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Artificial intelligence-based risk communication for traveller protection in Indonesia

[1]Choirul Fajri*, [2]Norma Sari, [3]Imam Karim Fathurrahman, [4]Muhammad Najih Farihanto, [5]Dani Fadillah

[1,4,5] Faculty of Literature, Cultre, and Communication, Universitas Ahmad Dahlan, Yogyakarta, 55191, Indonesia
[2] Faculty of Law, Universitas Ahmad Dahlan, Yogyakarta, 55191, Indonesia
[3] Faculty of Industrial Technology, Universitas Ahmad Dahlan, Yogyakarta, 55191, Indonesia
[1] choirul.fajri@comm.uad.ac.id*; [2]norma.sari@law.uad.ac.id; [3]haris.fathurrahman@te.uad.ac.id;
[4]muhammad.farihanto@comm.uad.ac.id; [5]dani.fadillah@comm.uad.ac.id
*Correspondent email author: choirul.fajri@comm.uad.ac.id

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ABSTRACT

Indonesia, as a global tourism destination, faces various challenges in protecting tourists from the risks of natural disasters, health crises, and security threats. This study aims to analyze the use of Artificial Intelligence (AI) technology in risk communication systems for tourist protection in Indonesia. Through a systematic literature review approach, this study examines the concept of risk communication, the application of AI in tourism crisis management, and the implementation of this technology in the Indonesian context. The results show that AI has significant potential to improve the effectiveness of risk communication through early warning systems, information personalization, interactive chatbots, and predictive analytics. The implementation of AI in tourism risk communication in Indonesia requires integration between the Ministry of Tourism and Creative Economy, the National Disaster Management Agency, and the private sector. This study recommends the development of an AI framework that is responsive to local contexts, increased human resource capacity, and policies that support technological innovation in tourist protection. Importantly, this study contributes to the existing body of knowledge by providing a comprehensive framework that highlights how AI can be systematically integrated into national tourism safety strategies. It also offers practical insights for policymakers, tourism practitioners, and researchers in designing context-specific AI-based solutions for risk communication. By addressing theoretical and practical gaps, this research not only strengthens the academic discourse on AI in tourism but also supports the creation of safer and more resilient tourism destinations in Indonesia.

1. Introduction

As the world's largest archipelagic nation, Indonesia boasts abundant tourism potential, boasting a diverse cultural, natural, and historical heritage (Antariksa et al., 2024). According to data from the Central Statistics Agency (BPS), the tourism sector is projected to contribute

approximately 5.5% to Indonesia's Gross Domestic Product (GDP) by 2024, with international tourist arrivals reaching over 15 million. However, Indonesia's geographical location on the "Ring of Fire" makes it vulnerable to various natural disasters such as earthquakes, tsunamis, volcanic eruptions, and floods (Achmad, 2019). Furthermore, Indonesia faces challenges from global health crises and security threats that can impact tourist safety. Risk communication is a crucial element in tourist safety management (Fang et al., 2021). Effective communication can mitigate the negative impacts of various risks faced by tourists during their stay at a tourism destination (Sinha, 2021). However, conventional risk communication systems still widely used in Indonesia have limitations in terms of speed, accuracy, and personalization of information. In today's digital era, Artificial Intelligence (AI) technology offers innovative solutions to improve the effectiveness of risk communication in tourism (Camilleri, 2024). Artificial Intelligence has experienced rapid development in recent years and has been implemented in various sectors, including tourism (Rizal & Maulini, 2020). AI technology is capable of analyzing large-scale data, recognizing patterns, and providing personalized recommendations based on individual needs (Truby et al., 2022). In the context of risk communication, AI can provide more accurate, timely, and relevant information for tourists.

Given Indonesia's high exposure to natural and human-induced risks, coupled with the increasing reliance on digital solutions in tourism, the urgency of this study is urgent to ensure that safety mechanisms evolve in parallel with technological advancements. This study aims to analyze the use of Artificial Intelligence technology in risk communication systems for tourist protection in Indonesia. Specifically, this study will answer the following questions: (1) What is the concept of risk communication in the context of tourism? (2) What are the applications of AI that can be used in tourism risk communication? (3) How can the implementation of AI in risk communication improve tourist protection in Indonesia? (4) What are the challenges and opportunities in implementing AI for tourism risk communication in Indonesia? Through this research, it is hoped that it can contribute to the development of a more effective AI-based risk communication system in protecting tourists in Indonesia. In addition, this research is also expected to be a reference for policymakers, tourism practitioners, and researchers in developing technological innovations for tourist safety. Artificial Intelligence has experienced rapid development in recent years and has been implemented in various sectors, including tourism (Sari et al., 2025).

AI technology is capable of analyzing large-scale data, recognizing patterns, and providing personalized recommendations based on individual needs (Marwala & Mpedi, 2024). In the context of risk communication, AI can provide more accurate, timely, and relevant information for tourists (Ahn & Chen, 2020). This study aims to analyze the use of Artificial Intelligence technology in risk communication systems for tourist protection in Indonesia. Specifically, this study will answer the

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2. Theoretical Framework

Risk communication is the process of exchanging information and opinions between individuals, groups, and institutions regarding risks. Effective risk communication must consider both technical and psychological aspects in conveying information (Covello, 2001). In the tourism context, risk communication includes conveying information about potential hazards, mitigation methods, and actions tourists should take in emergency situations. Risk communication in tourism has several specific characteristics (ALkharashi, 2019). First, the audience is highly heterogeneous, consisting of tourists with different cultural backgrounds, languages, and understandings of risk (Tabben et al., 2023). Second, information must be delivered in a timely manner given the often urgent nature of risks (Irawan et al., 2022; Tombeng et al., 2023). Third, communication must be accessible through various channels due to the high mobility of tourists (Bier, 2001). Several risk communication models have been developed in the academic literature. The Mental Noise Approach model emphasizes the importance of simplifying complex information to make it understandable to the general public (Fischhoff, 2011). Meanwhile, the Cultural Theory model highlights how risk perception is influenced by cultural values. In the context of Indonesian tourism, which has high cultural diversity, this cultural approach is highly relevant (Douglas & Wildavsky, 1982).

Artificial Intelligence (AI) refers to computer systems capable of performing tasks typically requiring human intelligence, such as learning, reasoning, problem-solving, perception, and language comprehension (Marwala & Mpedi, 2024). In the past decade, AI has experienced rapid development and is being implemented in various sectors, including tourism and crisis management (Guo & Li, 2024). AI applications in tourism crisis management can be classified into several categories. First, AI-based early warning systems that can analyze data from various sources (weather sensors, seismic data, social media) to predict potential risks. Second, chatbots and virtual assistants that can provide information and assistance to tourists in various languages. Third, sentiment analysis systems that monitor tourists' perceptions of risk through social media and review platforms. Fourth, personalized recommendation systems based on tourists' profiles and

preferences (Ramadhan et al., 2024). Recent research shows that AI has been successfully implemented in several global tourism destinations. For example, in Japan, AI is being used to predict potential tsunamis and provide early warnings to tourists in coastal areas (Giuseppe Aliperti; & Ana Maria Cruz, 2018). In New Zealand, AI-based chatbots help tourists obtain safety information during outdoor activities.

In the European Union, AI systems monitor developments in health crises and provide travel recommendations to tourists Regulation, (2004) Indonesia has begun adopting AI technology in the tourism sector, although implementation is still in its early stages. The Indonesian Ministry of Communication and Informatics (Kemkominfo) has developed several AI initiatives to support tourism, including in Bali (Kemkomdigi Develops AI for Culture and Tourism in Bali). This AI implementation aims to enhance the tourist experience while strengthening safety and security aspects. The Ministry of Tourism and Creative Economy (Kemenparekraf) is also encouraging the use of AI for culture and tourism (Ministry Pushes for AI utilization for cultural affairs and tourism, n.d.). These initiatives include the development of destination recommendation systems, tourist behavior analysis, and AI-based risk communication. Research conducted by several Indonesian academics demonstrates the potential of AI to support sustainable tourism in Indonesia (Regulation, 2024). However, this research also highlights challenges in AI implementation, such as limited digital infrastructure, human resource skills, and data integration between agencies.

The implementation of AI in tourism risk communication in Indonesia faces several challenges. First, limited digital infrastructure, especially in remote areas that are popular tourist destinations. Second, data availability and quality remain fragmented across government agencies. Third, limited human resource capacity in developing and managing AI systems. Fourth, data privacy and security issues are a concern for international tourists. On the other hand, there are several opportunities to be exploited. First, the high adoption rate of digital technology among Indonesians, including in the tourism sector. Second, government policy support that encourages digital transformation across various sectors. Third, the potential for collaboration between the government, the private sector, and academia in developing AI solutions. Fourth, tourists' interest in innovative technologies that can enhance their travel experience and safety.

As seen in Fig. 1, based on the literature review above, this study develops a conceptual framework that integrates the concepts of risk communication, AI technology, and the Indonesian tourism context. This framework consists of four main components: (1) Input (risk data, tourist profiles, destination characteristics), (2) AI Process (data analysis, prediction, personalization), (3) Output (risk information, action recommendations, warning systems), and (4) Impact (increased risk awareness, reduced crisis impact, increased tourist confidence).

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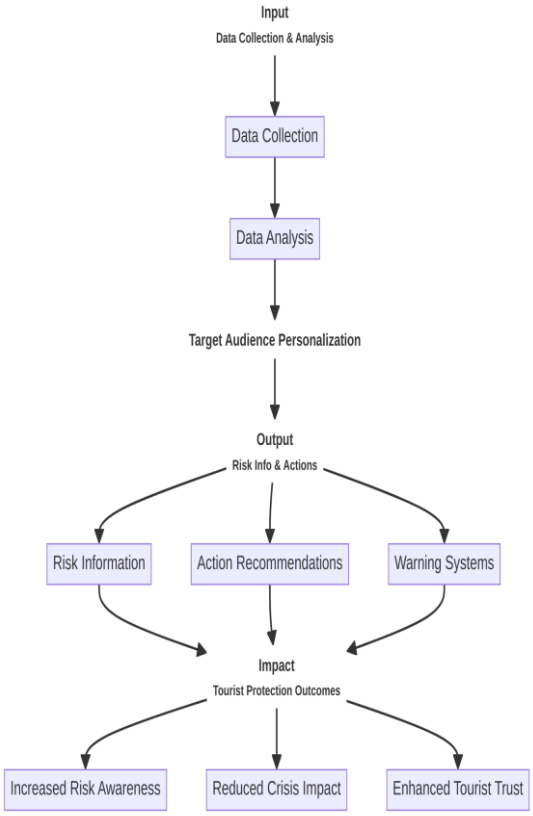

Fig. 1. A Conceptual Framework for AI-Based Risk Communication for Traveler Protection

3. Method

This study uses a systematic literature review approach to examine the use of Artificial Intelligence in risk communication for tourist protection in Indonesia. This approach was chosen because it allows for a comprehensive analysis of various scientific and practical sources relevant to the research topic. The systematic literature review was conducted following clear and structured standards to ensure transparency and reproducibility of the research (Baxter & Jack, 2015). This process includes formulating research questions, identifying literature sources, evaluating source quality, extracting data, and synthesizing findings. In conducting the literature review, the researcher reviewed several relevant academic data and information sources, including international databases such as Scopus, Web of Science, Google Scholar, and Springerlink. Furthermore, the researcher also collected data through national databases such as Sinta and Neliti, as well as other sources, including government reports (BNPB, Ministry of Health) and policies and regulations related to risk communication and tourist protection.

The data analysis process was conducted using a thematic analysis approach to identify patterns, themes, and relationships between concepts in the selected literature. The analysis process was carried out by: mapping the content of the selected literature, identifying important concepts and findings from each literature, grouping codes into broader themes, evaluating and refining themes

to ensure consistency and relevance, providing clear names and descriptions for each name, and presenting the findings in a coherent narrative form. Meanwhile, the data validation process was carried out using source triangulation by verifying various findings, obtaining input from experts in the fields of risk communication, tourism, and AI technology.

4. Result and Discussion

Based on an analysis of 40 selected literature, several key findings were found regarding the use of Artificial Intelligence in risk communication for tourist protection in Indonesia. These findings are grouped into five main themes: (1) Application of AI in tourism risk communication, (2) Effectiveness of data-driven AI systems and implementation challenges in Indonesia, (3) Technology adoption strategies and their impact on tourist behavior.

AI Applications in Tourism Risk Communication

Several applications can be used to communicate risks in the tourism sector, such as: 1). AI-based early warning systems, 2). Virtual Assistant Chatbots, 3). Sentiment Analysis and Social Media Monitoring, 4). Personalized Recommendation Systems. These applications each have their own advantages and disadvantages. With AI support, these applications can be utilized to provide protection for tourists. AI-based early warning systems are one of the most significant applications in tourism risk mitigation. AI is able to analyze real-time data from various sources such as weather sensors, seismic data, satellite imagery, and social media to predict potential risks with higher accuracy than conventional systems.

Research shows that AI-based early warning systems have been successfully implemented in several tourism destinations in Indonesia. For example, in Bali, AI is used to predict potential high waves and provide warnings to tourists engaged in beach activities. This system integrates data from the Meteorology, Climatology, and Geophysics Agency (BMKG) with social media data to provide more comprehensive and timely warnings. AI-based chatbots and virtual assistants have proven effective in providing risk information to tourists in real-time. This chatbot can operate 24/7, serve travelers in multiple languages, and provide personalized responses based on individual needs.

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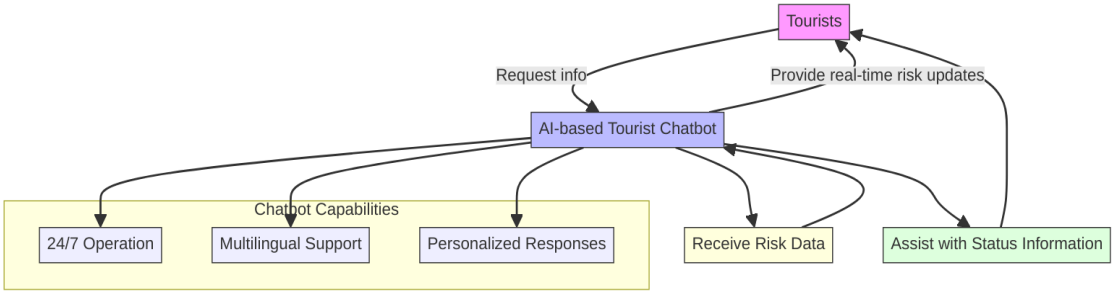

Fig. 2. AI-Based Travel Chatbot for Risk Communication

As seen in Fig. 2, AI-based chatbot helped tourists obtain information about the destination's safety status, evacuation routes, and the nearest health facilities during an earthquake. The chatbot can also provide step-by-step guidance on what to do in an emergency. AI can analyze the volume and sentiment of conversations on social media to identify emerging security issues. Natural Language Processing (NLP) techniques enable AI systems to understand the content of social media posts, traveler reviews, and local news to detect potential risks.

AI-based sentiment analysis successfully detected traveler complaints about maritime safety weeks before a significant incident occurred. This information enabled local authorities to take preventative measures before the situation escalated. Furthermore, AI can develop personalized recommendation systems based on traveler profiles, preferences, and travel history. These systems not only recommend safe destinations but also provide risk information relevant to traveler characteristics. For example, older travelers would receive more detailed information about accessibility and health facilities at a destination, while younger travelers interested in extreme activities would receive specific warnings regarding the risks of those activities.

Effectiveness and Challenges of Data-Driven AI Systems

One of the key findings from the literature review is the importance of quality data in implementing AI for tourism risk communication. Effective AI systems depend on the availability

of accurate, complete, and up-to-date data from multiple sources. Research shows that the most effective AI systems are those capable of integrating data from multiple sources, including: 1) Geospatial data: maps, location coordinates, elevation data; 2) Sensor data: weather, earthquakes, air quality; 3) Demographic data: traveler profiles, preferences, and abilities; 4) Historical data: previous incidents, seasonal patterns; 5) Real-time data: social media, user reports, CCTV. This data integration enables AI to produce more comprehensive analyses and more accurate predictions about potential risks faced by tourists. Machine learning techniques enable AI systems to perform predictive analysis of potential tourism risks. Based on historical data and identified patterns, AI can predict the likelihood of risks occurring and their impact on tourists.

Table 1. Shows examples of predictive analytics applications in AI-based tourism risk mitigation:

Types of Risk	Data Input	AI Techniques	Prediction Output
Natural disasters	Seismic, weather, historical data	Neural Networks, Time Series Analysis	Probability of an earthquake/tsunami occurring within 24 hours
Health Crisis	Health data, traveler demographics, case reports	Random Forest, SVM	Potential spread of disease in tourist areas
Security	Crime data, traveler reviews, social media	NLP, Sentiment Analysis	Areas with high potential security risks
Transportation	Traffic data, weather, road conditions	Deep Learning, Computer Vision	Estimated travel time and travel risks

As seen in Table 1, the main advantage of AI in risk communication is its ability to personalize information based on individual characteristics of travelers. Based on literature studies, this personalization increases communication effectiveness because the information becomes more relevant and easier to understand. Factors considered in personalizing risk communication include: 1). Demographics: Age, gender, education, 2). Nationality and Culture: Traveler origin, cultural norms, 3). Communication Preferences: Language, information format (text, audio, visual, 4). Physical Abilities: Disabilities, health conditions, 5). Previous Experience: Travel history, knowledge of risks, 6). Current Location: Geographical position, travel plans (Entradas, 2021).

Despite its great potential, the implementation of AI for tourism risk communication in Indonesia faces several challenges, such as: 1) Limited digital infrastructure, 2) Data fragmentation and interoperability, 3) Limited human resource capacity, 4) Privacy and data security issues, 5) Cultural and perception barriers. Unequal digital infrastructure is a major challenge in implementing AI in Indonesia (Jaelani et al., 2024). Many popular tourist destinations, especially in remote areas and small islands, still have limited or unstable internet connections. This condition hinders the operation of AI systems that require real-time connectivity. Research at tourist

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destinations in East Nusa Tenggara shows that more than 60% of tourist areas have weak internet signals, preventing AI-based early warning systems from operating optimally. Furthermore, limited electricity infrastructure in some areas also hinders the operation of AI devices. Data required for AI systems is often scattered across various government and private agencies without integrated standards. The Ministry of Tourism and Creative Economy, the National Disaster Management Agency (BNPB), the Ministry of Health, and local governments each have separate data systems. This fragmentation makes it difficult to access and integrate the data necessary for comprehensive AI analysis. Furthermore, differences in data standards and formats across agencies also hinder system interoperability.

AI implementation requires human resources with specialized expertise in data science, machine learning, and AI system development (Camilleri, 2024). Literature studies indicate that Indonesia still experiences a shortage of experts in this field, especially outside Java. A survey of 50 tourism agencies in Indonesia showed that only 12% had staff with sufficient technical expertise to manage AI systems. Furthermore, the lack of training and capacity-building programs for government officials and tourism industry players also poses a challenge. The use of AI in tourism risk communication involves the collection and analysis of tourists' personal data, such as location, preferences, and demographic information. This raises concerns about data privacy and security, especially for international tourists who have high privacy standards. Indonesia does not yet have comprehensive regulations regarding personal data protection, although a draft Personal Data Protection Law is currently under discussion. This regulatory uncertainty is a consideration for tourists and service providers in adopting AI technology. Cultural factors also influence the acceptance of AI technology in tourism risk communication. Some local communities in tourist destinations still hold traditional beliefs regarding disaster mitigation and may be skeptical of technology-based solutions. Furthermore, the perception that AI is a complex and expensive technology also hinders its adoption by small and medium-sized tourism businesses. Many tourism destination managers consider AI irrelevant to their day-to-day operations.

Technology Adoption Strategy and Impact on Tourist Behavior

Based on literature studies, several strategies can be implemented to address the challenges of implementing AI in tourism risk communication in Indonesia, such as: 1). Development of a National Framework, 2). Strengthening Digital Infrastructure, 3). Building Human Resource Capacity, 4). Multi-Stakeholder Collaboration, 5). A Phased and Scalable Approach (Zancan et al., 2023). The development of a comprehensive national framework is needed to guide the implementation of AI in tourism risk communication. This framework should include: data standards and system interoperability, AI-based risk communication protocols, implementation guidelines for various levels of tourist destinations, monitoring and evaluation mechanisms. This

framework should be developed through collaboration between the central government, local governments, academia, and the tourism industry to ensure relevance and implementability.

Improving digital infrastructure in tourist destinations is a key prerequisite for AI implementation. Strategies that can be implemented include: developing broadband internet networks in priority tourist destinations, installing alternative energy sources (solar cells, generators) for remote areas, implementing edge computing technology to reduce dependence on central connectivity, developing an emergency communication system independent of commercial infrastructure, and sustainable human resource capacity building efforts to create a strong AI ecosystem in tourism. Effective AI implementation requires close collaboration between various stakeholders. Successful collaboration models in several tourist destinations include public-private partnerships, academia-industry collaboration, local community engagement, and international collaboration.

The development of AI through various strategies has had a significant impact. AI can increase tourists' awareness of potential risks by delivering more personalized and relevant information (Kanbara & Shaw, 2021). Research shows that tourists who receive risk information through AI systems tend to have higher levels of awareness and compliance with safety guidelines. For example, tourists using an AI-based app in Bali showed 78% compliance with beach hazard warnings, compared to 45% of those who only received information through conventional noticeboards. Improved access to risk information through AI influences tourists' decision-making patterns. Tourists become more proactive in managing risks during their travels, including in selecting destinations, activities, and accommodations. Data from a survey of 500 international tourists in Indonesia showed that 65% changed their travel plans based on recommendations from AI-based apps, particularly regarding weather conditions and the destination's safety status. The implementation of AI in risk communication also impacts tourists' levels of trust and satisfaction. Tourists feel safer and more protected when they know that a destination has a sophisticated risk management system. A study at the tourist destination of Lombok showed that tourist satisfaction levels increased by 32% after the implementation of an AI-based early warning system, with key indicators being a sense of security and a rapid response to risk reports. Despite its many benefits, the adoption of AI technology by tourists also faces several challenges. Some travelers, especially older generations, may struggle to use AI-based applications or systems. Furthermore, concerns about data privacy and the reliability of the technology are also a concern. Research shows that approximately 25% of older travelers are reluctant to use AI-based applications due to technical difficulties, while 18% of international travelers expressed concerns about the use of their personal data (Ministry of Communication, 2025).

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Discussion

The findings of this study demonstrate that Artificial Intelligence (AI) holds substantial potential in advancing the effectiveness of risk communication for tourist protection in Indonesia. By organizing the results into three major dimensions, applications of AI in risk communication, the effectiveness and challenges of data-driven systems, and technology adoption strategies, this study not only confirms but also extends previous theoretical and empirical works in the field.

First, the identification of AI applications, including early warning systems, virtual assistant chatbots, sentiment analysis, and personalized recommendation systems, corroborates prior research conducted in international contexts. Aliperti and Cruz (2018) highlighted the role of AI-based early warning systems in enhancing disaster preparedness in Japan, while Kanbara and Shaw (2021) underscored the positive effect of AI-driven disaster risk reduction systems on compliance with safety measures. The empirical evidence presented in this study, such as the use of AI in Bali for predicting high waves and issuing real-time warnings, further strengthens these findings and illustrates the transferability of global best practices into the Indonesian context. These results also align with Covello's (2001) assertion that effective risk communication must emphasize timeliness and accuracy, both of which are significantly improved through AI integration.

Second, the effectiveness of AI in risk communication is closely tied to the integration of diverse and high-quality data sources. This observation is consistent with Bier (2001), who argued that risk communication effectiveness is contingent upon reliable information dissemination tailored to heterogeneous audiences. The current study expands this theoretical position by demonstrating how AI can operationalize such principles through advanced data integration across geospatial, sensor, demographic, and real-time social media datasets. Nonetheless, persistent challenges remain. Issues such as fragmented data governance across institutions, insufficient digital infrastructure in peripheral destinations, and limited human resource expertise have been identified, echoing earlier findings on AI governance and implementation challenges in developing contexts (Camilleri, 2024; Jaelani et al., 2024). These obstacles highlight that while AI offers technical solutions, institutional and systemic readiness remains a determining factor in its success.

Third, this study reinforces and extends literature on technology adoption strategies in tourism. Zancan et al. (2023) emphasized the importance of multi-stakeholder collaboration in the adoption of AI, while Entradas (2021) demonstrated that trust in information sources strongly influences behavioral compliance with risk communication. The Indonesian evidence presented here substantiates these claims by showing that the development of a national framework, the strengthening of digital infrastructure, and active community engagement are essential prerequisites for effective adoption. Furthermore, empirical data from Bali and Lombok show that tourists' compliance with safety guidelines and their satisfaction with destinations increased

significantly after AI-based systems were introduced. These findings confirm that AI does not merely function as a technological tool but also as a driver of behavioral change and trust-building in tourism risk management.

This study contributes to the academic discourse by integrating risk communication theories, such as the Mental Noise Approach (Fischhoff, 2011) and Cultural Theory (Douglas & Wildavsky, 1982), with the practical application of AI technologies in the Indonesian tourism context. Theoretically, the study demonstrates how AI operationalizes risk communication principles through personalization, predictive analytics, and real-time dissemination. Practically, the study provides actionable insights for policymakers and tourism practitioners, particularly in designing AI-based systems that are contextually relevant, culturally sensitive, and technologically feasible. Moreover, by offering a phased and scalable framework for AI adoption, this study contributes to policy formulation for developing countries seeking to enhance tourist protection while addressing infrastructural and governance constraints.

Despite its contributions, several limitations must be acknowledged. First, the study relies on secondary data from a systematic literature review, which may not fully capture emerging or unpublished practices in Indonesia's tourism sector. Second, the analysis prioritizes technological and infrastructural dimensions, while cultural and behavioral responses to AI-based communication remain underexplored. Third, the absence of empirical validation through primary data collection,such as stakeholder interviews, case studies, or tourist surveys, limits the depth of contextual understanding. Future research should therefore adopt mixed-method approaches, integrating big data analytics with field-based investigations to validate AI applications, assess cultural acceptance, and explore long-term behavioral impacts.

5. Conclusion

Based on the comprehensive literature review, this study concludes that Artificial Intelligence (AI) possesses substantial potential to enhance the effectiveness of risk communication for tourist protection in Indonesia. The integration of AI technologies can overcome the limitations inherent in conventional systems, particularly with regard to speed, accuracy, and personalization of information. AI-based risk communication thus represents an innovative and transformative approach to strengthening tourist safety, while simultaneously supporting the development of safe, reliable, and sustainable tourism destinations. The implementation of AI is expected to generate both immediate and long-term benefits. In the short term, AI can improve the timeliness and relevance of risk information, thereby increasing tourists' sense of security and compliance with safety guidelines. In the long term, the adoption of AI will contribute to the recovery and growth of Indonesia's tourism sector in the post-pandemic era, enhance destination competitiveness, and

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support the achievement of national tourism targets. Moreover, successful implementation will strengthen Indonesia's international image as a technologically advanced and responsive tourism destination, potentially positioning the country as a pioneer in the use of AI for tourist safety in the Southeast Asian region.

Achieving this vision, however, requires strong commitment and collaboration among key stakeholders, including government institutions, the tourism industry, academia, and local communities. A comprehensive national framework should be developed to coordinate AI implementation across tourism destinations, covering standardized data management, communication protocols, and implementation guidelines. Parallel efforts are also necessary to improve digital infrastructure, particularly broadband internet, alternative energy sources, and emergency communication systems, as well as to enhance human resource capacity through education, training, and the establishment of AI centers of excellence in tourism. In addition, the prompt finalization of comprehensive personal data protection regulations is essential to ensure legal certainty and to build tourists' trust in AI-based systems. While this study contributes to advancing knowledge on AI-based risk communication, it has certain limitations as it relies primarily on secondary data from literature sources. Future research should therefore employ empirical approaches, such as case studies, field experiments, and stakeholder interviews, to validate the practical effectiveness of AI applications in diverse tourism contexts. In particular, further studies are needed to examine tourists' behavioral responses, cultural perceptions, and levels of trust in AI-based systems, as well as to evaluate the long-term socio-economic impacts of AI adoption on destination sustainability. Comparative research between Indonesia and other countries with similar geographical and cultural characteristics would also provide valuable insights for refining strategies and policies on AI-enabled risk communication in tourism.

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