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# Environmental and Safety Information Needs for Smart Tourism Development in Pahawang Island, Indonesia

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**Abstract**

Small-island tourism is closely influenced by environmental conditions, making accessible and timely information important for tourism safety and destination management. Pahawang Island has significant marine tourism potential, but environmental and safety information is not always available in an accessible, timely, and integrated form. This study aims to identify the availability and accessibility of environmental and safety information for tourists and tourism stakeholders and to examine its importance for tourism management and smart tourism development. A qualitative approach was employed using qualitative content analysis. Data were collected through semi-structured interviews with 20 tourists and 3 tourism stakeholders —Head of the Destination Development Division, Tourism Office of Pesawaran Regency; Head of Pahawang Village; Chairperson of the Tourism Awareness Group (Pokdarwis)—, supported by non-participant observation and secondary data. The findings show that tourists primarily require information on weather, waves, currents, tides, water quality, safe tourism locations, and safety procedures. Although information is available through tour guides, social media, and other channels, its accessibility, timeliness, and integration remain limited. Tourists also showed interest in digital and real-time information to complement existing tourism information practices. The findings indicate that environmental and safety information supports tourist decision-making, tourism safety, and destination management. This study contributes a planning-oriented perspective to smart tourism by emphasizing the identification of information needs before technological implementation. The findings provide a basis for improving tourism information management in Pahawang Island and considering appropriate digital technologies for future development.

**Keywords:** *information management; environmental information; Pahawang Island; smart tourism; tourism planning.*

## INTRODUCTION

Tourism is an important activity that can support the development of local areas, especially those with natural and cultural tourism potential. In small-island areas, tourism activities are closely related to environmental conditions, infrastructure, and the local community. This relationship is particularly relevant to marine tourism because weather and sea conditions can affect tourism activities and visitor safety. As digital technology continues to develop, smart tourism has become an increasingly relevant concept in destination management. Smart tourism relies on information and technology to support tourism services and brings tourists and stakeholders into destination management (Shafiee et al., 2021). In island tourism specifically,

smart tourism can help address the particular conditions and challenges island areas face (Bulchand-Gidumal, 2022).

Information quality matters here, since tourists need information that fits the conditions they will encounter during their activities. Jeong & Shin (2020) found that the quality of information delivered through smart tourism technology affects tourists' overall experience. Shafiee et al. (2021) similarly pointed out that information sits at the core of what makes a smart tourism destination work. This becomes even more important in marine tourism, where shifting weather and sea conditions can directly affect both activity decisions and safety. Pelegri-Sebastia et al. (2024), for example, built a Smart Beach system that monitors environmental conditions to inform beach visitors, and Islam et al. (2025) created a similar environmental monitoring system aimed at tourist safety. Both studies point to the same conclusion: environmental information can meaningfully support tourism activities. Research that looks specifically at what environmental and safety information tourists and local stakeholders need in small-island tourism areas remains limited—especially in Indonesia.

This issue is also tied to how local actors manage tourism on the ground. In small-island destinations, tourism development usually involves several parties: local communities, tourism groups, village governments, tour operators, and government agencies. On Pahawang Island, earlier research found that tourism development there has been shaped by community capacity building, grassroots initiatives, collaboration, and shifting governance arrangements (Nurhasanah & Van den Broeck, 2022). More recent studies add that community initiatives and youth involvement have also played a role in environmental conservation and community-based tourism on Pahawang (Nurhasanah et al., 2024; Nurhasanah & Van den Broeck, 2025). Taken together, these studies highlight how central local actors are to managing both tourism and environmental issues

Small-island tourism is closely connected to the destination's environmental conditions, as marine tourism activities are often influenced by weather, sea conditions, and other coastal factors (Kurniawan et al., 2019). In Pahawang Island, where tourism activities largely relate to the marine environment, these conditions also affect visitor safety and tourism management. Clear, accessible environmental and safety information can therefore help tourists and local tourism actors make decisions based on current destination conditions. This aligns with the concept of smart tourism, which emphasizes using information and technology to support tourism decision-making and destination management (Gretzel et al., 2015; Yoo et al., 2017).

Pahawang Island provides a relevant condition for examining this issue because its tourism activities are strongly associated with marine resources and involve tourists, local tourism actors, community organizations, and government institutions. Based on this background, this study has two objectives: (1) to identify the availability and accessibility of environmental and safety information for tourists and tourism stakeholders; and (2) to identify the importance of environmental and safety information for tourism management and the improvement of a smart tourism destination. Rather than evaluating a specific technological system, this study focuses on the information needs and existing information practices in Pahawang Island. The findings are expected to provide a planning-oriented basis for improving tourism information management and for considering appropriate technological solutions in the future.

## LITERATURE REVIEW

### *Smart Tourism in Small-Island Tourism*

Smart tourism has developed through the use of information and communication technologies in tourism, particularly by collecting, integrating, and using data to support tourism activities (Gretzel et al., 2015). Rather than referring only to digital applications, smart tourism connects technology with information, tourists, tourism businesses, and destination stakeholders

(Shafiee et al., 2021). Soares et al. (2022) also argue that smart destinations need to be understood through the relationship between technology, planning, governance, innovation, and sustainability. This broader perspective matters for small-island destinations, where geographical isolation, limited infrastructure, and dependence on natural resources can create tourism management challenges different from those in mainland destinations (Bulchand-Gidumal, 2022).

Recent studies also show that smart-tourism development does not depend on digital infrastructure alone—governance, institutional capacity, stakeholder coordination, and other destination-level factors also play a role (Gomes et al., 2026; Safitri & Puspawati, 2026). At the same time, Soares et al. (2022) further note that smart destination development still needs better integration between technological initiatives and destination planning. Taken together, these studies suggest smart tourism should be adjusted to fit the specific characteristics and needs of each destination, rather than applied as a one-size-fits-all technological model. From this perspective, the present study views smart tourism as an approach that connects information, technology, tourism activities, and local stakeholders while considering Pahawang Island's characteristics.

### *Environmental and Safety Information Needs in Small-Island Tourism*

Information needs refer to the information individuals require to support their activities and decisions. Environmental information matters greatly in marine tourism, since factors like weather, waves, currents, tides, and water conditions can directly shape tourism activities and visitor safety. In smart tourism, environmental data can support decision-making by providing tourists and tourism managers with information relevant to changing destination conditions (Shafiee et al., 2021; Soares et al., 2022). Recent studies illustrate this through different forms of environmental monitoring. Pelegri-Sebastia et al. (2024) developed a Smart Beach System that monitors environmental conditions and delivers information to coastal users. Accordingly, identifying environmental and safety information needs provides the basis for examining whether such information is currently available and accessible to tourism users and stakeholders in Pahawang Island.

### *Information Availability, Accessibility, and Quality*

Identifying information needs must be distinguished from the conditions that determine whether the required information can actually be used. Information availability concerns whether the required information exists or is provided, whereas information accessibility concerns whether users can obtain and access it through available channels. Information quality concerns how useful information is for its intended purpose—relevance, clarity, accuracy, and timeliness. This distinction matters because information can be available yet hard to access, or accessible yet unclear or too slow actually to help with decision-making. Yoo et al. (2017) found that information quality and accessibility are key features of smart tourism technologies and that both positively affect travelers' satisfaction with the decision support they receive.

Similarly, Kullada & Michelle Kurniadjie (2021) found that digital information quality influences tourists' experiences before and during their trips, showing that information quality matters beyond simply making information available. In marine destinations, timeliness is especially critical because environmental conditions can shift quickly, while clarity is essential so tourists can understand warnings or environmental information without confusion. Integration is also relevant when information comes from multiple sources and must be connected to support tourism activities effectively. In this study, these concepts distinguish environmental and safety information, while availability and accessibility remain the primary focus of the first research objective.

### *Information Management and Tourism Destination Development*

Environmental and safety information is provided within a destination-management context involving different actors and information sources. Government institutions, village authorities, tourism organizations, tourism operators, guides, and local communities may contribute to obtaining, communicating, or updating information. Therefore, the availability and accessibility of information cannot be separated from how the destination manages tourism information. Research on Pahawang Island shows that its tourism transformation has been shaped by local capacity building, grassroots initiatives, collaboration, and shifting governance arrangements, with local actors taking key roles in addressing environmental and tourism-related challenges (Nurhasanah & Van den Broeck, 2022). Nurhasanah et al. (2024) highlight how alternative governance arrangements, community capacity, and involvement from multiple actors matter for small-island community-based ecotourism.

Meanwhile, Nurhasanah & Van den Broeck (2025), also studying Pahawang Island, show how youth-led initiatives and local networks contribute to environmental conservation and community-based ecotourism. These studies offer useful insight into the local and institutional context in which tourism information gets produced and shared. However, they do not specifically examine the availability and accessibility of environmental and safety information for tourism users and stakeholders. Thus, the present study treats stakeholder coordination only as background for understanding how information is provided and communicated, rather than as a separate research objective concerning participation, collaboration, or governance.

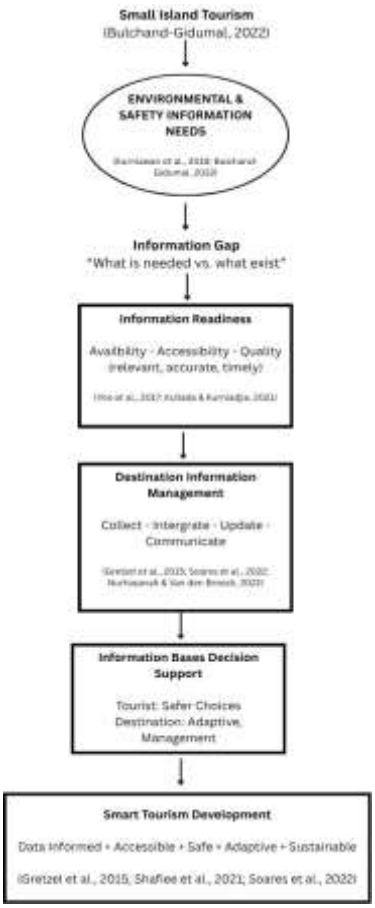



Figure 1. Conceptual Framework

Source: Research data, 2026

Earlier studies have established the importance of information, technology, and destination management in smart tourism, while research on small-island tourism has tended to focus more on environmental conditions, local capacity, and stakeholder involvement. Work on smart tourism technologies has shown how important accessible, useful information is for tourists (Gretzel et al., 2015; Yoo et al., 2017), while environmental-monitoring research has shown how technological systems can provide information on changing coastal conditions (Pelegri-Sebastia et al., 2024). Research on Pahawang Island has mostly examined community capacity, governance, environmental conservation, and community-based tourism (Nurhasanah & Van den Broeck, 2022; Nurhasanah et al., 2024; Nurhasanah & Van den Broeck, 2025). However, limited attention has been given to the availability and accessibility of environmental and safety information for tourism users and stakeholders, as well as its importance for destination management in Pahawang Island. This study addresses this gap by identifying the availability and accessibility of environmental and safety information and examining its importance for managing and improving Pahawang Island as a smart tourism destination.

In short, for the context of small-island tourism, smart tourism development can be understood as the destination's capacity to identify relevant environmental and safety information needs, ensure that such information is available, accessible, timely, and usable, and manage its production and communication across destination stakeholders so that it supports safer, more informed, and adaptive tourism decision-making.

## METHODS

### *Research Approach and Data Collection*

This study used a qualitative research approach and content analysis to examine tourists' information needs and tourism information management in Pahawang Island, Pesawaran Regency, Lampung. A qualitative approach was selected because the study focuses on understanding participants' experiences, perceptions, and information needs within small-island tourism rather than testing relationships between predetermined variables (Creswell & Poth, 2017). The study used qualitative content analysis to systematically organize and interpret textual data through coding, categorization, and pattern and meaning identification (Hsieh & Shannon, 2005; Elo & Kyngäs, 2008). The unit of observation consisted of tourists and tourism stakeholders involved in tourism activities and management in Pahawang Island, while the unit of analysis was tourism-related information and its management within the study area.

In this study, data were collected using both primary and secondary sources. Primary data were collected through semi-structured interviews, non-participant observation, and data collection at relevant institutions, and were supported by secondary data. Semi-structured interviews were selected because they provide a consistent research structure while allowing participants to elaborate on their experiences and perceptions (Kallio et al., 2016). The study used non-participant observation to examine tourism activities, environmental conditions, facilities, safety practices, and the availability and accessibility of tourism information in the study area without participating in the observed activities. The study obtained secondary data from academic literature to provide contextual information.

The study selected informants using purposive sampling. This technique was used because participants were intentionally selected based on their experience, knowledge, or involvement in tourism activities and management in Pahawang Island, rather than for statistical representativeness (Palinkas et al., 2015). According to Subhaktiyasa (2024), the number of informants was not fixed in advance; it was determined based on data saturation, meaning interviews continued until the information gathered was sufficient and no new significant findings emerged. Table 1 below shows the criteria used to select informants for this study.

Table 1. Informant Criteria

| Selected Informant | Criteria | Code |
|---|---|---|
| Head of the Destination Development Division, Tourism Office of Pesawaran Regency | 1. The informant is a representative of a government institution responsible for tourism destination development.<br>2. Holds a position relevant to tourism destination planning and regulation.<br>3. The informant knows the social and economic conditions, as well as the tourism potential, of Pahawang Island. | KP |
| Head of Pahawang Village | 1. The informant is responsible for village administration.<br>2. The informant has an understanding of the social and economic conditions of the local community.<br>3. The informant is involved in decision-making related to village development and tourism destination development. | KD |
| Chairperson of the Tourism Awareness Group (Pokdarwis) | 1. The informant is a tourism destination operator responsible for the operational management of the tourism destination on Pahawang Island.<br>2. The informant has a comprehensive understanding of tourism activities, tourism community management, and interactions with tourists.<br>3. The informant has experience in managing field activities and implementing tourism programs. | POK |
| Tourist | 1. The informant directly accesses the Pahawang Island tourism destination. | WIS |

Source: Research data, 2026

Based on the interviews conducted, 23 informants were identified: 1 Head of the Destination Development Division, Tourism Office of Pesawaran Regency; 1 Head of Pahawang Village; 1 Chairperson of the Tourism Awareness Group (Pokdarwis); and 20 tourists. Data collection was conducted from 23 December 2025 to 2 January 2026. Primary data were collected through semi-structured interviews and non-participant observation. The tourists were selected as users of tourism information, while the stakeholders were selected based on their involvement in tourism development and management in Pahawang Island. The interviews were conducted in Indonesian. Each tourist interview lasted approximately 5–10 minutes because the questions focused on the predetermined indicators. Interviews with the village head and the Tourism Office lasted about 20 minutes, while the Pokdarwis Chairperson responded via chat. All face-to-face interviews were audio-recorded with the participants' permission, while the Pokdarwis interview was documented through the chat responses. The researcher listened to the recordings and manually transcribed the interviews. The researcher conducted non-participant observation to examine tourism activities, environmental conditions, safety practices, and the availability and accessibility of tourism information without participating in the observed activities. The research instruments included an interview guide, observation sheet, consent form, document checklist, mobile phone for documentation and audio recording, and a laptop for data processing.

In qualitative research, the analytical focus is generally not on measuring relationships between variables, as is common in quantitative research. Instead, qualitative research emphasizes an in-depth understanding of phenomena, processes, meanings, and social contexts. Therefore, the term "components" denotes the key elements or parts of the analytical framework used to examine the research phenomenon (Hennink et al., 2010).

Table 2. Research Component and Indicator

| Research Objective | Component | Indicators |
|---|---|---|
| 1. Identify the availability and accessibility of environmental and safety | 1. Environmental Condition Information | 1. Weather&sea conditions; wave height; currents; tides; water quality; coral reef/environmental conditions; safe tourism locations |

| Research Objective | Component | Indicators |
|---|---|---|
| information for tourists and tourism stakeholders | 2. Tourism Safety Information<br>3. Information Accessibility | 2. Safety equipment & procedures; emergency & warning/early-warning information; safe and unsafe activity conditions; emergency contacts<br>3. Availability of information; information sources; ease of access; clarity/understandability; timeliness/update frequency; accessibility for tourists and stakeholders |
| 2. Identify the importance of environmental and safety information for tourism management and the improvement of a smart tourism destination | 1. Importance of Environmental and Safety Information<br>2. Smart Tourism Information Management | 1. Support for tourist decision-making, tourism safety, destination management, environmental monitoring; support for service quality, and sustainable tourism management<br>2. Integration of information; real-time information; information sharing among stakeholders; use of digital information |

Source: Research data, 2026

### *Data Analysis*

The collected data were analyzed using conventional content analysis with a deductive approach. In directed content analysis, previous research or theoretical knowledge guides the initial coding categories (Hsieh & Shannon, 2005). In this study, the deductive approach used predetermined categories and indicators based on the research objectives and literature review to guide the coding and analysis of interview and observation data.

The analysis followed a systematic process of data—codes—categories—themes—interpretation. First, the researcher repeatedly listened to the interview recordings, reviewed the manually transcribed data, and examined the observation notes to become familiar with the dataset. Second, the researcher coded relevant statements according to the predetermined indicators in Appendix A. Third, the researcher grouped and compared similar statements across tourists and tourism stakeholders. Fourth, the coded findings were compared with field observations and relevant supporting documents. Finally, the findings were organized into themes that addressed the two research objectives. This procedure kept the analysis guided by the predefined analytical framework while using participants' statements as the basis for interpreting the findings.

The analysis incorporated data from both tourists and tourism stakeholders and was complemented by non-participant observation. Comparing interview statements with observed conditions allowed the researcher to identify consistencies and differences between participants' accounts and the conditions observed in the field.

### *Ethical Considerations*

Before each interview, the researcher introduced herself, explained the study's purpose and how the interview data would be used, and provided an informed consent form for participants to confirm their willingness to participate. Participants were informed that their responses would be used for academic purposes and that their identities would be kept confidential. For recorded interviews, participants provided permission to record. Respondents are therefore identified using codes rather than personal names in the manuscript.

## RESULTS AND DISCUSSION

This section presents the findings on the availability and importance of environmental and safety information in Pahawang Island. The results are based on interviews with 23 informants, comprising 1 Head of the Destination Development Division, Tourism Office of Pesawaran Regency, 1 Head of Pahawang Village, 1 Chairperson of the Tourism Awareness Group (Pokdarwis), and 20 tourists, supported by non-participant observations and secondary

information. The findings are organized according to the two research objectives: (1) identify the availability and accessibility of environmental and safety information for tourists and tourism stakeholders; and (2) identify the importance of environmental and safety information for tourism management and the improvement of a smart tourism destination.

### *Availability and Accessibility of Environmental and Safety Information*

The interview findings show that tourists' information needs in Pahawang Island are closely related to the environmental conditions they encounter during marine tourism activities. Weather information was the most frequently identified environmental information need, mentioned by 18 of the 20 tourists. This finding indicates that weather directly influences tourists' decisions to undertake or adjust marine tourism activities. Similarly, 17 tourists mentioned sea conditions, waves, or currents. Unlike general destination information, these conditions directly affect safety during marine activities because changes in waves and currents may affect the suitability of activities such as snorkeling and boat trips. One tourist stated, "Information on weather and sea conditions should be updated more frequently to ensure that visitors receive accurate and up-to-date information" (WIS-02). These findings indicate that tourists require information not only about tourism attractions but also about environmental conditions that may influence their activities.

The Head of Pahawang Village explained that weather, high tides, rainfall, and wind conditions can influence tourism activities and visitor numbers. He also noted that local tourism actors use BMKG information as a reference. As the village head stated, "information from relevant institutions, from BMKG, is very supportive because our tourism activities are marine-based" (KD). The Chairperson of Pokdarwis identified similar information needs, particularly weather and marine conditions. "The most needed information is weather conditions, wave height, currents, tides, water quality, coral reef conditions, and safe locations for tourism activities" (POK). This indicates that local tourism managers also recognize tourists' information needs.



**Figure 2. Marine Tourism Activities And Environmental Conditions In Pahawang Island**
Source: Research data, 2026

The observation supports the interview findings by showing that environmental conditions shape where and how tourism activities take place. Weather and sea conditions are therefore relevant not only as physical characteristics of the destination but also as information that can influence tourists' decisions regarding tourism activities. Safety information was also identified through interviews and observation. Existing safety practices include handing out life jackets,

providing briefings from tourism operators, and giving guidance before activities begin. The Head of Pahawang Village explained that tour leaders and guides work with Pokdarwis and have participated in safety and post-disaster training. The village also has observation and monitoring posts and conducts additional security patrols during major holiday periods.



**Figure 3. Safety Practices During Marine Tourism Activities**
Source: Research data, 2026

The Chairperson of Pokdarwis explained that safety information is currently delivered through guide instructions, life jackets, and briefings, though it still needs reinforcement through information boards, early-warning systems, and more complete digital information. This suggests that while safety information is already communicated directly and through existing practices, stakeholders still see room to improve how it is delivered.

However, information availability does not always match its accessibility and timeliness. Tourists reported getting information through tour guides, social media, and other digital channels, while stakeholders indicated that environmental information comes from several sources. The Chairperson of Pokdarwis explained that information is commonly obtained from BMKG, local fishermen, boat operators, and direct field observations, but it is not always available in real time, and there is no integrated system specifically for the tourism area.

The Head of the Destination Development Division, Tourism Office of Pesawaran Regency, also explained that the tourism office provides information through its social media platform, and that the accuracy of environmental information aligns with BMKG information. This indicates that information is already distributed through several channels, but the sources are not yet integrated into a single tourism-specific information system.

The observed safety practices indicate that safety information is currently communicated largely through direct interaction between tourism operators and visitors. This direct communication guides tourists when they need it during activities, but its effectiveness depends on whether tourism actors are present and able to deliver it. The findings therefore show that

safety information is available in the destination, although its delivery remains largely dependent on direct communication.

The interviews also indicate that information availability does not always match its accessibility and timeliness. Tourists said they typically get tourism information through tour guides, social media, and other digital channels. Stakeholders, however, described information as coming from multiple different sources, and noted that it is not always real-time or specifically integrated for tourism purposes. This suggests a distinction between the existence of information sources and the accessibility, timeliness, and integration of information.




**Figure 6. Existing tourism information facilities or information media in Pahawang Island**
Source: Research data, 2026

The observation can be used to show whether information facilities are physically available and how information is presented to visitors. However, the presence of information facilities alone does not indicate that all environmental and safety information required by tourists is available or up to date. This finding matters because the first research objective concerns not only the availability of information but also whether users and stakeholders can access it.

The interviews also show a relatively high acceptance of digital information. 19 of the 20 tourists expressed interest in or acceptance of an application as a tourism information medium, while approximately 10 respondents explicitly mentioned real-time information. One respondent stated, "The application could also provide real-time information on weather and wave conditions" (WIS-04). This finding indicates that tourists are receptive to digital channels, particularly when they can provide information that changes with current environmental conditions.

### *Importance of Environmental and Safety Information for Tourism Management*

The findings also indicate that environmental and safety information matters not only to tourists but also to the management of tourism activities in Pahawang Island. Weather, waves, currents, and tides were linked to decisions about snorkeling, boat trips, and other marine activities. The Head of Pahawang Village emphasized that environmental information is particularly important because tourism activities take place in marine areas, and that BMKG weather information supports local tourism actors.

This information is also linked to the quality of tourism services. When environmental and safety information is available and understandable, tourists can make better decisions about their

activities, while tourism operators can provide guidance based on current conditions. Stakeholders also pointed out the need to strengthen safety information — through information boards, warning systems, and more up-to-date environmental data. These findings suggest that information is not just a communication tool, but also plays a supporting role in overall tourism management.

The connection between information and tourism management is especially important in a small-island destination like this, where tourism activities are closely tied to environmental conditions. Earlier research on Pahawang found that the island's tourism development has involved ecological challenges, local capacity building, grassroots initiatives, and collaboration among various actors (Nurhasanah & Van den Broeck, 2022). In this study, the need for environmental and safety information similarly shows how tourism management depends on interaction among tourists, tourism operators, local communities, and other stakeholders.

The findings also show that environmental and safety information matters beyond just the individual tourist experience. Information on environmental conditions can help tourism actors determine appropriate activities, communicate risks, and manage visitors. In this sense, information becomes part of destination management because it connects physical conditions in the tourism area with decisions made by tourists and stakeholders.

### *Discussion*

The findings show that environmental and safety information is not merely supplementary for tourists but part of the information needed to conduct and manage marine tourism in Pahawang Island. Tourists primarily require information about weather, waves, currents, tides, and safe tourism locations because these conditions directly influence tourism activities. This supports the smart-tourism view that information and data can shape tourist experiences and destination management (Gretzel et al., 2015; Shafiee et al., 2021). The findings also support the distinction between availability and accessibility: information can be available through various sources, but that does not always mean it is accessible, up to date, or integrated in a way that's useful for tourism specifically. This lines up with Yoo et al. (2017), who identify information quality and accessibility as key parts of smart tourism technology.

The findings also point to a link between information management and the involvement of different tourism actors. This fits with earlier research on Pahawang, which highlighted local capacity, grassroots initiatives, and collaboration in tourism development (Nurhasanah & Van den Broeck, 2022). However, the present study does not assess participation or collaboration as independent variables. Instead, these relationships help explain how environmental and safety information is communicated and accessed. Tourists' interest in real-time information also suggests that digital technology may serve as a means of delivering information already identified as necessary. Thus, the findings support a planning-oriented approach to smart tourism in which information needs are identified before introducing technological solutions.

## CONCLUSION

This study finds that environmental and safety information is important for tourism activities and destination management in Pahawang Island. Tourists primarily require information on weather, sea conditions, waves, currents, tides, water quality, coral reef conditions, safe tourism locations, and safety procedures. However, the findings indicate that information availability does not always correspond to accessibility, timeliness, clarity, or integration across information sources. Environmental and safety information is therefore relevant not only to tourists' decision-making and safety but also to managing marine tourism activities.

The findings indicate that improving tourism management in Pahawang Island requires greater attention to providing and making relevant environmental and safety information

accessible before determining specific technological solutions. Conceptually, this study contributes a planning-oriented understanding of smart tourism by positioning environmental and safety information needs as an important consideration in destination management, particularly in small-island tourism contexts.

This study has some limitations worth noting: it focuses on a single island, covers a relatively short data-collection period, and draws on a sample of only 20 tourists and 3 institutional stakeholders. It also did not include specific marine-safety or weather-information agencies, and it did not examine the technical or economic feasibility of potential information systems. Because of these limitations, the findings may not fully transfer to other destinations or different seasonal conditions. Future research could therefore compare multiple small-island destinations, conduct data collection across different seasons, involve a broader range of tourism and environmental stakeholders, and assess the technical and economic feasibility of environmental and safety information systems.

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## APPENDIX A.

### Triangulation Matrix

| No. | Key Finding | Tourism Office | Village Head | Pokdarwis | Tourists | Tourist Evidence (n=20) | Final Theme | Triangulated Interpretation |
|---|---|---|---|---|---|---|---|---|
| 1 | Weather information | ✓ | ✓ | ✓ | ✓ | 18 (90%) | Environmental Information Needs | Strong convergence across all sources indicates that weather information is a core requirement for supporting tourism activities and operational decisions. |
| 2 | Sea conditions (waves, currents, tides) | ✓ | ✓ | ✓ | ✓ | 17 (85%) | Environmental Information Needs | Both tourists and institutional stakeholders emphasize the importance of marine-condition information, particularly for activities conducted in coastal and marine environments. |
| 3 | Real-time information | ✓ | ✓ | ✓ | ✓ | 10 (50%) | Technology & Information Integration | Stakeholders consistently identify the need for timely information, although explicit demand among tourists is moderate. This indicates a gap in real-time information provision. |
| 4 | Safety of marine activities | ✓ | ✓ | ✓ | ✓ | 1 (5%)* | Safety Information & Early Warning | Safety concerns converge strongly across stakeholder interviews, despite being rarely articulated explicitly by tourists as a separate information need. |
| 5 | Application as an information medium | ✓ | ✓ | ✓ | ✓ | 19 (95%) | Technology & Information Integration | The very high tourist preference for application-based information supports stakeholder views regarding the potential role of digital technology in destination information delivery. |
| 6 | Human resource and training readiness | ✓ | ✓ | ✓ | Not dominant | — | Implementation Readiness & Governance | Institutional stakeholders identify training and capacity building as prerequisites for effective technology implementation. |
| 7 | Digital connectivity and infrastructure | ✓ | ✓ | ✓ | Not dominant | — | Implementation Readiness & Governance | Existing connectivity provides an initial foundation, but devices, networks, system support, and maintenance require further development. |
| 8 | Integrated information system | ✓ | ✓ | ✓ | Not explicit | — | Technology & Information Integration | Institutional stakeholders identify fragmentation of information sources and the absence of an integrated destination-specific information system. |