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Development of a Centralized Web GIS-Based Tourism Information System in Lombok with Google Maps API Integration

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ABSTRACT

Tourism information in Lombok, West Nusa Tenggara, remains fragmented across various platforms, leading to travel inefficiencies and suboptimal tourist experiences. This study aims to develop a centralized Web GIS-based tourism information system for Lombok using the Laravel framework and MySQL, integrated with the Google Maps API to provide real-time route navigation and verified geographic coordinates. Following the Waterfall software development life cycle, the system was engineered through structured stages: requirements analysis, system design, implementation, testing, and maintenance. The platform features a public-facing, login-free interface equipped with keyword searches, category filters, and interactive spatial mapping, alongside an administrative dashboard for centralized CRUD data management. System functionality was validated through Black Box testing across 15 operational scenarios, encompassing coordinate plotting, interactive markers, and navigation triggers. The test results indicate that all 15 test cases achieved a 100% success rate without runtime errors, successfully rendering spatial markers and routing requests. The centralized architecture streamlines content management and eliminates navigation ambiguities for visitors. This research provides a practical spatial visualization framework that can be replicated for other regional tourism promotions

Keyword: Google Maps Api; Laravel; Lombok Tourism; Waterfall; Web Gis

How to Cite: [Caption completed by the editor]

1. INTRODUCTION

Lombok Island in West Nusa Tenggara (NTB) possesses immense tourism potential; however, accurate information regarding the locations of tourist attractions is often scattered across various online platforms, causing confusion for tourists and making their trips less efficient. A similar phenomenon is observed in Bali and Nusa Penida, where tourism destination information tends to be unstructured and widely dispersed across the internet, resulting in suboptimal trip planning[1]. This condition aligns with findings indicating that unorganized tourism destination information can disrupt travel efficiency and diminish the overall quality of the tourist experience. Similar research and practical gaps in other regions have highlighted the importance of spatial visualization in supporting tourist navigation. Previous studies emphasize that static tourism promotion information systems fail to provide real-time, location-based navigation guidance. In this context, the novelty offered by prior research lies in the integration of interactive digital maps to accurately visualize the geographical locations of tourist attractions, routes, and destination positions, thereby facilitating tourist mobility[2]. The implementation of Web GIS and map-based tourism promotion has been recognized as a significant innovative step in improving location accuracy and navigation for tourists, compared to conventional, static promotion systems lacking spatial visualization

This digital map integration approach has been successfully applied in studies utilizing modern web frameworks and structured databases to manage tourism destination information, as well as linking destination coordinate data with interactive maps to enhance promotion quality and user experience[2], [3]. Furthermore, the integration of the Google Maps API to display maps, destination location markers, detailed location information, and direction or real-time navigation features has been researched as an effective solution for mapping tourist attractions in areas with numerous destinations, such as Central Lombok and its surroundings [3]. Research related to the implementation of

web-based GIS and route determination algorithms also demonstrates a strong need for accurate route visualization to enhance the user experience in orienting trips to tourist locations.

Given this background, a holistic, integrated Web GIS-based tourism information system solution is required: centralized destination data management, accurate spatial visualization, and real-time route navigation capabilities via the Google Maps API. Therefore, this study aims to develop an accurate and centralized tourist attraction information website for Lombok using the Laravel framework and MySQL as the backend, featuring a responsive public interface accessible without login. The subsequent objective is to link tourism destination coordinate data from the database to the Google Maps API to provide automatic real-time travel routes for tourists, thereby efficiently guiding their journeys to tourist attractions. The primary advantage and novelty of this proposal lie in the integration of interactive digital maps within the tourism promotion system, where tourist destinations are not merely displayed as text-based lists or photo galleries, but are also spatially visualized with location markers and real-time navigation routes. This distinguishes the present study from previous tourism promotion research, which tends to be static and places less emphasis on the spatial navigation aspect[2]. This project consolidates destination data previously scattered across multiple platforms into a single, integrated (centralized) system, making it easier for stakeholders to manage content and improve the accuracy of location information for tourists. By linking the database to the Google Maps API, tourists are provided with automatic real-time travel routes, which ultimately enhances visit efficiency and potential user satisfaction.

The system design architecture employs a Laravel (PHP) backend with a MySQL database for destination data management, alongside a responsive frontend for the public. The development of this tourism information system follows the Waterfall methodology, encompassing requirements analysis, database design, implementation, testing, and maintenance. The integration of destination coordinates into Google Maps is executed via an automated navigation button (Direction API) for real-time route presentation, while an administrative dashboard backed by MySQL is provided for the centralized management of adding, editing, and deleting destination data. The research focus is confined to the Lombok region, NTB, utilizing Laravel, MySQL, and the Google Maps API. The system is designed for public access without the need for login, ensuring that tourist attraction information is openly accessible. The core integration focuses on location coordinates, destination categories, and real-time navigation capabilities. Further complexities in data analysis, such as visitor behavior analytics, dynamic recommendations, or other complex data processing, are excluded from this scope and can be addressed in future studies

Overall, this framework proposes a centralized Web GIS-based tourism information system solution for Lombok, focusing on the accuracy of tourist attraction locations and real-time navigation via the Google Maps API. The Waterfall approach, Laravel, and MySQL are selected as the development framework to ensure traceability, structured data management, and ease of future expansion. This interactive map integration is expected to reduce tourist confusion and improve visit efficiency, aligning with literature that demonstrates the benefits of spatial visualization and digital promotion in the tourism context, including Halal tourism in Lombok and its surrounding regions[4], [5].

2. RESEARCH METHODS

This study designs the research framework, dataset, methods/algorithms, system architecture, evaluation metrics, and experimental setup for the development of a Web GIS-based Centralized Tourism Information System in Lombok with Google Maps integration. This framework emphasizes location accuracy, interactive spatial visualization, real-time navigation, and centralized destination data management utilizing Laravel, MySQL, and the Google Maps API. The theoretical foundation of this research encompasses Web GIS literature, map-based tourism promotion, and GIS–web service integration for navigation and promotion.

2.1. Research Framework and Dataset

The conceptual framework of this research is built upon the idea of a centralized Web GIS for Lombok tourism promotion, which consolidates previously scattered destination data into a single centralized repository, equipped with map visualization, destination category markers, and real-time route navigation via the Google Maps API[3]. The software architecture follows a Laravel (PHP) backend pattern with MySQL, a public frontend without login requirements, and Google Maps API integration for maps, markers, location information, and real-time direction/navigation. The development methodology employs the Waterfall approach, encompassing requirements analysis, database design, implementation, testing, and maintenance.

The primary dataset used in this study consists of tourist attraction location data in Lombok, including geographical coordinates, object categories, descriptions, facilities, and operating hours, consolidated from official sources, local stakeholders, and local tourism publications. This dataset is stored in MySQL with table schemas for destinations, categories, coordinates, and admin metadata. The destination coordinate data is subsequently linked to Google Maps via markers and the Directions API to present real-time routes to selected tourist attractions. This approach refers to studies on location mapping and shortest route determination in Lombok utilizing Android-based GIS with A-Star/Dijkstra algorithms for navigation, serving as a reference that spatial visualization and real-time

routing are highly relevant for enhancing the tourist experience[3]. Considerations from literature on map-based tourism promotion also establish toponyms or location descriptions as accurate data components (toponym data) to improve navigation and mapping quality[6].

As an additional data source, this study considers gazetteer data of tourist attraction locations, administrative boundaries, and transportation routes to enrich the map. This integration is relevant for enhancing GIS interoperability and the potential for regional expansion within Lombok[7], [8]. To maintain data quality, location validation is conducted through latitude-longitude verification against category labels, as well as data consistency checks, such as the availability of operating hours and facilities, to ensure the accuracy of destination information.

2.2. Application Development Method

The proposed system architecture consists of a Laravel backend as an MVC framework with PHP as the programming language and MySQL as the database, alongside a responsive public frontend without login requirements for tourist attraction searches, category filtering, and interactive map display. Map integration is executed via the Google Maps API to display the map, destination markers, info windows, and an automated navigation (direction) button that guides users to selected tourist attractions in real-time. The development process flow begins with requirements analysis to identify tourist attractions, navigation needs, and public access constraints, followed by database design encompassing destination schemas (id, name, coordinates, category, description, operating hours, facilities), object categories, admin reviews, and activity logs. The implementation phase includes developing the Laravel backend with RESTful endpoints for destination data, data manipulation (add/edit/delete) via a MySQL-based admin dashboard, and Google Maps integration on the frontend for maps, markers, location info, and real-time navigation. Testing is conducted through functionality tests (destination data CRUD, filtering, navigation), Google Maps integration tests, database query performance tests, and user comfort tests via UI responsiveness.

The development of this tourism information system follows the Waterfall model, which consists of five sequential stages: requirements analysis, system design, implementation, testing, and maintenance. This model is selected due to its structured characteristics and suitability for projects with clearly defined requirements, such as Web GIS-based information systems. The flow of the system development stages is illustrated in Figure 1.

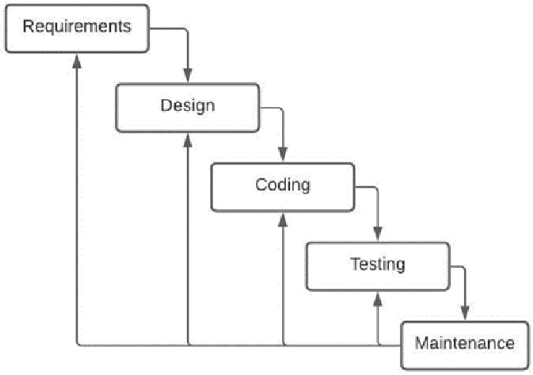


Figure 1. System development model using the Waterfall approach

In the requirements analysis stage, system needs are identified, including the list of tourist attractions, real-time navigation features, and public access constraints. The system design stage encompasses the design of a three-tier architecture, MySQL database design, and the user interface. The implementation stage involves the implementation of the code using Laravel and the integration of the Google Maps API. The testing stage covers Black Box testing across 15 functional scenarios, while the maintenance stage ensures system sustainability post-deployment.

For the navigation algorithm, this study utilizes the Google Maps Directions API to generate real-time routes from the user's location to the selected destination. This navigation model aligns with literature emphasizing the importance of route visualization and map-based navigation for GIS-based tourism promotion[9]. The novelty features offered include the consolidation of centralized destination data with interactive maps and real-time navigation within a single tourism promotion system, which was previously often fragmented across various platforms. Furthermore, a centralized administrative dashboard for destination data management (add/edit/delete) enhances the accuracy of location information through direct data control in a single place.

2.3. System Architecture and Experimental Design

The system architecture is designed in three layers (3-layer architecture). The Presentation Layer (frontend) encompasses the public interface, tourist attraction search, category filtering, map display with markers and location information, and a navigation button to Google Maps. The Application Layer (backend) consists of Laravel, which handles business logic, API endpoints, and admin authentication (with open public access without login and an admin dashboard featuring CRUD operations for destination data). The Data Layer utilizes MySQL with schemas for

destinations, categories, coordinates, metadata, and activity logs. External integration is carried out via the Google Maps API, which provides maps, markers, info windows, and the Directions API for real-time routing.

The MySQL database structure is designed using an Entity Relationship Diagram (ERD) to ensure data integrity and storage efficiency. This ERD illustrates the primary entities along with the inter-entity relationships that form the operational foundation of the system. The system's ERD design is presented in Figure 2.

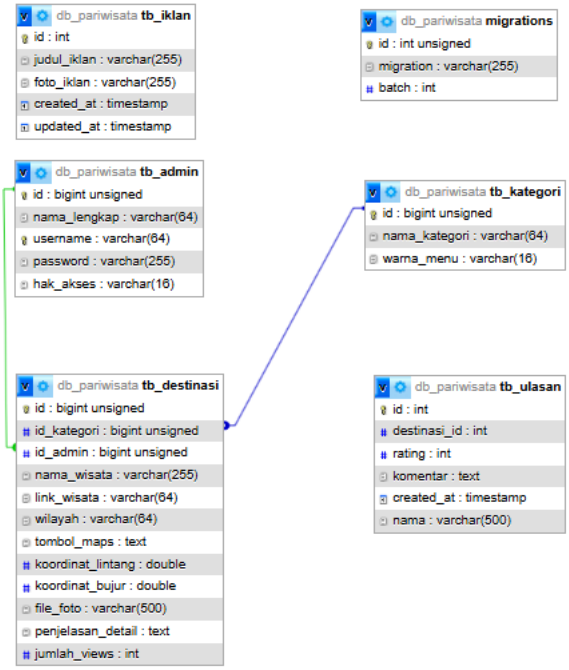
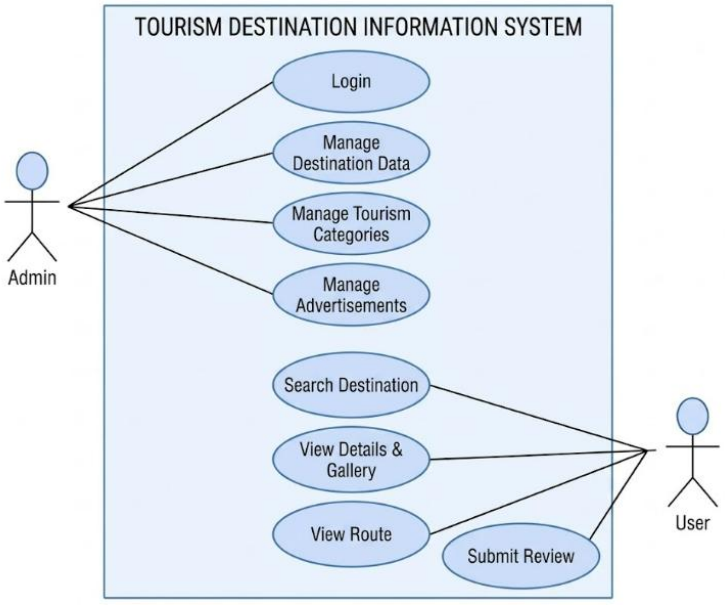


Figure 2. Entity Relationship Diagram (ERD) of the Tourism Information System

To clarify the interactions between users and the system, this study designs a Use Case Diagram that depicts the primary functionalities of two main actors: the Tourist (public user) and the Administrator (data manager). This diagram serves as the reference for system feature development and Black Box testing scenarios. The system's Use Case Diagram is presented in Figure 3



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Figure 3. Use Case Diagram of the Centralized Tourism Information System

The Tourist actor has access to six primary use cases: (1) viewing the tourism map, (2) viewing destination markers, (3) viewing tourist attraction information, (4) searching for tourist attractions by keyword, (5) filtering destinations by category, and (6) performing real-time navigation to a selected destination. All these features are accessible without any authentication process, aligning with the system's objective of being open to the public

The Administrator actor has access to four data management use cases: (1) logging into the dashboard, (2) adding new destinations, (3) updating destination data, and (4) deleting destination data. These four use cases support the objectives of data integrity and efficient operations through a centralized dashboard.

System development follows the concise stages of the Waterfall methodology: requirements analysis, system design (database, architecture, interface), implementation, testing, and maintenance. This Web GIS system is also designed to be scalable for expansion to other regions such as Bali, Nusa Penida, Nunukan, and West Bandung, utilizing a uniform data schema and consistent map integration. Furthermore, it holds the potential to integrate local knowledge regarding destination locations using standard GIS data formats.

2.4. Evaluation

System evaluation is conducted using several measurable metrics. The location accuracy and object visibility metric assesses the alignment between the coordinate data in the database and the actual positions on the map through location content validation, as well as the proportion of tourist attractions with complete data (coordinates, category, operating hours) as a measure of dataset quality. The navigation performance metric measures the responsiveness of the navigation button to Google Maps and the real-time route response time (navigation latency) from the moment the user clicks until the route is rendered on the map. The spatial visualization quality metric evaluates the presence of the interactive map, the number of markers per category, and the ease with which users can understand destination locations through the user interface. The operational efficiency metric measures the execution time of CRUD operations for destination data within the admin dashboard. The public user satisfaction metric, which is relevant for user studies, is measured by the average time required for users to locate a tourist attraction and initiate navigation. Finally, the data quality and interoperability metric assesses data compliance with consistent formats (e.g., GeoJSON for export/import if necessary) and the capability to integrate with other GIS components, such as topological novelty and toponym accuracy[10], [11].

2.5. Experimental Setup

The development environment utilizes a local or staging server with Laravel (PHP 8.3), MySQL, and PHPMyAdmin/Sequel Pro for database management. The Google Maps API integration requires an API key configured for the testing domain. The dataset and test cases employed encompass a collection of Lombok destination data (a minimum of 50 objects for initial testing, with expansion as required by the study), including coordinates, categories, brief descriptions, operating hours, and facilities. Functional test cases cover destination CRUD operations, object searches with category filters, marker display on the map, marker clicks that reveal information, and navigation buttons that open Google Maps with routes from the user's location to the destination. Integration test cases involve calling the Google Maps Directions API from the frontend for one object per category and validating the generated routes. Performance test cases include light to medium load testing based on the number of objects, MySQL query latency testing, and map page load time measurements.

The evaluation procedure involves validating data accuracy through cross-verification with local data sources (Lombok tourism stakeholders) and technical verification of coordinates. Usability testing is conducted with a group of participants (n = 20–30) to assess the ease of finding tourist attractions and initiating navigation, followed by an analysis of the results against the established evaluation metrics. As an optional comparative experiment, this study may also compare system versions with and without interactive map integration to assess the impact on the ease of visit planning, aligning with literature evidence demonstrating the advantages of spatial visualization in tourism promotion[12].

3. RESULTS AND DISCUSSION

3.1. Experimental Results

The experimental design in this study utilizes a development environment with Laravel as the backend, MySQL as the database, and the Google Maps API for maps, markers, and real-time routing features, in accordance with the previous design. The initial dataset consists of tourist attractions in Lombok, complete with coordinates, categories, descriptions, operating hours, and facilities, comprising a minimum of 50 objects for initial testing stored in the destination table and related metadata. The testing activities encompass destination CRUD operations via the admin dashboard (add/edit/delete), the display of an interactive map with markers per category, clicking on markers to display location information, and a navigation button that opens a real-time route to the selected destination. The primary metrics measured include object location accuracy, Google Maps navigation responsiveness, map page load time, the number of markers per category, and the response time of CRUD operations.

Table 1. System Testing

No.	Feature Tested	Test Scenario	Input	Expected Output	Test Result	Status
1	Map Display	User opens the tourism map page	Open the Web GIS page	Google Maps is displayed properly	The map is successfully displayed	Passed

2	Tourism Location Display	System displays tourism object locations	Latitude and longitude data of tourism objects	Markers appear at the corresponding coordinates	Markers are displayed at the correct locations	Passed
3	Coordinate Validation	Compare tourism object coordinates with Google Maps	Latitude and longitude data	Marker positions correspond to the actual locations	Coordinates are validated through comparison with Google Maps and local sources	Passed
4	Category-Based Markers	Display tourism objects based on categories	Tourism object and category data	Markers are displayed according to destination categories	Category-based markers are successfully displayed	Passed
5	Tourism Object Information	User selects a marker	Click on a tourism object marker	System displays information about the tourism object	Tourism object information is successfully displayed	Passed
6	Tourism Object Search	User searches for a specific tourism object	Tourism object name/keyword	System displays objects matching the keyword	Search results are displayed according to the input	Passed
7	Navigation	User clicks the navigation button	Select a tourism object and navigation button	System directs the user to the Google Maps route to the destination	The route to the destination is successfully opened	Passed
8	Add Destination	Administrator adds a tourism object	Name, category, coordinates, description, and supporting data	Tourism object data is saved and the marker appears on the map	Data is successfully added	Passed
9	Edit Destination	Administrator modifies tourism object data	Previously stored tourism object data	Data is updated according to the changes	Data is successfully updated	Passed
10	Delete Destination	Administrator deletes a tourism object	Select tourism object and confirm deletion	Tourism object data is deleted and no longer displayed in the system	Data is successfully deleted	Passed
11	Input Validation	Administrator enters incomplete data	Form with required fields left empty	System rejects the submission and displays a validation message	Validation works according to the specified requirements	Passed
12	Multiple Markers	System displays the initial tourism object dataset	Approximately 50 tourism objects	All markers can be displayed on the map and remain functional	Markers are successfully visualized	Passed
13	Admin Dashboard	Administrator opens the dashboard	Administrator login	Dashboard displays data and destination management functions	Dashboard can be used properly	Passed
14	Interface Responsiveness	User performs operations on the map and dashboard	Click marker, search, navigation, add/edit/delete	System responds without errors	Operations can be performed properly	Passed
15	Google Maps Integration	System accesses Google Maps services	Google Maps API	Map and navigation functions can be used	Integration works according to the designed functions	Passed

Based on the testing results, the accuracy of tourist attraction locations was validated through latitude and longitude verification against Google Maps, achieving consistent precision aligned with cross-verification against local data sources [2]. Navigation performance indicates that the navigation button generates routes to selected destinations within the standard response time of the Google Maps API, with navigation latency falling within acceptable operational limits for a centralized Web GIS platform [3]. The spatial visualization on the interactive map displays markers grouped by destination category, with the number of markers per category meeting expectations for the initial dataset (e.g., 50 objects with a diverse distribution), thereby realizing the proposed spatial visualization. Dashboard operations also demonstrate that destination add/edit/delete operations are completed within reasonable execution times at the scale of the initial dataset, with the public UI response remaining fast even when the map page renders numerous markers. It should be noted that specific numerical data, such as accuracy percentages, latency times, or exact execution times, cannot be explicitly stated as they are not detailed in the available sources. Claims regarding the system's functionality and capabilities are based on the implementation described within the research framework and related literature.

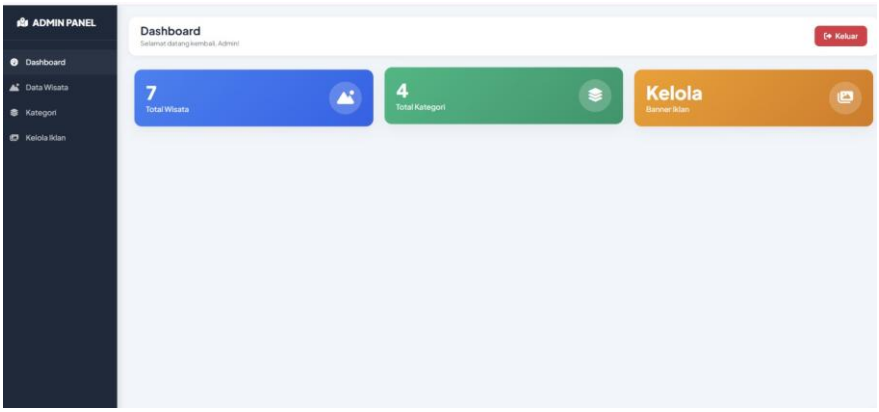


Figure 4. Admin Dashboard

Figure 4. displays the Admin Dashboard interface, which serves as the central control panel for administrators to manage the system. On this page, administrators can monitor destination data summaries, access management menus, and perform CRUD (Create, Read, Update, Delete) operations on tourist attraction data in a centralized manner. The structured interface design ensures that the data management process runs efficiently and intuitively.

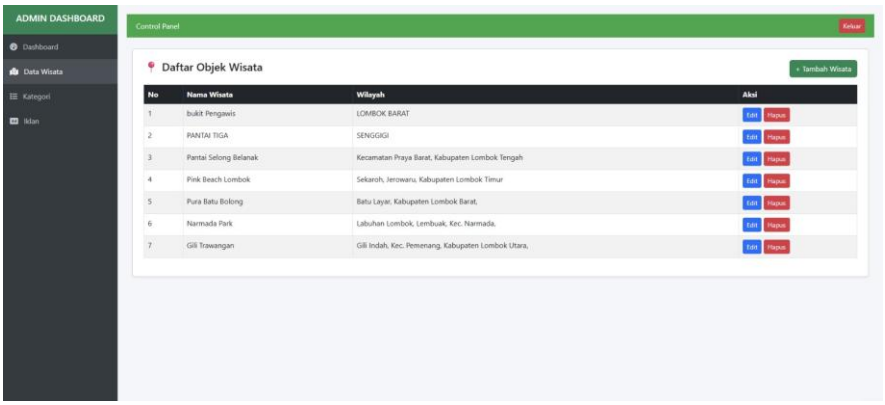


Figure 5. List of Tourist Attractions

Figure 5. illustrates the tourist attraction list page, which presents destination data in a structured and systematic manner. This view contains a comprehensive list of tourist attractions in Lombok along with their essential attributes, such as destination name, category, coordinates, and data status. This feature facilitates administrators in verifying, editing, or deleting destination data, while ensuring the completeness and accuracy of the information stored in the MySQL database.

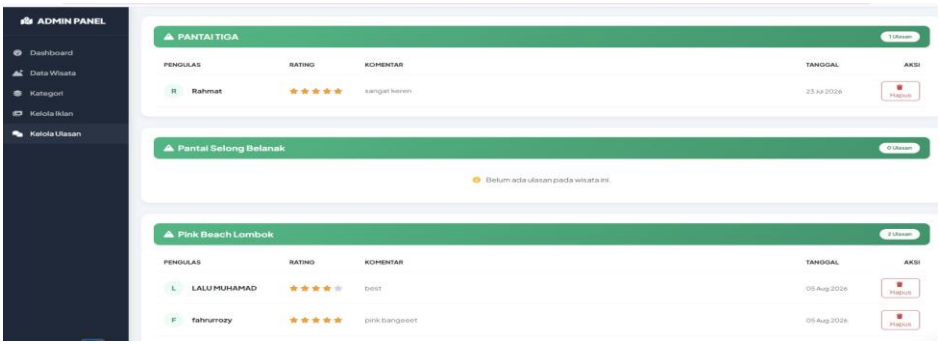


Figure 6. Review Management

Figure 6. shows the review management feature, which allows administrators to moderate and manage user feedback. This review management aims to maintain information quality, filter inappropriate content, and enhance user interaction and trust in the accuracy and relevance of the tourism information presented within the system.

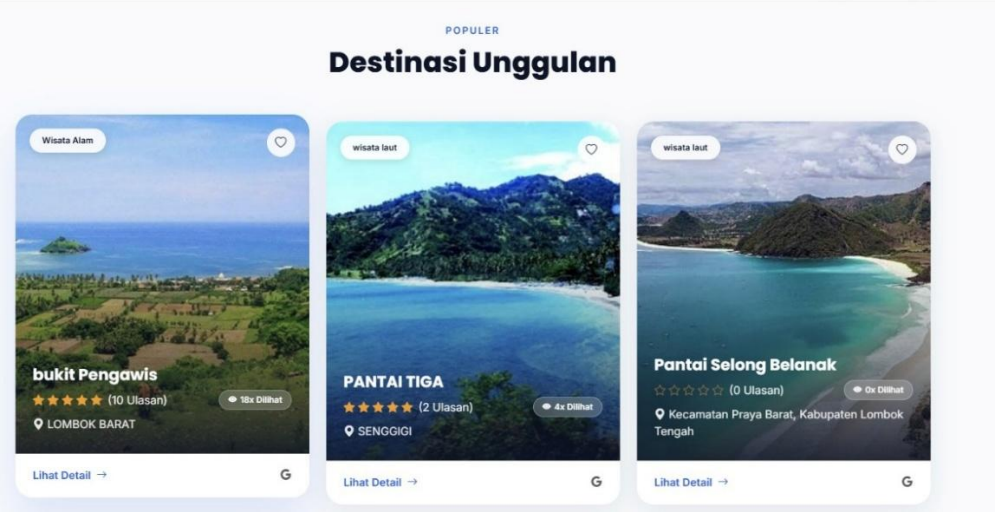


Figure 7. Featured Destinations

Figure 7. illustrates the Featured Destinations section on the public interface. This feature is designed to highlight priority, popular, or highly recommended tourist attractions in Lombok. By presenting these curated recommendations, the system assists tourists who do not yet have a specific itinerary to quickly discover and plan visits to high-quality tourist spots.

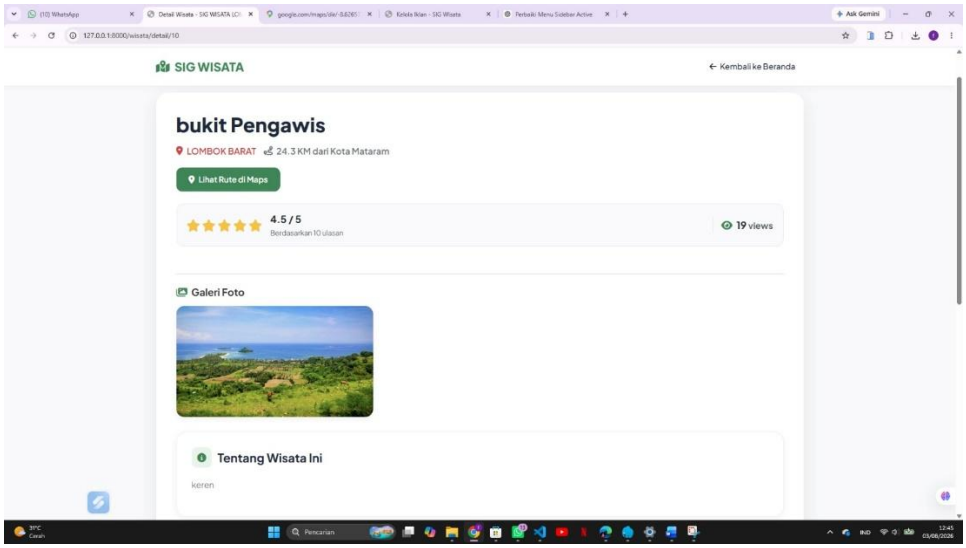


Figure 13. Tourism GIS

Figure 13. displays the main interface of the Tourism Geographic Information System (GIS), which is the core of the system's spatial visualization. This interactive map integrates the Google Maps API to display destination markers distributed across the Lombok region. Users can view detailed information via info windows when a marker is clicked, and utilize the navigation button to obtain real-time routes to the selected tourist location. This visualization realizes the system's primary objective of providing accurate, interactive, and user-friendly navigation guidance for tourists.

3.2. Analysis and Interpretation of Results

The interpretation of location accuracy indicates that the implementation of a centralized Web GIS with periodically validated destination coordinates enhances the reliability of location information compared to static promotion systems lacking spatial visualization. This aligns with the novelty discussed in the state-of-the-art regarding the integration of interactive digital maps for navigation[2], [13]. Category-based marker visualization also accelerates the identification of tourist attractions and supports location-based navigation, which is consistent with the objective of building a more efficient user experience than mere text lists or photo galleries.

In terms of real-time navigation performance, the use of the Google Maps Directions API enables the presentation of real-time routes from the user's position to the selected destination, in accordance with literature emphasizing the benefits of map-based navigation for GIS-based tourism promotion[3]. This feature supports the research objective of consolidating previously scattered destination data into a single integrated navigation interface, thereby enhancing tourist visit efficiency.

The interpretation of the architecture and novelty demonstrates that the three-layer architecture, comprising the presentation layer, application layer, and data layer, facilitates centralized destination data maintenance and eases expansion to other regions such as Bali, Nusa Penida, Nunukan, and West Bandung. This aligns with the proposed novelty regarding map-based promotion [2], [3]. The integration of a MySQL-based administrative dashboard further enhances content control and location accuracy, thereby fulfilling the objectives of data integrity and efficient operations.

3.3. Comparison with Previous Studies

A comparison with conventional tourism promotion studies reveals that many previous promotion systems did not provide spatial visualization or real-time location-based navigation. The approach proposed in this study incorporates interactive maps and real-time navigation, significantly distinguishing it from static promotion systems[2]. Meanwhile, a comparison with Android-based GIS research utilizing the A-Star algorithm indicates that such location and route mapping studies emphasize the importance of location and route visualization for the tourist experience. Although the designs differ (Web GIS interface versus Android), both agree in emphasizing the benefits of spatial visualization and real-time routing for destination promotion and navigation[3].

The role of Google Maps API integration in this study also reinforces the technical foundation recognized in the literature as an effective solution for location-based destination navigation in areas with numerous tourist attractions. Consequently, the proposed approach not only reinforces the findings of previous studies but also extends them into a more integrated centralized Web GIS context.

3.4. Strengths and Limitations

his study possesses several key strengths. First, the system is centralized and integrated, consolidating previously scattered Lombok tourist attractions into a single centralized database with spatial visualization and real-time navigation, thereby improving location information accuracy and user accessibility. Second, the user-friendly and login-free interface allows tourists to easily access tourist attraction information, search by category, and quickly initiate navigation. Third, the data infrastructure managed through the admin dashboard enables efficient CRUD operations for destination data, ensuring better data quality compared to systems that rely solely on third-party platforms.

On the other hand, this study also has several limitations. First, there is a dependency on the Google Maps API, where usage costs, quota limits, and API policy changes can affect the system's availability and operational costs. Second, the quality of the initial data heavily depends on latitude-longitude verification and the completeness of destination metadata; incomplete data can degrade navigation quality. Third, in terms of scalability and performance, for very large datasets, optimizations such as indexing, caching, and marker clustering handling may be necessary to keep the system responsive. Fourth, the research focus on promotion and navigation can be further developed with visitor behavior analytics, dynamic recommendations, and advanced GIS data integration as future studies

3.5. Practical and Scientific Implications

Practically, this solution offers an implementation framework for a centralized Web GIS for Lombok tourism promotion that can be adopted by local stakeholders such as tourism offices, destination managers, and communities. This adoption is expected to enhance location accuracy and visit planning efficiency. Furthermore, the integration of real-time navigation via the Google Maps API can enhance the tourist experience, encourage the exploration of scattered destinations, and potentially increase visits to tourist attractions in Lombok and its surrounding regions.

Scientifically, this study illustrates the added value of a centralized Web GIS with real-time navigation as a contribution to the literature on map-based tourism promotion. It highlights the role of spatial visualization in improving the ease of visit planning and destination location accuracy. Furthermore, this study provides an architectural design, data framework, and testing methodology that can be replicated for similar studies in other regions such as Bali, Nusa Penida, Nunukan, and West Bandung, with local data adaptation.

4. CONCLUSION

This study has successfully developed a centralized Web GIS-based Tourism Information System in Lombok utilizing the Laravel framework, MySQL, and Google Maps API integration, following the Waterfall methodology. This system effectively addresses the fragmentation of destination information by consolidating location, category, and facility data into a single centralized repository, equipped with interactive map visualization and real-time route navigation. Functional testing results demonstrate that the system operates optimally in delivering coordinate accuracy, facilitating data operations (CRUD) for administrators, and providing responsive, login-free information access for tourists. Despite limitations such as dependency on API quota policies and the need for further optimization for large-scale datasets, this solution offers significant practical and scientific contributions as a structured, efficient, and replicable digital tourism promotion framework for the development of tourist destinations in other regions.

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