

DIGITAL STRATEGIES FOR ENHANCING GEOTOURISM AWARENESS: INSIGHTS FROM THE MANAGEMENT OF BANDUNG'S TAHURA JUANDA

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Abstract

Tahura Juanda, an urban forest in Bandung, Indonesia, is a popular recreational destination that offers a respite from the hustle and bustle of city life. The park has significant geological features that showcase the Lembang Fault and the historic eruption of Mount Sunda, in addition to its recreational opportunities. These geological remnants offer vital insights into the benefits that the forest provides to Bandung people. Thanks to a community service grant from a collaboration between STIEPAR Yapari, Exotic Java Trails, and PGWI (the Indonesian Geo-tourism Guides Association), the park recently unveiled the Bagendit (Bandung Geotourism Digital Interpretation) system. Nine interpretive displays featuring QR code technology are part of this program, which aims to improve visitor education. Despite the diverse geology of Tahura Juanda, many visitors remain unaware of its significance. The effectiveness of current interpretive methods—such as the newly implemented Bagendit system—in conveying geological information and engaging tourists is not well understood. Additionally, it is uncertain how well park visitors grasp the area's geological features due to these educational efforts. This study seeks to assess how interpretive displays, particularly the Bagendit system, influence visitor awareness and understanding of the geological importance of Tahura Juanda. The research adopts a qualitative approach, conducting in-depth interviews with visitors and management staff and observational studies. Semi-structured interviews, observation checklists and visitor feedback questionnaires are used to collect data. Thematic coding of observation notes and interview transcripts is part of the study to identify key trends in visitor experiences and the effectiveness of interpretation techniques. Results show different levels of participation in the Bagendit system. A lot of people see the QR codes on the signs, but not everyone uses them because sometimes the internet is not very good in certain areas. When visitors chat with park workers, they become more curious about the interesting rocks and landforms. The study suggests that improving the internet, telling more people about the QR codes, and showing visitors fun ways to learn about rocks could help everyone enjoy and understand the special geology at Tahura Juanda even more.

Keywords: geotourism, interpretive displays, visitor awareness, urban forests, Tahura Juanda

A. INTRODUCTION

Geotourism, emphasizing the interaction between natural landscapes and human experience, offers powerful opportunities for both education and conservation, particularly in regions like Bandung with rich geological history. Situated at the heart of West Java, Indonesia, Tahura Juanda (Juanda Forest Park) stands as an urban forest destination where both the local community and tourists seek an escape from Bandung's urban intensity (Herrera-Franco et al., 2020; Ólafsdóttir & Tverijonaite, 2018; Mallette et al., 2024). Recreational activities like hiking, picnicking, and nature walks are available to tourists at the park, which serves mainly as a

recreation center (Duarte et al., 2020; Gordon, 2018; Walliss & Kok, 2014). However, the common tourist is usually unaware of the abundance of geological and historical aspects hidden within its serene surroundings.

An important collection of geological artifacts that document the history of prehistoric volcanic activity may be found on Tahura Juanda. Its topography has unique pyroclastic deposits, lava remnants, and natural forest benefits, all of which offer Bandung's residents important cultural and scientific insights (Wirakusumah et al., 2021; Herrera-Franco et al., 2020; Li et al., 2022). Among the park's most notable features are clear geological indicators of the Lembang Fault and remnants from the ancient eruption of Mount Sunda, both of which offer invaluable insights into Indonesia's geological past (Wirakusumah et al., 2021; Gordon, 2018; Li et al., 2022).

To enhance the awareness and educational potential of these features, a collaborative community service initiative was recently launched by the Bandung Tourism Institute (STIEPAR Yapari) in partnership with PT Exotic Java Trails and the Association of Indonesian Geo Tourism Guides (PGWI). This project, which was funded by the Kedaireka program of the Indonesian Ministry of Education and Culture, created "Bagendit" (Bandung Geotourism Digital Interpretation), which consists of nine interpretive displays that use QR codes to give visitors easily accessible digital information about the park's geological significance.

Despite these positive efforts, there are still many gaps in the park's geology features and visitors' understanding of them. It is unclear how many of the park's recreational visitors actively participate in Tahura Juanda's interpretative elements or are aware of the park's geologic heritage (Herrera-Franco et al., 2020; Duarte et al., 2020; Fenton & Gallant, 2016). The Bagendit digital interpretation system presents an innovative educational approach, but questions remain about its effectiveness, especially in terms of visitor engagement, accessibility, and the challenges of digital connectivity within the park (Li et al., 2022; Fenton & Gallant, 2016).

In geotourism and heritage tourism, authenticity plays a crucial role in shaping meaningful visitor experiences. Authenticity enriches the visitor's connection to a place, fostering a sense of genuine engagement with its natural and historical significance (Agustiani & Agoes, 2021; Agoes & Lesmana, 2023). Exploring areas like Tahura Juanda allows tourists to discover the history of the land, including geological formations and historical artifacts that show the region's unique character and past. Interpretive displays like the Bagendit system can enhance authenticity by giving visitors insights to deepen their understanding and appreciation.

This paper explores strategies to bridge these gaps, drawing on insights from the management of Tahura Juanda to enhance geotourism awareness through improved interpretive methods and visitor engagement strategies. By investigating these issues, this research aims to develop actionable recommendations for fostering a deeper understanding and appreciation of Bandung's unique geologic landscapes, turning recreation into a conduit for geological education and conservation.

B. RESEARCH METHOD

Rationale and Purpose

This research was vital in assessing and enhancing visitor awareness of the geological richness within Tahura Juanda, aiming to transform recreational visits into more meaningful educational experiences. By evaluating the Bagendit QR code system's effectiveness, the study provided insights into innovative interpretive methods in geotourism, positioning the system as a potential model for urban forests and geological sites worldwide.

The purpose was to bridge the current gap between recreational activities and geological education by investigating the Bagendit system's role in encouraging tourist engagement with Tahura Juanda's geological narratives, such as lava fragments and traces of ancient volcanic activity. Through conducting interviews with park management and visitors, alongside observational studies, the study assessed the impact of existing educational tools like the Bagendit system, offering recommendations to optimize visitor engagement with geological information. This study also addressed challenges specific to technology-based interpretation in outdoor environments, such as connectivity issues and visitor receptiveness to digital learning aids. Ultimately, the research developed integrated strategies that balanced recreational and educational experiences in Tahura Juanda, enriching geotourism practices and promoting conservation efforts by highlighting the park's geological importance.

Methods

a. Research Design

The present study used a qualitative research approach to explore how interpretative displays impacted tourists' awareness of Tahura Juanda's geological significance. The design aimed to show how visitors interact with content for learning in order to increase the educational value of displays. The study combined in-depth interviews and observational studies to capture detailed feedback from visitors and management staff regarding the interpretive features.

b. Population, Sample, and Informants

The study population included visitors to Tahura Juanda and members of the forest management team. A purposive sample was selected, comprising a diverse group of visitors who had interacted with the interpretive displays, as well as key informants from the management team overseeing the park's educational initiatives. This approach ensured a comprehensive perspective on the interpretive systems' impact from both user and managerial viewpoints.

c. Instruments

The data collection tools were semi-structured interviews, observational checklists, and visitor feedback forms. The interviews collected information about how visitors feel, what they know, and what they think about the displays at the site. They also looked at ideas for making the displays better. Observational checklists were utilized to observe visitor interactions with the exhibits. Visitors were able to provide feedback on the geological features of Tahura Juanda using forms.

d. Procedures

Through thematic coding of observational notes and interview transcripts, key themes and recurrent patterns were found during data analysis. A systematic analysis of this data assessed the interpretive displays' effectiveness, uncovering insights into their impact on visitor understanding of Tahura Juanda's unique geological features. Visitor feedback was analyzed to gauge shifts in awareness and attitudes toward the park's geological significance, forming the basis for recommendations aimed at enhancing interpretive displays and fostering a more educationally enriching geotourism experience in the park.

C. FINDINGS AND DISCUSSION

The Bagendit (Bandung Geotourism Digital Interpretation) system, established through a community service initiative, incorporated nine interpretive displays with QR code features designed to provide visitors with access to additional geological information online. Each display was strategically placed to highlight the unique geological and historical significance of key points of interest within Tahura Juanda, especially in nine locations (see figure 1). This section describes each display, emphasizing its thematic focus and intended impact on enhancing visitor awareness and engagement with the park's geological features.

Table 1. Locations and Descriptions of 9 (Nine) Bagendit Interpretive Displays in Taman Hutan Raya (Tahura) Juanda

Number	Point of Interest	Location	Description
1	Benteng Pasir Malang	Mekarwangi	This display focuses on the remnants of the Benteng Pasir Malang site, offering visitors insight into its geological formation and historical significance as a fortification. Interlinked with geological features that provided natural protection.
2	Lava Curug Ciomas	Mekarwangi	This display focuses on the lava formations around the Ciomas Waterfall. It delves into the formation processes of these lava deposits and invites visitors to appreciate the scenic yet scientifically significant landscape sculpted by volcanic activity.
3	Karaton di Gawir Sesar Lembang	Ciburial, Cimenyan	Karaton di Gawir Sesar Lembang, also known as Cadas Jontor or Tebing Karaton, stands as a magnificent testament to the geological history of the region. This site is a witness to the formation of the ancient Sunda Caldera, offering visitors a unique opportunity to explore its stunning cliffs and learn about the geological processes that shaped this landscape.
4	Ropi Lava di Gua Lalay	Mekarwangi	This display focuses on a narrow crevice formed by the erosion of the Cikapundung River, revealing the earth's mysteries in the form of ropy lava structure.
5	Lava Pahoehoe	Ciburial	This display focuses on lava flows that form intricate, thread-like patterns known as Pahoehoe. According to local folklore surrounding Gunung Tangkubanparahu, this landscape is interpreted as the embrace of Dayang Sumbi. Visitors can appreciate the unique textures and shapes created by the cooling and solidification of lava, while also exploring the cultural narratives that enrich the understanding of this geological phenomenon. The site beautifully combines natural history with

Number	Point of Interest	Location	Description
6	Dam Bantar Awi	Ciburial	local legends, making it a fascinating destination for both geology enthusiasts and cultural explorers. This display focuses on the first hydroelectric power plant established during the colonial era in Pakar Dago. Utilizing the flow of the Cikapundung River, the Bendungan Bantar Awi generates electricity through turbines powered by the water from the dam.
7	Gua Belanda	Ciburial	This display focuses on the cave that channels the Cikapundung River's irrigation to the tranquil ponds of Dago Pakar. Carved from the hard volcanic deposits of the Sunda Mountain, the cave features a distinctive horizontal cross-section.
8	Gua Militer Jepang	Ciburial	This display focuses on the military defense system established by Japanese occupiers in the highlands of Pakar Dago. Utilizing the natural landscape and the hard volcanic rock formed by the deposits of hot clouds from Gunung Sunda, Gua Jepang served as a strategic location for military operations during World War II.
9	Curug Dago	Dago	This display focuses on the historical formation of the Sunda Caldera and the emergence of the young volcano, Gunung Tangkubanparahu. It showcases deposits from multiple volcanic eruptions, providing a geological record of the region's dynamic volcanic activity.

Source: Researchers' Data, 2023.

Table 1 provides an informative overview of various points of interest, primarily centered around geological formations, historical sites, and cultural narratives in the Tahura Juanda territory. Here are several key insights and lessons we can derive from it:

a. Geological Significance

Volcanic Activity: Many attractions in the area showcase its rich volcanic history, such as Lava Curug Ciomas, Ropi Lava di Gua Lalay, and Curug Dago. It is crucial to study natural events like eruptions because the deposits and structures they leave behind provide valuable information about the geological processes that have shaped the landscape over time.

Formation Processes: Caldereras and certain forms of lava are examples of how the processes result in the creation of distinctive geological features. Sites like Karaton di Gawir Sesar Lembang and Lava Pahoehe (also called "Batu Batik" or "Selendang Dayang Sumbi") are two examples.

b. Cultural Integration

Legends and Folklore: The story of Lava Pahoehe shows how local tales and geological features can come together to influence cultural stories. The blending of science and culture enhances the tourist experience, providing a better understanding of the local identity and heritage.

Historical Context: The inclusion of historical sites like Bendungan Bantar Awi and Gua Militer Jepang demonstrates the significance of geological locations in past events. Being conscious of the connections between natural and human history can enrich our appreciation of both.

c. Educational Opportunities

Tourism and Awareness: The descriptions illustrate the advantages of educational tourism. This is done by displaying geological characteristics, volcanic impacts, and historical contexts. Thus, tourist destination will benefit both for local and foreign tourists.

Environmental Awareness: There is also environmental education available, with locations such as Gua Belanda stressing the value of conservation and sustainable methods. These displays educate visitors on how to use natural resources responsibly.

d. Interdisciplinary Connections

Furthermore, the table demonstrates how different disciplines such as history, geology, and cultural studies are interconnected. Utilizing an interdisciplinary approach can enhance individual comprehension of the connections between different facets of human existence and the environment. Examples of specific areas of interest can be used by academics and educators to examine the connections between human behaviors and geological characteristics.

e. Conservation and Preservation

Raising awareness about the importance of these sites can also enhance efforts to conserve them for future generations. Tahura Juanda could encourage visitors to feel more responsible by offering more information on the geological and historical importance of these locations.

Overall, table 1 offers important insights on the Tahura Juanda region's history, culture, and geology. It invites reflection on how natural landscapes shape human experiences and emphasizes the importance of preserving these sites as both educational resources and cultural heritage. Visitors to these points of interest can gain a comprehensive understanding of the region's unique identity and geological history, enriching their appreciation for the natural world and its cultural significance.

Explanation of the Bagendit System

The Bandung Geotourism Digital Interpretation Application (Bagendit) is a new way to enhance geotourism through the use of digital storytelling methods. This platform offers an engaging and interactive experience for guests through the integration of technology, geological information, and community narratives.



Figure 1. Map of the Distribution of 9 (Nine) Bagendit Interpretive Displays in Taman Hutan Raya (Tahura) Juanda.

Source: Researcher's data, 2023.

a. Concept and Functionality

- 1) *Storytelling Approach:* Bagendit primarily uses storytelling to engage visitors. The app creates a stronger bond between tourists and the landscapes they visit by blending local legends, historical information, and geological facts into an interesting story. This method enhances visitors' understanding and appreciation of the unique geological features of the Bandung region
- 2) *Citizen Journalism:* The platform is based on a citizen journalism approach, enabling locals and tourists to contribute to the database of information. This collaborative approach not only increases the platform's content, but it also fosters community engagement and ownership of the local legacy.

b. Accessibility and Technology

- 1) *Website and Mobile Application:* Website and Mobile Application: The Bagendit system's principal center is a website, with an associated Android app allowing travelers to obtain information on the move. This dual approach guarantees that visitors may interact with the material at their leisure, whether planning a trip or exploring the area.
- 2) *QR Code Integration:* The use of QR codes in geotourism improves access to comprehensive interpretative information. Each geosite will include QR codes on the interpretative panels, allowing visitors to scan and quickly get relevant material on their mobile devices. This technology simplifies the information-gathering process and increases engagement, resulting in a more customized experience.

c. User Experience

- 1) *Interactive Exploration:* To enhance the interactive feature, tourists may use the Bagendit application. They need to install the application by scanning the QR codes, that can be found on the interpretive panels located in several spot of interests within the Tahura Juanda. This app will offer more information than it is displayed on the printed panels.

- 2) *Real-Time Updates*: The concept of citizen journalism is to make sure that the content will be updated in real time. Any geotourism enthusiast can contribute information to Bagendit app and it will continually update the data. This will make the resource more dynamic.



Figure 2. Logo of Bagendit application.

Source: Researcher's data, 2023.

d. Educational Impact

- 1) *Promoting Awareness*: One of the objective of Bagendit app is to foster greater awareness and understanding of the geological and cultural heritage of Bandung. This is done through offering interpretive content. Thus, this app not only serves as a guide for tourists but also as an education tools for the visitors. This approach shall promote awareness among visitors.
- 2) *Encouraging Sustainable Practices*: The Bagendit app promotes sustainable habits by highlighting the value of conservation and ethical travel through informative displays. The Bagendit app encourages users to appreciate and preserve the environment.



Figure 3. Design of the interpretive display for Lava Pahoeheo as one of the points of interest within the Tahura Juanda area.

Source: Researcher's data, 2023.

Figure 3 displays an example of the design of the interpretive display installed in one of the points of interest in Tahura Juanda area. In summary, the Bagendit system exemplifies a forward-thinking approach to geotourism by integrating technology with local storytelling. Its user-friendly

interface, combined with the engaging narrative content, positions it as a valuable resource for both tourists and the local community. By fostering collaboration through citizen journalism, Bagendit not only enriches the geotourism experience but also helps preserve and promote the rich heritage of the Bandung region for future generations.

Visitor Engagement and Experience with the Bagendit System

Visitor engagement with the Bagendit system has revealed a spectrum of interactions, highlighting both strengths and areas for improvement in the overall experience. In Figure 4, we can observe how a visitor benefits from using the Bagendit application by scanning the QR code provided on the interpretive display at a specific point.



Figure 4. Visitor tries to obtain a complete interpretation from the Bagendit application by scanning the QR code.

Source: Researcher's data, 2023.

a. Physical Engagement with Interpretive Displays

Even though there are physical interpretive exhibits nearby for visitors to read and interact with, many do not use the QR code to access online material. This demonstrates that, despite the availability of instructions, many visitors may not grasp or appreciate the benefits of adopting this technology. There is a lack of engagement when it comes to understanding QR codes and how they can improve the visitor experience.

b. Impact of Personal Interaction

Personal interactions with park officers play a big role in making the visitor experience better. When staff explain the geological features on interpretive displays, visitors show more interest and value the geological interpretations. This discovery shows that it is important for

people to connect in educational environments. It indicates that having someone explain things can help people better understand the geological and historical backgrounds of certain places.

c. Technical Challenges

Challenges exist in using the Bagendit system to its full potential. Some interactive displays are placed in places without internet connection. This makes it more difficult for people to use QR codes to get information online. The Bagendit application is not very interactive because it doesn't connect well with visitors. Tourists are thus unable to obtain the supplementary material designed to improve the presentations. Technical difficulties must be resolved so that all users may take advantage of the system's potential.

d. Infrastructure Improvements

Tahura Juanda's administration understands the difficulty and need of expanding the park's facilities, particularly its internet connection. Improved connectivity will make it simpler for users to access online information, maximising the Bagendit system's benefits. Improving technological systems is critical to enhancing visitor experiences and increasing satisfaction.

e. Increasing Visitor Awareness

It is important to increase visitor awareness of the interpretive displays and the Bagendit system in general. Enhancing visitor engagement at Tahura Juanda could be achieved by emphasizing the educational value of the interpretive content, in addition to promoting its recreational aspects. Raising awareness and knowledge about the resources on offer can encourage visitors to delve into the geological stories and cultural importance within the landscape, resulting in a more fulfilling experience.

Overall, although the Bagendit system has established a solid groundwork for boosting geotourism with digital interpretation, there are ample chances for enhancement. By tackling technical issues, enhancing infrastructure, and raising visitor awareness, we can achieve a more immersive and informative experience. This method enhances the visitor experience and promotes a deeper understanding of the geological and cultural heritage in the Tahura Juanda area.

Bridging the Awareness Gap

The study demonstrates a strong distinction between Tahura Juanda's geological significance and the tourists' understanding. While the park has remarkable geological features such as different lava remains and evidence of previous volcanic eruptions, most tourists are ignorant of them. The lack of communication highlights the pressing need for better strategies to connect recreational use with geological education. A study conducted by Herrera-Franco and colleagues. The idea is supported by studies from both Smith (2020) and Gordon (2018), who emphasize that without increased awareness, the educational value of natural sites goes untapped.

Effectiveness of Interpretive Displays

The adoption of the Bagendit system, which incorporates interpretative displays enabled by QR codes, is a forward-thinking way to closing the previously noted awareness gap. Nonetheless, the research outcomes indicate varying degrees of efficacy. While physical exhibitions attract attention from visitors, the potential of digital exhibits remains largely untapped due to technical difficulties. This finding is consistent with earlier research, such as studies carried out by Li et al

(2022). According to recent studies by Fenton and Gallant (2016), it is important for interpretive methods in geotourism to be easily understandable and interesting in order to enhance their educational effectiveness.

Impact of Personal Interaction

A key discovery of this research is the notable positive impact that one-on-one interactions with park rangers have on visitor involvement and curiosity about geological attractions. This supports the idea that effectively communicating geological information involves more than just using technology. It suggests that although innovations such as the Bagendit system show potential, they should ideally support, rather than substitute for, the crucial role of human-guided interpretation, as demonstrated by the research of Mallette et al. (2024) and Duarte et al. (2020).

Technological Challenges and Infrastructure Needs

Moreover, the research shows that poor internet connection in some parts of Tahura Juanda greatly impacts the efficiency of the Bagendit system that relies on QR codes. Wirakusumah et al. (2021) discuss the importance of improving infrastructure to fully utilize digital educational tools in geotourism for urban forest contexts. They reveal previously unknown factors that impact the success of digital interpretation methods in this setting,

Balancing Recreation and Education

The findings show a crucial necessity to improve the incorporation of geological education into recreational activities. This will help address concerns about visitor engagement with geological features. This indicates that managers of the park should create plans to blend educational elements into the recreational experience at Tahura Juanda, improving both aspects of a visit. Findings from Ólafsdóttir & Tverijonaite (2018) and Walliss & Kok (2014) show that taking a comprehensive approach can enhance visitor experiences and promote a deeper understanding of the park's geological importance.

Enhancing Visitor Awareness and Engagement

Finally, the research highlights the importance of educating visitors about the park's geological characteristics and the interpretive tools offered by the Bagendit system. It is important to fill this knowledge gap in order to improve the educational experience by understanding how visitors perceive and engage with the content. Creating specific marketing plans for the Bagendit system and other educational resources could greatly increase interest in Tahura Juanda's geological history, as demonstrated in the studies by Gordon (2018) and Li et al. (2022). By strengthening the link between park visitors and the geological stories of the area, we can create a more knowledgeable and involved community, enhancing the experience for everyone who comes to visit.

D. CONCLUSION

The study focused on how the geological features at Tahura Juanda interact with visitors, showing the difficulties and chances related to geotourism. The research found that visitors to the park are not very aware of its geological features, even though there are interactive systems like Bagendit in place. Although these systems can help improve visitor education, technical issues and lack of use are currently preventing them from being as effective as they could be.

The study shows that talking to park officers is important for making visitor experiences better and helping people understand geological events more deeply. Insights show that combining human guidance with technology is crucial for a well-rounded education approach. In order to make visitors more interested, it is important for management to focus on training park officers on how to use interpretive displays. This will help them give immediate explanations and educational information to tourists. This combination will make the visitor experience better and help them appreciate the park's special features even more.

It is important for interpretive displays to be key points of interaction for park officers to use as local guides. Park officers can improve their interactions with visitors and make tours more educational by using these displays. This helps visitors learn more about the geological heritage of the park.

Future research should focus on the long-term impact of improved interpretative approaches and visitor engagement at Tahura Juanda. Researchers should look into enhancing infrastructure, such as internet connection, to make the most of digital teaching tools in geotourism zones. Furthermore, more research might be conducted to determine how successfully certain advertising efforts can enhance tourist knowledge of geological sites and interpretative materials. Quantitative research may be conducted to have a better understanding of how tourists react to the geotourism system at Tahura Juanda. This includes assessing how effectively it works and how much it influences tourists' perceptions of geoheritage.

To summarize, it is important to recognize the geological significance of Tahura Juanda. It is crucial to fill the current knowledge gap and enhance visitor involvement by using effective teaching methods. We can protect the beauty and history of Tahura Juanda for the future by managing the park in a way that helps visitors connect with its geological story.

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