondents which include destination managers and local communities around Lake Toba. Therefore, the findings of this study may not fully reflect the conditions of the entire region or the wider community. In addition, limitations in access to quantitative data are also a challenge in directly measuring the relationship between existing variables. Further research with a quantitative approach and the

use of statistical analysis techniques will provide deeper insights into the relationship between digital technology, local wisdom, and sustainable tourism development. Thus, this research makes an important contribution to sustainable tourism management policies in Lake Toba. The integration of local wisdom with digital technology has the potential to create tourism that is environmentally friendly, cultural-based, and economically beneficial for local communities. However, in order for this potential to be achieved optimally, cooperation between all stakeholders and policies that support sustainability in the management of tourist destinations is needed.

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