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Web GIS for Historical Tourism Sites in Sumenep Regency Using Location-Based Services

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***Abstract*— This study presents the development of a Web-based Geographic Information System (Web GIS) aimed at mapping historical tourism sites in Sumenep Regency. The system integrates Location-Based Services (LBS) to enhance the delivery of spatial information and support tourism promotion. A prototype-based methodology was used in designing and building the application, which includes planning, requirements analysis, system design, data collection, and testing. The system architecture was modeled using UML diagrams, including use case, activity, and entity-relationship diagrams to ensure functionality and data integrity. Spatial and attribute data were collected through literature reviews and transformed into an interactive web platform that allows users to search for and visualize historical tourism locations. The system supports administrative features for data input and updates, alongside public-facing features such as maps and visitor statistics. Testing was conducted using black-box methods, which successfully verified that all core functionalities—including user login, data manipulation (add, edit, delete), and map visualization—performed as expected without critical issues. The final output is a fully functional Web GIS platform that enhances public access to tourism information and assists local authorities in managing tourism data effectively. This research contributes to the advancement of digital tourism infrastructure and promotes cultural heritage visibility in the region.**

Keywords*— *GIS, Web-based System, Location-Based Services

I. INTRODUCTION

Sumenep Regency, situated in Madura, is characterized by a wealth of cultural heritage and historical tourist sites, including palaces, traditional architectures, legends, and coastal attractions [1]. The local government has actively promoted tourism development as part of its strategy to support economic and social progress by enhancing facilities and improving the quality of services for visitors [2]. To support the promotion of historical and cultural destinations, the use of web-based Geographic Information Systems (GIS) has become increasingly relevant. GIS is a digital platform for storing, analyzing, and visualizing spatial data through interactive maps, and has proven to be effective in mapping tourism objects and facilitating access to spatial information for both the public and local authorities [3], [4].

Recent studies have highlighted the growing importance of digital tools in tourism. Research on island tourism governance in Sumenep emphasizes the need for sustainable development planning, where technology can play a key role [1]. Other studies have focused on identifying popular tourist locations on Madura Island using computational methods, demonstrating a demand for data-driven approaches to tourism management [2]. The development of Web GIS for digital tourism mapping is a significant trend, offering capabilities for forecasting and strategic planning [3]. The role of geovisualization within these systems is critical, as it improves the user's ability to analyze spatial data and enhances public access to complex information [5].

Location-Based Services (LBS) enhance GIS by integrating user location data, allowing tourism sites to be mapped and categorized based on the user's current position. This integration has shown significant results in previous studies. For instance, the implementation of WebGIS with LBS and Google Maps API in West Jakarta helped map tourism objects effectively [6], while a similar system in Langkat Regency supported real-time discovery of nearby points of interest [7]. Furthermore, Web and mobile GIS applications have been developed to locate specific facilities like places of worship to support halal tourism, showcasing the versatility of this technology [8].

Although similar research has been successfully implemented in other regions, there is a clear research gap: the absence of a centralized platform specifically designed to map and promote historical sites in Sumenep Regency. Existing systems are often general in nature and do not highlight the specific cultural heritage of Sumenep. Therefore, this study aims to fill this gap by developing a customized Web GIS prototype for historical sites in Sumenep, addressing the need for an interactive and accessible information platform for tourists and administrators.

In the context of Sumenep, developing a GIS-based tourism information system using the LBS method is expected to contribute to improving digital tourism infrastructure. It can support the local government in promoting historical tourism and increasing public access to location-based services, ultimately boosting local economic development and enhancing the visibility of cultural heritage [4]. This study builds on these past efforts by creating a tailored Web GIS prototype specifically for the historical sites in Sumenep, addressing the need for a centralized, interactive, and accessible information platform for tourists and administrators.

II. RESEARCH METHODS

This study applies a prototype-based system development methodology to build a Geographic Information System (GIS) focused on mapping historical tourism sites in Sumenep Regency using the Location-Based Service (LBS) method.

A. Research Flow

To ensure structured and systematic system development, this research follows a clear methodological flow illustrated in Figure 1. The research comprises five main stages: Planning, System Requirements Analysis, System Design, Data Collection, and System Testing.

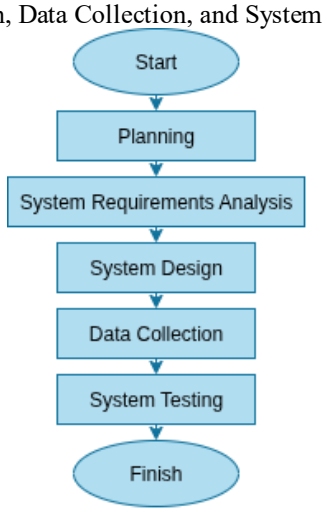

Fig. 1 Research Flow

The overall process of this research is presented in Figure 1 (Research Flow), which outlines the design and development phases of the GIS for historical tourism mapping. The research comprises five main stages:

1) Planning

In the planning stage, a prototype development model is employed. This approach allows for system modeling based on user needs even if detailed requirements such as input, processes, and output are not initially available [3]. This study aims to develop a GIS application tailored to tourism mapping using LBS features. The initial process involves identifying system requirements by conducting literature studies and collecting relevant references, including journals, books, statistical data, and information from tourism departments [1], [2].

The prototype development follows three steps: (1) Listen to the customer (requirements gathering), (2) Build or revise mock-up (design process), and (3) Customer test-drives mock-up (evaluation). These stages culminate in the construction of a GIS-based web application that displays historical tourism data with location accuracy and visual representation.

2) System Requirements Analysis

This stage involves analyzing both functional and non-functional requirements needed to design the GIS. Requirements were gathered primarily through literature review methods. The system must support mapping of historical tourism sites in Sumenep and allow features such as viewing, editing, and searching data [3], [7].

3) System Design

In the design phase, a software framework is developed using Unified Modeling Language (UML) to describe the system architecture and flow. Two types of data are considered: spatial data (such as roads and locations) and attribute data (such as site names, ticket prices, and descriptions). The process includes map object selection, map editing, data processing, and route-based search functions by name or category. Output requirements include displaying tourism site locations, their coordinates, and supporting information [4], [5].

The system's business process considers two primary actors: administrators and tourists. Administrators are responsible for data input, editing, and system maintenance, while tourists can access the platform to view tourism maps and information.

4) Data Collection

Data collection was conducted via literature study to gather insights and requirements for GIS-based tourism systems. The collected data defines the content needed for the platform, such as historical tourism site details, spatial coordinates, map visualization, and descriptive site data. These inputs support the database creation and web interface functionality [1], [7].

5) System Testing

The system is evaluated using Black Box Testing to ensure that each function performs as expected. Test scenarios include login, data viewing, data manipulation (add, edit, delete), map and graph visualization, and system logout. Functional results are documented to verify the system's operational readiness [3], [5].

B. Use Case Diagram

To model the system's functionality and user interactions, a Use Case Diagram is employed. It provides a high-level view of the system's behavior by identifying actors and the actions they can perform. The diagram in Figure 2 illustrates the interaction between 'Admin' and 'User' actors, where both must log in to access system features, ensuring data integrity and security.

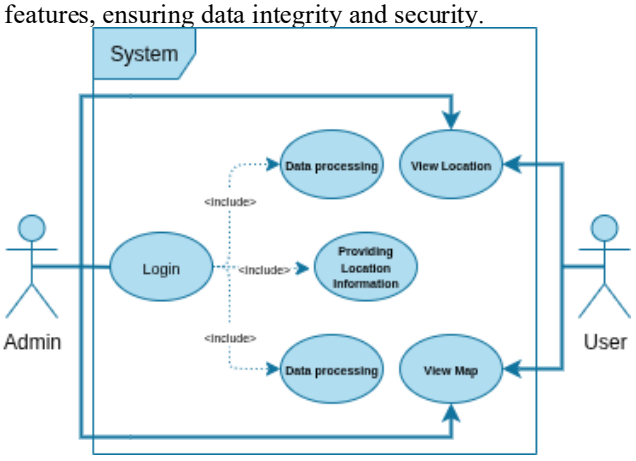

Fig. 2 Use Case Diagram

The Use Case Diagram presented in Figure 2 illustrates the interaction between the system and two types of actors: Admin and User. Both actors are required to log in before they can access the core features of the system. The login process serves as the entry point, ensuring secure access to system functionalities. Once authentication is successful, the system automatically performs several included processes, such as providing location information and executing data processing operations.

After these internal processes are completed, users are able to view location details and map data. This diagram reflects how the system enforces authentication and

internally prepares necessary information before granting access to spatial data. This access control approach ensures that data integrity and security are maintained in accordance with standard GIS development practices [10].

C. Activity Diagram

To model the system's functionality and user interactions, a Use Case Diagram is employed. This type of diagram provides a high-level view of the system's behavior by identifying the key actors (users or external systems) and the use cases (goals or actions) they can perform. It effectively illustrates the relationships between actors and use cases, offering a clear and intuitive way to understand the system's requirements from a user's perspective.

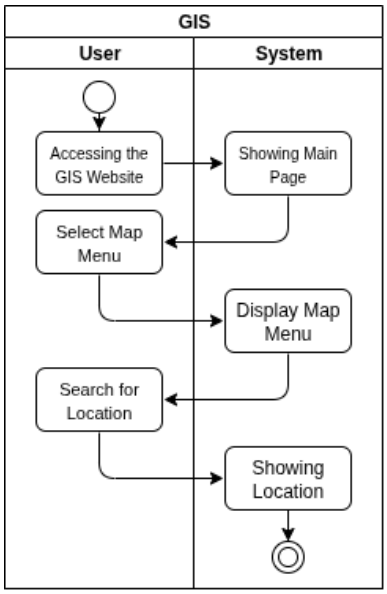

Fig. 3 Admin Activity Diagram

The Activity Diagram shown in Figure 3 outlines the sequence of actions taken by users when interacting with the web-based Geographic Information System. The process begins with users accessing the GIS platform, followed by the system displaying the main homepage. Users then navigate to the map menu, initiating a search for spatial information. Upon selecting the search function, the system processes the input and presents relevant location data.

Figure 3 outlines the sequence of actions taken by users, from accessing the GIS platform to searching for and viewing location data. This flow demonstrates a structured interaction pattern, which is vital for modeling user-system behaviors effectively. Activity diagrams such as this are vital in system design, as they visually represent dynamic behaviors and user-system interactions, allowing developers to model conditional flows and parallel processes effectively [11].

D. Entity Relationship Diagram (ERD)

The logical structure of the database is conceptualized using an ERD, as shown in Figure 4. This diagram details the main entities (tables), their attributes, and the relationships connecting them, ensuring data is stored logically and efficiently without redundancy.

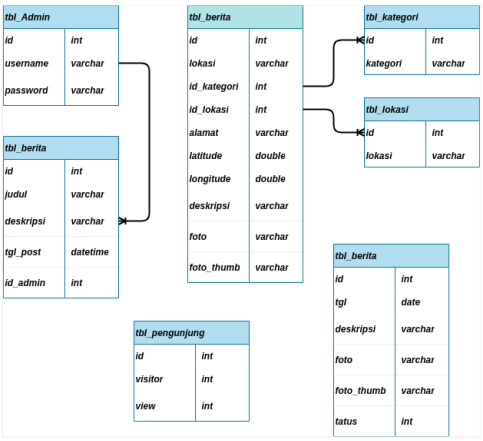

Fig. 4 Entity Relationship Diagram

The ER diagram presented in Figure 4 illustrates the relationships between data entities in the GIS. This relational schema ensures that the system's database design adheres to normalization principles, which reduce redundancy and enhance consistency. The ER diagram is essential in visualizing how tables interconnect, thereby supporting efficient data modeling and retrieval processes within the application [12].

E. *System Testing*

To validate the functional performance of the developed GIS application, black-box testing was applied utilizing actual tourism-related datasets from the Department of Culture and Tourism of Sumenep Regency. This method examines the system's external behavior while disregarding the internal code structure, ensuring that user-facing features respond correctly to various inputs [15].

The testing process included all essential functionalities such as login authentication, data display, record editing, data entry, deletion, map rendering, graphical visualization, and session termination. Each of these modules was evaluated individually to verify conformance to functional requirements [14].

All scenarios executed during the test yielded positive outcomes, with no critical issues detected. This confirms that the system operates reliably and is prepared for deployment to its intended users. These findings support the principles of black-box testing, which prioritize system correctness and operational stability as fundamental aspects of quality assurance [9].

III. RESULT AND DISCUSSION

A. Testing Environment

The GIS application developed for mapping historical tourism sites in Sumenep Regency was evaluated on a personal laptop equipped with an Intel® Core™ i5-8265U processor (8 logical cores operating at 1.8 GHz), 8 GB of RAM, an NVIDIA GeForce MX110 graphics card with DirectX 12 support, and a 1 TB solid-state drive (SSD).

In terms of software, the development and validation were performed on Windows 10 Pro 64-bit. Visual Studio Code served as the main programming environment, while XAMPP functioned as the local database and server platform. UML modeling was carried out using StarUML, and Google Chrome was used to access and assess the web-based interface during testing.

This well-documented environmen-including both hardware and software settings-enables reproducible testing conditions and ensures consistent results across test runs. Proper documentation of configuration details is essential to validate outcomes, enhance transparency, and support future replication by other researchers or stakeholders, especially in system testing scenarios

B. *System Implementation*

This section provides an overview of the system's interface and functionality, including the main dashboard, data input interface, and tourism mapping features.

1) System Dashboard

Fig. 5 Main Dashboard

Figure 5 displays the main dashboard of the system, which serves as a centralized visual summary of key tourism data in Sumenep. The interface presents four distinct panels that highlight essential statistical information, including the total number of registered tourism destinations and annual visitor counts across multiple years. This dashboard functions as a crucial information hub, offering administrators a clear overview of tourism trends and facilitating effective monitoring and management of tourism activities in the region.

2) Tourism Data Input Page

This interface enables administrators to add and manage tourism destination data. It includes input fields for relevant information such as the name, location, and description of each historical site. The goal is to maintain a comprehensive and up-to-date tourism database that can be displayed on the geographic map.

3) Mapping Results

One of the key components of the system is its mapping feature, which visualizes the distribution of historical tourism sites across the districts of Sumenep Regency. This is shown in the following figure:

Fig. 6 Tourism Mapping

The interactive map, shown in Figure 6, provides users with a spatial overview of tourist site locations and serves as a valuable tool for identifying tourism clusters and planning development strategies. Visual geographic mapping plays a significant role in enhancing decision-making processes, especially in regional planning and heritage conservation. By clicking on a marker, users can retrieve detailed information about a specific location, including visitor data. According to [5], integrating map-based interfaces in GIS systems improves the user's ability to analyze spatial data and facilitates broader public access to information.

4) Visitor Statistics Page

This section presents an overview of visitor data related to historical tourism destinations in the region. The page includes summary statistics and visual aids to help administrators monitor tourist interest and identify trends over time. While not depicted in this section, it plays a crucial role in system analytics and reporting.

C. *Research Results and Outputs Obtained*

The primary result of this research is the development of a Web-based Geographic Information System (Web GIS). Additionally, the outcome of this study includes a draft article intended for publication in a scientific proceeding.

IV. Conclusion

Based on the results of the study, the implementation of a web-based Geographic Information System (Web GIS) significantly facilitates the mapping and presentation of tourism information in Sumenep Regency. By utilizing GIS technology, spatial data related to tourist attractions can be accessed interactively and conveniently, enabling users to efficiently locate tourism destinations.

Furthermore, the geographic information system simplifies the work of tourism managers in updating and managing tourist data, as well as in monitoring the development of the tourism sector in Sumenep. Overall, the development of this system serves as an effective tool for enhancing the local tourism industry by providing accurate and easily accessible information to both tourists and tourism administrators.

As a follow-up, several future developments can be made to improve the functionality of this system. Further research could focus on developing mobile applications to improve accessibility for tourists. In addition, integrating real-time visitor reviews and ratings could provide valuable qualitative data. Finally, visitor data collected from this system could be used for predictive analysis to forecast future visitation trends, enabling more proactive planning.

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