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Toward a smart tourism system for luwuk banggai: integrating ai assistant and interactive WebGis

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ABSTRACT

The tourism potential of Luwuk Banggai is constrained by the lack of comprehensive and interactive information. Limited data on destinations, routes, and personalized guidance reduces the overall tourist experience. AI and WebGIS technologies offer innovative solutions for building a smarter tourism ecosystem. This study designed and implemented a smart tourism system in Luwuk Banggai by integrating an interactive AI assistant and WebGIS. The objective is to enhance the tourist experience through accurate information, personalized recommendations, intuitive visualizations, and to support tourism managers in decision-making. A system development approach was employed, beginning with needs analysis and literature review. The design involved a modular architecture an AI module for natural language interaction and a WebGIS module for spatial visualization. The implementation utilized modern web technologies with a responsive user interface and a structured database. System testing was conducted using black box testing to assess functionality and reliability. The developed smart tourism system successfully integrated an AI assistant capable of answering questions and providing recommendations, alongside an interactive WebGIS that displays locations and routes. Testing results indicated that the system operated according to specifications, improving both information access and interactivity. The integration of the AI assistant and WebGIS within the Luwuk Banggai smart tourism system effectively enhances the tourist experience and the efficiency of tourism information management. This system contributes to sustainable tourism and opens opportunities for future service personalization and spatial data analytics.

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1. INTRODUCTION

The Tourism has developed into one of the strategic sectors for driving economic growth, strengthening cultural identity, and improving local community welfare. In many countries, tourism serves as a pillar of sustainable development because it creates employment opportunities, attracts investment, and becomes a medium for preserving natural and cultural heritage. The advent of the digital era, particularly within the framework of Tourism 4.0, has brought significant implications for how destinations are managed, marketed, and consumed. The concept of smart tourism emphasizes the integration of information technology, data analytics, and digital interactivity to enhance the quality of tourist experiences while improving destination management efficiency. Recent studies highlight the shifting behavior of tourists who increasingly rely on digital technology to seek information, plan trips, and evaluate destinations (Abdurakhmanova et al., 2022; Bratić et al., 2025; Zeqiri et al., 2025). Digitalization is no longer merely an additional feature, but has become the main foundation of global tourism industry transformation.

This global trend finds its relevance in the Indonesian context, including the Luwuk Banggai region in Central Sulawesi, which possesses abundant natural, cultural, and marine tourism potential. The beauty of waterfalls, small islands with white sandy beaches, and exotic mountain landscapes positions this region as a promising destination at both national and international levels (Akbar et al., 2020; Yusuf & Mambuhu, 2020). However, limitations in providing comprehensive, integrated, and interactive digital information remain a major challenge. Tourists often rely on general platforms such as Google Maps or international travel websites, which frequently lack local details, facility descriptions, and destination accessibility information. Emphasize that the lack of digitalization in local destinations can reduce the competitiveness of regional tourism in today's global market. In this context, the development of technology-based smart tourism systems has become an urgent need, not only to expand promotion but also to provide accurate, contextual information that can support tourists' travel planning (Rosário & Dias, 2024; Wu et al., 2024).

The feasibility of implementing a smart tourism system in Luwuk Banggai is inherently intertwined with the existing state of its digital infrastructure and the ecosystem supporting technological adoption. Reliable internet access, particularly in tourist areas and for local stakeholders, is a foundational requirement for the seamless operation of interactive AI assistants and real-time data sharing via WebGIS. Challenges in internet connectivity or bandwidth limitations, especially in remote attractions, could hinder tourist engagement and data synchronization, potentially leading to a degraded user experience. Furthermore, the prevalence and adoption rate of tourist devices (smartphones, tablets) among visitors will influence how effectively they can access and utilize the smart tourism system. Equally critical is the level of support and digital literacy within local government and tourism businesses. Without dedicated support for system maintenance, data updates, and capacity building for local operators, the long-term sustainability and effectiveness of the smart tourism system would be significantly compromised. Therefore, a comprehensive assessment of these infrastructural and ecosystem factors is crucial for understanding the practical limitations and potential challenges in rolling out and scaling a smart tourism initiative in a region like Luwuk Banggai.

The main problem arising from this condition is the absence of a digital platform capable of systematically integrating spatial and non-spatial information on Luwuk Banggai's tourism destinations. Tourists seeking to explore this region often encounter information gaps related to location, transportation access, facilities, costs, and activity recommendations. This situation not only complicates the decision-making process for tourists but also reduces the potential contribution of tourism to the local economy. (H.

Wang & Yan, 2022; X. Wang et al., 2023) showed that unclear digital information can influence perceptions of destination quality, visitation levels, and tourist loyalty. A general solution offered in the literature is the application of WebGIS-based technology and intelligent recommendation systems that can provide interactive, contextual, and personalized information (Mateos & Bellogín, 2024;). However, most of these studies still focus on major destinations with more advanced digital infrastructure, while potential areas such as Luwuk Banggai remain overlooked.

In addressing these challenges, various studies emphasize the importance of integrating Geographic Information System (GIS) technology to map tourism destinations and visually present spatial information. WebGIS enables users to explore destinations through interactive digital maps, track routes, and understand the geographical distribution of attractions (Chang & Caneday, 2011; Mohamed et al., 2021). Nevertheless, while WebGIS is effective for spatial visualization, it remains limited in providing personalized experiences for tourists. On the other hand, advancements in artificial intelligence, particularly large language models, have opened new opportunities through the application of AI-based conversational assistants in the tourism sector. AI assistants can interact with tourists naturally, provide preference-based recommendations, and answer practical questions about destinations (Prasanna et al., 2025). Combining the two has the potential to deliver a holistic smart tourism system, where spatial and narrative information complement each other.

More specific solutions have been offered by prior studies. First, tourism recommendation systems based on content-based filtering and collaborative filtering have been shown to improve the relevance of destination information to tourist preferences (Aldayel et al., 2023; Fahrizal et al., 2024). Second, research on the use of chatbots in tourism indicates that real-time conversational interaction can reduce uncertainty for tourists and increase satisfaction with digital experiences (Magano et al., 2025). Third, studies on WebGIS for promoting local tourism highlight the importance of integrating spatial data with descriptive attributes to enrich tourists' understanding of destination accessibility and facilities (Ristianti et al., 2022). However, most of these studies have progressed separately, either by developing WebGIS or by implementing AI-based recommendation systems, leaving room for innovation in merging the two approaches into one integrated framework.

Furthermore, solutions more closely aligned with the present study can be seen in experimental integrations of conversational recommender systems with digital maps. Recent works, such as (Baizal et al., 2021), demonstrate how AI-driven conversations can assist tourists in discovering destinations through interactive map interfaces. With this approach, users can inquire about specific tourism categories, budget preferences, or travel distances, and the system automatically displays relevant locations on the map. This concept contributes to enhanced user experience by combining the flexibility of conversation with the clarity of spatial visualization. Nevertheless, the literature indicates that empirical studies on integrating AI Assistants with WebGIS in the context of local tourism destinations in developing countries, including Indonesia, remain very limited. This gap further reinforces the urgency of the present study.

An overview of the literature related to digital technology integration in tourism reveals both significant potential and gaps that must be bridged. Globally, the concept of a smart tourism ecosystem has been widely discussed, particularly in the context of smart cities or flagship destinations with sufficient digital infrastructure (Chuang, 2023). Studies in Europe, China, and the United States show that integrating spatial data, AI-based recommendation systems, and IoT sensors can create adaptive and sustainable tourism systems (Aliyah et al., 2023). However, in local destinations that are still developing, such as Luwuk Banggai, research focusing on the adaptation of simple technology based on tourists' real needs and tailored to infrastructural limitations remains scarce. Previous studies in Indonesia have largely emphasized developing

promotional applications based on maps or destination catalog websites, without leveraging artificial intelligence to enhance interactivity. Thus, there is a clear gap in the literature regarding how AI Assistants and WebGIS integration can be contextually applied to support the digitalization of local tourism destinations.

Based on the above discussion, the objective of this research is to design and test a prototype smart tourism system for Luwuk Banggai by integrating an AI Tourism Assistant module with an interactive WebGIS. This study highlights its novelty in merging two technological approaches that have previously operated separately: WebGIS as a medium for spatial visualization and AI Assistant as a medium for conversational interaction. The contribution lies in providing a system that not only displays destination data visually but also delivers personalized recommendations through conversation, answers practical questions, and guides tourists in navigating their travel choices. The scope of the study includes mapping at least 15 tourism destinations in Luwuk Banggai, developing a spatial and descriptive attribute database, designing the WebGIS interface, and implementing an online-accessible AI Assistant module. With this approach, the study is expected to make a scientific contribution to the smart tourism literature and a practical contribution to the development of local tourism in Indonesia.

2. RESEARCH METHOD

This study adopts a system development approach (System Development Life Cycle/SDLC) using a modified waterfall model, focusing on the design and implementation of a smart tourism system. This approach was chosen because it allows for structured and sequential stages, from requirements analysis to system testing, ensuring that each phase is completed before moving on to the next. The sources that guided the selection of this method include literature on software engineering and information system development, which emphasizes the importance of thorough planning and validation at every stage ((Adriani et al., n.d.; Christanto & Singgalen, 2023; Hananta et al., 2025).

a. DataCollection:

The data used in this study include tourism destination data in Luwuk Banggai (name, geographical location, description, facilities, operating hours, ticket prices), travel route data, and other related information. These data were collected through several methods: (a)Literature Review: Collecting information from scholarly journals, articles, and publications related to smart tourism, AI assistants, WebGIS, and tourism in Luwuk Banggai. (b)Observation: Observing existing tourism information systems (if any) and identifying the needs and challenges faced by tourists and managers. (c) Document Analysis: Analyzing documents related to local tourism, such as tourism maps, brochures, and official regional government websites.

b. System Design:

The system design stage involves developing the system architecture, user interface (UI) design, and database design. The research framework is outlined as follows: (a) *Requirements Analysis*: Identifying functional requirements (e.g., destination search, AI recommendations, map visualization) and non-functional requirements (e.g., performance, security, usability) based on literature review and analysis of existing systems. (b) *System Architecture Design*: Designing a modular architecture that separates the front-end (user interface), back-end (business logic and APIs), AI module (Natural Language Processing/NLP and recommendations), and WebGIS module (map and spatial data integration). (c) *Database Design*: Designing a relational database schema to store information on destinations, users, AI interactions, and geographic data. (d) *User*

Interface (UI) Design: Creating intuitive and responsive layouts and interactions for the web platform, including the homepage, destination page, AI assistant page, and interactive map page.

c. System Implementation:

Implementation is carried out based on the prepared design. The technologies used include: (a) *Front-end*: HTML, CSS, JavaScript (with frameworks such as React.js or Vue.js for dynamic interfaces. (b) *Back-end*: Python (with frameworks such as Flask or Django) to manage business logic, APIs, and integration with AI and WebGIS modules. (c) *Database*: PostgreSQL or MySQL for data storage. (d) *AI Module*: Utilizing NLP libraries (e.g., NLTK, SpaCy) and recommendation algorithms (e.g., collaborative filtering, content-based filtering). (e) *WebGIS Module*: Integration with OpenStreetMap or Google Maps API, and JavaScript libraries such as Leaflet.js or OpenLayers for interactive map visualization.

d. Testing and Evaluation:

System testing is conducted to ensure that the system functions according to the specified requirements and meets user needs. The testing method used is *black box testing*. This approach focuses on the external functionality of the system without considering the internal code structure. Testing is performed by providing inputs and verifying the resulting outputs to ensure that each feature works as intended. The testing procedures include: (a) *AI Assistant Functionality Testing*: Verifying the AI assistant's ability to understand user queries, provide relevant answers, and generate accurate recommendations. (b) *WebGIS Functionality Testing*: Verifying the interactive map's ability to display destination locations, filter by category, and show travel routes. (c) *User Interface Testing*: Ensuring all UI elements work properly, are responsive, and user-friendly. (d) *Integration Testing*: Verifying that all modules (AI, WebGIS, database) are well integrated and communicate seamlessly.

3. RESULTS AND DISCUSSIONS

In Figure 2, the homepage displays the Explore Luwuk Banggai brand identity at the top bar, flanked by the navigation menu items Home, Destinasi, Peta, AI Assistant, and Tentang. At the center, the prominent headline "Explore Luwuk Banggai" stands out, accompanied by the subheading "Temukan Keindahan Tersembunyi di Ujung Timur Sulawesi Tengah," which directly conveys the site's value proposition. Just below, two call-to-action buttons guide the main user flow: Mulai Jelajahi in green with a map icon leads visitors to the destination catalog, while AI Assistant in an outlined style opens the conversational assistant for quick recommendations and inquiries.

Figure 1. homepage displays the Explore Luwuk Banggai

The interactive map shown in Figure 2 is a spatial representation of tourism destinations in the Luwuk Banggai region utilizing Leaflet-based WebGIS technology. Each destination is marked with different symbols according to its tourism category, such as waterfalls, beaches, lakes, caves, islands, and hills, as indicated in the legend on the right side. This visual approach allows users to quickly grasp the geographical distribution of tourist attractions while comparing distances between locations within one administrative area. The zoom in/zoom out feature and marker interactivity support more detailed spatial exploration, ensuring that the information is not only textual but also connected to its spatial context. Scientifically, this map functions as an instrument for enhancing the accessibility of tourism information by presenting geospatial data dynamically and comprehensibly, in line with the principles of smart tourism that emphasize spatial data integration, digital interactivity, and improved user experience. Thus, the use of interactive maps not only facilitates tourists in planning their trips but also supports strategic decision-making for local governments in spatially based destination management.

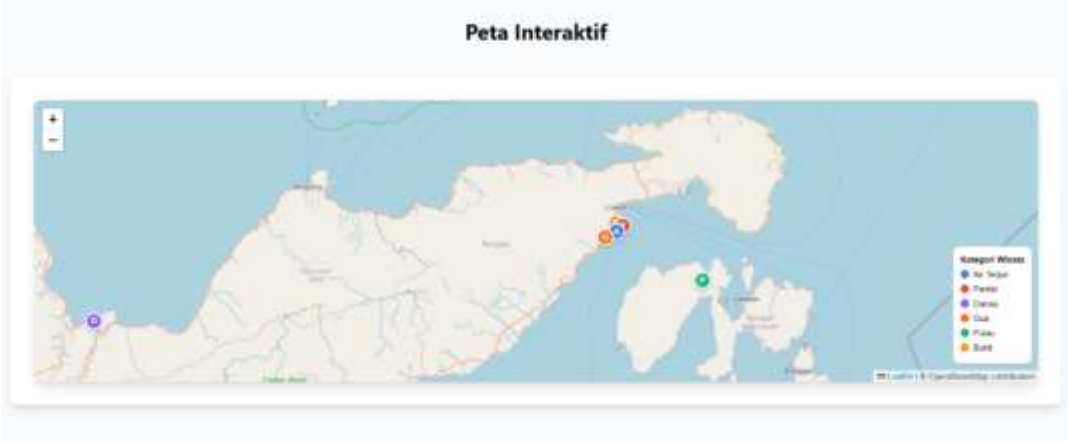

Figure 2. Interactive Map

Figure 3 shows the display of the Tourism Destinations page, designed to present destination information systematically and interactively within the framework of developing a smart tourism system. At the top of the page, users are provided with category filter features such as Waterfalls, Beaches & Islands, Hills & Scenic Views,

Lakes & Water Tourism, and Conservation, enabling faster and preference-based information searches. Each destination is presented in the form of an information card containing a representative photo, destination name, category, and a brief description of its main attractions and relative location. This visual design not only improves readability but also functions as a knowledge visualization instrument that supports tourists' decision-making processes in selecting destinations. Scientifically, the presentation based on filters and destination cards aligns with the principles of user-centered design in tourism information systems, as it minimizes users' cognitive load and enhances the accessibility of tourism data. Thus, this display serves not only as a promotional medium but also as an effective digital education tool to expand the reach of technology-based tourism information in the Luwuk Banggai region.

Figure 3. The Tourism Destinations page

Figure 4 shows the detailed view of a tourism destination, presenting information more comprehensively through an interactive modal window. In this example, the Salodik Waterfall destination is displayed complete with a representative photo, destination category, operating hours, entrance ticket price, accessibility, and a list of available facilities. This structured presentation integrates textual and visual data, thereby enhancing information clarity while reinforcing the destination's appeal. The presence of a View Route button expands the system's function toward spatial navigation, enabling users to connect directly with digital maps for trip planning. From a scientific perspective, this detailed view represents the implementation of the information-rich interface principle in smart tourism systems, where users not only obtain a general overview but also practical data that support decision-making.

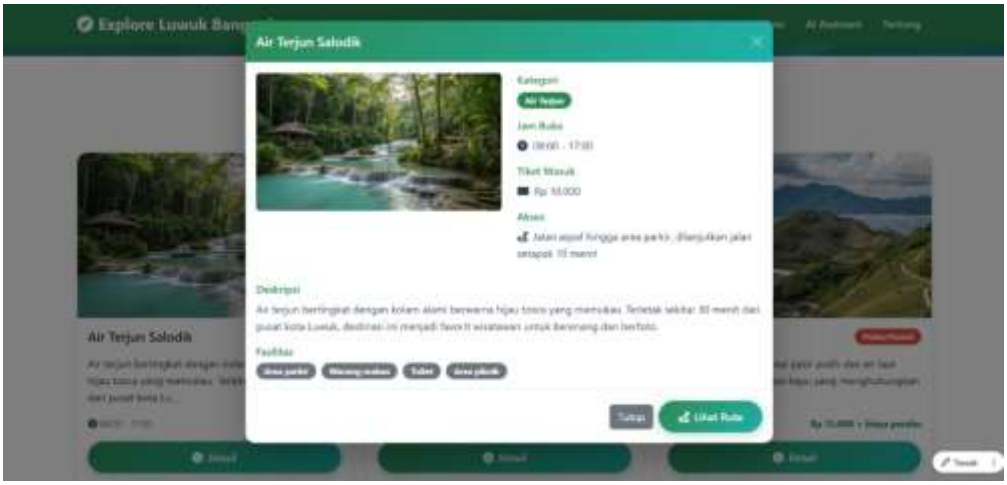

Figure 4. The detailed view of a tourism destination.

Figure 5 illustrates the implementation of the AI Tourism Assistant, which functions as an AI-powered conversational assistant module within the Luwuk Banggai smart tourism system. This feature is designed to provide interactive services such as destination recommendations, weather and real-time condition updates, travel guidance, as well as tourism tips and advice relevant to user needs. The simple interface with a text input field enables tourists to interact naturally through direct questions, allowing the system to deliver personalized and contextual responses. From a scientific perspective, the application of this AI assistant reflects the integration of Natural Language Processing (NLP) technology in the tourism sector, aiming to enhance user experience through real-time, preference-based information services. Its presence also demonstrates the adoption of conversational recommender system principles, where tourists are not merely passive recipients of information but can engage in dialogue with the system to obtain tailored travel solutions. Thus, the AI Tourism Assistant contributes to the development of a more adaptive and responsive smart tourism ecosystem, supporting more efficient tourism decision-making.

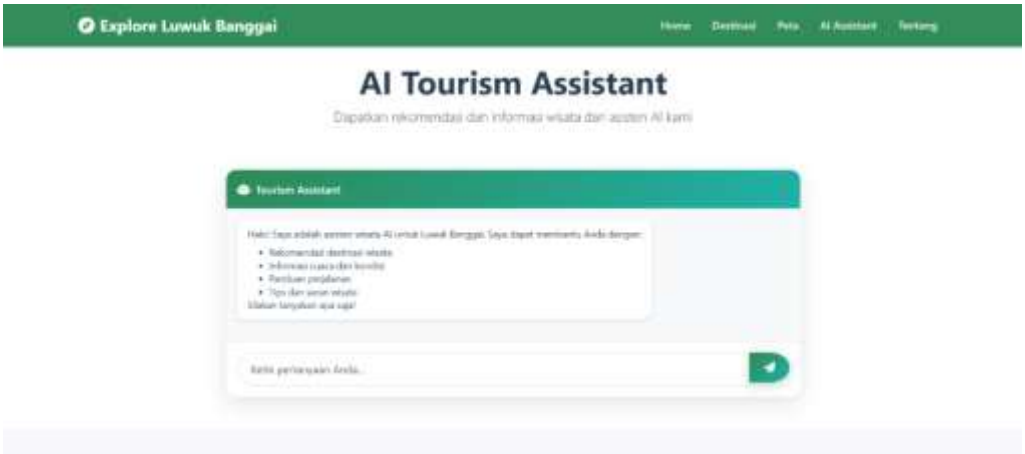

Figure 5. AI Tourism Assistant

3.1 Black Box Testing

Black box testing is a software testing method that focuses on the functionality of the application without paying attention to the internal structure of the code, design, or implementation of the program (Jaya, 2018; Pratama et al., 2023; Wijaya & Astuti, 2021).

Table 2 presents the results of system testing using the Black Box Testing method, which focuses on validating the system's external functionality without examining the internal code structure. This approach is suitable for evaluating whether the system's features—such as navigation menus, search functions, interactive maps, AI assistant modules, and destination detail modals perform according to their intended behavior when provided with various input scenarios. Each test case is designed to assess specific user interactions, expected outputs, and response handling under different conditions, including both normal and boundary inputs. By employing test design techniques such as decision tables, equivalence partitioning, state transitions, error guessing, and boundary value analysis, this testing phase ensures that the tourism information system delivers a reliable, user-friendly, and functionally complete experience. The structured validation helps verify that the integration of WebGIS and AI Assistant modules meets the predefined requirements and contributes effectively to the overall goal of building a smart tourism platform for Luwuk Banggai.

Table 2. Block Box Testing

ID	Feature	Test Case	Precondition	Test Steps	Expected Result	Status
F-01	Homepage Navigation	Click 'Destinations' menu	Website loaded	Click 'Destinations' in navbar	Destinations page loads	Valid
F-02	Hero CTA Buttons	Click 'Start Exploring'	Homepage visible	Click 'Start Exploring' button	Scrolls to destination section	Valid
F-03	AI Assistant Launch	Click 'AI Assistant' button	Homepage visible	Click 'AI Assistant'	Chat module opens	Valid
F-04	Category Filter	Filter 'Waterfalls'	Destination list visible	Click 'Waterfalls' filter	Only 'Waterfalls' shown	Valid
F-05	Search Function	Valid keyword search	Search bar visible	Type 'Salodik' and press enter	'Salodik Waterfall' appears	Valid
F-06	Search Function	Invalid keyword search	Search bar visible	Type 'abcxyz' and press enter	'Not found' message displayed	Valid
F-07	Map Display	Zoom and pan	Map loaded	Zoom in/out, drag map	Map responds smoothly, markers stay	Valid
F-08	Map Marker Interaction	Click marker	Map loaded	Click destination marker	Popup appears with name and detail link	Valid
F-09	Destination Detail Modal	Open detail modal	Card visible	Click on 'Salodik' card	Detail modal with image and info appears	Valid
F-10	Route Button in Modal	Click 'View Route'	Detail modal open	Click 'View Route' button	External map opens with coordinates	Valid
F-11	Responsive Layout	Mobile view rendering	Open devtools	Resize to 360px width	Layout adjusts, menu collapses	Valid

F-12	AI Assistant Q&A	Ask for beach suggestions	AI module open	Ask: 'Recommended beaches for kids'	Assistant lists 2-3 family-friendly beaches	Valid
F-13	AI Assistant Fallback	Send unclear input	AI module open	Send '???'	System asks for clarification	Valid

The results of this study indicate that the integration of AI assistants and WebGIS significantly enhances the capabilities of smart tourism systems. AI assistants provide personal interactions and instant responses, which surpass traditional static information systems. This capability aligns with the findings of Vass (2024) and Botgo (2025), which emphasize the role of AI in personalization and efficiency of tourism services. The presence of WebGIS complements the AI assistant with spatial dimensions, allowing tourists to visualize locations and routes—an aspect that cannot be provided by text-based AI assistants alone. This strengthens the argument of Maymuna and Utomowati (2025) regarding the effectiveness of WebGIS in mapping tourism potential. Compared to similar research, the uniqueness of this system lies in its focus on Luwuk Banggai, an area with developing tourism characteristics. While many AI and WebGIS studies in tourism focus on established destinations, this research demonstrates how advanced technology can be applied effectively in more specific contexts that may have initial data limitations. The tight integration between AI assistants and WebGIS in a single platform is also a significant contribution, as many existing systems tend to separate these two functionalities.

A significant challenge in implementing a smart tourism system, especially in developing regions like Luwuk Banggai, is the inherent limitation of available data for certain destinations or transportation routes. This study addressed this by employing a multi-pronged approach within the system's design. For destinations with minimal textual or feature information, the AI assistant is programmed to acknowledge the data gap explicitly to the user, managing expectations and preventing misinformation. Instead of providing speculative details, it might offer to search for publicly available information or guide the user on how to find more information on-site. For such cases, the WebGIS component can still provide crucial spatial context, such as visualizing the general location and potentially identifying nearest facilities or accessible roads, even if detailed points of interest are scarce.

Furthermore, for transportation routes that are not well-documented, the system leverages probabilistic inference and crowdsourcing capabilities. The AI assistant can ask users for input on their travel preferences and then suggest the most likely or commonly used routes based on available general data (e.g., main road networks). Users can also be prompted to contribute their own route information, which, after a moderation process, can be integrated into the system, incrementally enhancing the database over time. This capability not only bridges immediate information gaps but also fosters a community-driven approach to data enrichment, making the system more robust and adaptable to the evolving information landscape of the region. Feedback mechanisms for users to report outdated or missing information are also integrated, enabling continuous data quality improvement.

4. CONCLUSION

This study successfully designed and implemented a smart tourism system for Luwuk Banggai that effectively integrates an interactive AI assistant and WebGIS, demonstrating that the combination of these technologies can significantly enhance both the tourist experience and the efficiency of tourism information management. The key findings

indicate that the AI assistant is capable of delivering personalized recommendations and accurately answering user queries, while the WebGIS component provides intuitive spatial visualizations of destinations and routes. Both components performed optimally based on the results of black box testing. The contribution of this research lies in offering a holistic and integrated implementation model for smart tourism systems in developing regions such as Luwuk Banggai, addressing a research gap where these technologies have often been treated separately or applied primarily in more established destinations. The implications of this study suggest strong potential for promoting sustainable tourism through personalized services, improved information accessibility, and better data-driven decision-making for local tourism stakeholders. Nonetheless, this study has several limitations, including its reliance on publicly available data, the AI assistant's current scope being limited to the tourism domain, and the absence of quantitative measurements of real user experience. For future research, it is recommended to enrich the destination database, expand the capabilities of the AI assistant, conduct more in-depth performance evaluations, and quantitatively assess the system's impact on tourist satisfaction. To realize the sustainable adoption of this system, local governments and tourism operators are advised to take practical steps, such as: local governments need to invest in building and continuously updating a measurable destination database, which includes information on attractions, accommodation, transportation, as well as its environmental and social impacts.

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