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Web-Based Geographic Information System for Mapping and Spatial Visualization of Cultural and Historical Tourism Objects in Makassar City

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ABSTRACT

Purpose of the study: This research aims to develop a web-based Geographic Information System (GIS) for mapping and visualizing the spatial distribution of cultural and historical tourism objects in Makassar City, integrating location coordinates, access routes, and descriptive information into an interactive digital platform accessible to the public and stakeholders.

Methodology: This study employed a descriptive qualitative method with a system development approach. The research stages included planning, data collection through interviews and observations at the Makassar City Culture and Tourism Office, and system development using ArcView 3.3 for map digitization, ALOV Map v.096 as the WebGIS framework, PHP programming language, and MySQL database. Black-box testing was conducted to evaluate system functionality and interface performance.

Main Findings: The research successfully produced a web-based GIS application displaying 20 cultural and historical tourism sites across Makassar City, complete with coordinate points and descriptive information. The system integrates supporting spatial data including 14 sub-district boundaries, 143 urban village boundaries, 20 main roads, and river networks, all accessible through an interactive map interface with navigation features (zoom in, zoom out, pan, recenter) and query capabilities. Black-box testing confirmed all system functions operated as expected.

Novelty/Originality of this study: This study presents the first integrated WebGIS specifically designed for Makassar's cultural heritage that combines multi-layer spatial data with dynamic content management capabilities. The innovation lies in utilizing ALOV Map's client-side processing architecture to reduce server load during high-access periods, integrated with real-time content management features for tourism news and events, transforming the previously restricted internal system into an open-access platform that advances regional cultural promotion and supports data-driven tourism management.

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1. INTRODUCTION

Makassar City, as the capital of South Sulawesi Province and a growth center in eastern Indonesia, has valuable cultural and historical heritage assets, including Fort Rotterdam, the Mandala Monument, and the Tomb

of Prince Diponegoro [1]. These objects not only reflect regional identity but also have significant potential as tourist attractions that can boost the local economy. In today's information age, the public and stakeholders' need for fast, accurate, and comprehensive access to information is becoming increasingly important, requiring not only textual descriptions but also spatial information that visually depicts the geographic location, coordinates, and access routes to these attractions [2], [3]. Geographic Information Systems (GIS) emerged as a solution to this need, defined as computer-based systems used to store, manage, analyze, and display geographically referenced data, enabling the integrated visualization, exploration, and analysis of spatial and non-spatial data [4]. In my opinion, the development of a web-based Geographic Information System is a strategic step to optimize the historical tourism potential of Kota Makassar by providing accurate, interactive, and easily accessible spatial information for both the public and tourists.

However, preliminary research conducted at the Makassar City Culture and Tourism Office identified significant issues related to information accessibility and presentation. Although the information system was computerized, the existing interface was not user-friendly and was only accessible to certain internal parties [5]. The general public seeking information on the location of cultural and historical tourist sites must undergo special permitting procedures from data managers, limiting public access to this important information [6]. Furthermore, existing data on the distribution of tourism potential has not been integrated with informative digital maps [7]. Consequently, users experience difficulties in obtaining a visual representation of the distribution, coordinates, and access routes to tourist attractions, thus suboptimal promotion and management of regional tourism assets [8], [9]. Therefore, it is necessary to develop a more open, integrated, and user-friendly digital map-based information system so that the accessibility of tourism information can be increased and support the optimization of promotion and management of regional tourism assets effectively.

Although several studies have examined the use of Geographic Information Systems (GIS) in tourism [10], most of them primarily focus on potential inventory and spatial analysis of tourist attractions without emphasizing open access to information and public-oriented system integration. For instance, research by Rahayuningsih and Muntasib [11] developed a GIS-based inventory of island tourism potential in Makassar City using a spatial analysis approach; however, the study mainly concentrated on identifying and classifying tourism development status rather than designing a system that is publicly accessible. Similarly, many tourism GIS developments still present static location mapping and descriptive information without fully integrating spatial and non-spatial data into a single interactive and user-friendly platform [12], [13]. Moreover, the current condition at the Makassar City Culture and Tourism Office indicates that the existing information system remains limited to internal access and lacks informative digital maps that comprehensively display coordinates, distribution patterns, and access routes. Based on interviews and observations, the information system at the Makassar City Culture and Tourism Office is still limited to internal use. Therefore, this study proposes an open and interactive integrated GIS to support public access and tourism management. These conditions reveal a gap between GIS development as a spatial analysis tool and the increasing need for an open and interactive geographic information system that effectively supports tourism promotion and management [14], [15]. In response to these identified gaps, this research proposes a more integrated and publicly accessible GIS framework.

The novelty of this research lies in the development of a Geographic Information System (GIS) that functions not only as an inventory and spatial analysis tool but also as an open and interactive public information platform [16]. This study integrates spatial data such as locations, coordinates, and access routes with non-spatial historical and descriptive information within a structured and user-oriented system. Unlike previous studies that primarily emphasized mapping and classification, this research prioritizes user accessibility, transparency, and system usability for the wider public. The system is specifically designed to overcome the limitation of internal access within the Makassar City Culture and Tourism Office, thereby providing a more applicable and contextual solution for tourism promotion and management [17].

This research is considered urgent because limited accessibility and the lack of integration between spatial and non-spatial data have hindered effective dissemination of cultural and historical tourism information. The absence of comprehensive interactive digital maps reduces the accuracy of visual representation and limits data-based planning and decision-making processes [18]. Moreover, restricted internal systems weaken transparency and decrease the effectiveness of destination promotion. Therefore, the development of an open, integrated, and user-friendly Geographic Information System is essential to support optimal utilization of cultural and historical tourism assets as drivers of local economic growth [19]. This study aims to design and develop a digital-based GIS capable of presenting integrated, accurate, and publicly accessible tourism information in Makassar City, thereby enhancing promotion, management efficiency, and regional tourism development [20].

2. RESEARCH METHOD

2.1. Type of Research

This research employed a qualitative descriptive approach aimed at analyzing and describing the existing tourism information management system at the Makassar City Culture and Tourism Office [21]. The qualitative

descriptive method was chosen because it allows an in-depth understanding of real conditions, user needs, and system limitations without statistical manipulation. Through this approach, the researcher systematically identified problems related to accessibility, data integration, and system usability [22]. The findings from this analysis became the foundation for designing a more integrated and publicly accessible Geographic Information System (GIS). Thus, the research not only describes existing conditions but also formulates practical solutions based on identified needs.

2.2. Data Sources and Data Collection Techniques

This study utilized both primary and secondary data sources to ensure comprehensive information collection. Primary data were obtained through interviews with tourism data managers and system operators at the Makassar City Culture and Tourism Office [23]. Direct observations were also conducted at tourism locations to verify spatial information such as geographic coordinates, distribution patterns, and access routes. Secondary data were collected from official tourism documents, previous research, academic journals, books, and relevant regulations related to GIS and tourism management. These data collection techniques enabled the researcher to obtain accurate spatial and non-spatial information for system development.

2.3. Research Instruments

The research instruments consisted of hardware and software used in the development and testing of the system. The hardware included a computer device with adequate specifications to process spatial data and support web-based system development [24]. The software tools included GIS processing software for spatial data digitization and mapping, database management systems for organizing non-spatial data, and web development tools for system implementation. Web browsers were used to test system accessibility and interface functionality. These instruments supported the integration of spatial and non-spatial data into a unified WebGIS platform.

2.4. System Design and Development

The system design and development process was carried out based on the results of qualitative analysis. The first stage involved identifying functional and non-functional system requirements derived from interviews and observations. The next stage included designing the database structure, organizing spatial data layers, and developing the user interface to ensure user-friendliness and accessibility [25]. Spatial data such as tourism locations, district boundaries, and road networks were structured into interactive digital map layers, while non-spatial data such as historical descriptions and tourism categories were stored in a relational database [26]. All components were integrated into a web-based Geographic Information System designed to provide open and interactive access to tourism information.

2.5. Data Analysis and System Testing

Data analysis was conducted descriptively and qualitatively by interpreting findings from interviews, observations, and documentation. Spatial data were processed and digitized using GIS tools to generate thematic map layers, while non-spatial data were structured and integrated into the system database. The developed system was then subjected to functional testing to ensure that all features operated according to defined requirements. Testing focused on map visualization, coordinate accuracy, access route display, and data retrieval functionality [27]. The results of the testing process were used to refine and optimize the system to ensure effective performance and public accessibility.

3. RESULTS AND DISCUSSION

This research successfully produced a web-based Geographic Information System that displays cultural and historical tourism data in Makassar City along with supporting information such as location coordinates, main roads, sub-districts, villages, and rivers, integrated into a digital map [28]. The system was developed using ArcView software for mapping, Alov Map as a WebGIS framework, and PHP as the primary programming language with a MySQL database [29]. Through this system, users can access geographic information interactively through features such as layer legends, map navigation (zoom-in, zoom-out, pan, recenter), and query information that enables spatial and non-spatial data searches [30]. System testing using the black-box method demonstrated that all interface functions functioned as expected, from data input and admin management of news and event content to the output of map information and supporting tourism data displayed to website visitors.

The system implementation results demonstrate that this WebGIS application is capable of meeting the public's spatial information needs regarding cultural and historical tourism locations in Makassar City without time and place constraints [31]. This system displays 20 digitized cultural and historical tourist attractions with complete coordinates, including various objects such as Somba Opu Fort, Fort Rotterdam, Al-Markas Al-Islami Mosque, Agung Bahari Temple, and Makassar City Museum. Other supporting data includes 14 sub-districts, more than 100 urban villages with area information, and 20 important roads in Makassar City. Each system is equipped with

information on its condition, direction, and administrative location. The system also features an admin page that allows managers to dynamically add, edit, and delete content such as news, events, profiles, and tourist attractions.

Further discussion revealed that the developed system successfully overcomes the limitations of the old system at the Makassar City Culture and Tourism Office, which was only accessible to internal parties and was not user-friendly [32]. With its web-based architecture, the system is accessible to the general public through an internet browser, making it easy to obtain information on the location and coordinates of cultural and historical tourist sites. The system's advantage lies in the use of ALOV Map, an open-source framework that places data processing on the client side, thereby reducing server load when user access increases. However, this study still faces limitations in terms of coordinate point accuracy, which needs to be improved for further research, and limited spatial analysis features that can be further developed.

The findings of this study align with various previous studies on WebGIS development for cultural and historical tourism mapping, such as the VIDA-HTL study by Hidalgo-Sanchez et al. (2024) in the lower Guadalquivir region of Spain, which integrated architectural and archaeological data into a digital platform. This study also supports the results of a study by Nur et al. (2024) in Sumenep Regency, which showed that Location-Based Services-based WebGIS facilitates interactive mapping, data updates, and tourism monitoring through dynamic dashboards [33]. In line with the study by Bandarnata et al. (2024) in Lahat Regency, the use of ArcView and PHP proved effective in building a user-friendly and well-functioning web-based tourism mapping system based on blackbox testing. Furthermore, the results of this study corroborate the findings of Nucifera et al. (2023) in the cultural heritage area of Kotabaru, Yogyakarta, that WebGIS plays an important role in spatial analysis and tourism promotion. Overall, this study confirms that digitalization through WebGIS can improve information access, data management efficiency, and support local economic development based on cultural and historical tourism.

Based on a gap analysis of four previous studies, this research offers novelty through the first WebGIS that specifically integrates cultural and historical tourism data in Makassar City within one comprehensive platform. The system covers 20 tourist sites, 14 sub-districts, more than 100 villages, major roads, and rivers in a multi-layered map. Its main technical innovation lies in the use of ALOV Map as an open-source framework with client-side processing, which reduces server load compared to previous studies that relied on server-side processing [34]. This research also integrates the geographic information system with a dynamic content management system that enables real-time updates of news, events, and tourism profiles. Additionally, the query info feature supports simultaneous spatial and non-spatial searches, making the platform more interactive and accessible to the public compared to earlier studies [35].

This research has practical implications for the Makassar City Culture and Tourism Office, by providing an integrated platform that facilitates the management of tourist destination data and real-time information updates through a dynamic admin page [36]. For the public and tourists, this system opens access to broader and more accurate information regarding cultural and historical tourist locations and their supporting infrastructure, thus supporting more efficient travel planning. From a regional development perspective, this system has the potential to encourage equitable distribution of tourist visits to various sub-districts and villages in Makassar City while increasing public awareness of the cultural heritage values scattered throughout the region [37]. Theoretically, this research contributes to the development of science by proving the effectiveness of client-side processing architecture using ALOV Map in the context of tourism WebGIS in developing countries and enriching the literature on the integration of geographic information systems with dynamic content management to support sustainable tourism.

This study has several limitations that need to be acknowledged and can be considered for future development [38]. First, the accuracy of the displayed tourist attraction coordinates still needs to be improved because coordinate data collection was carried out using a handheld GPS device with limited precision, in contrast to the study by Hidalgo-Sanchez et al. (2024) which used more sophisticated geospatial technology with high accuracy standards [39], [40]. Second, the spatial analysis features in this system are still limited to basic functions such as info queries and map navigation, not including more complex analyses such as network analysis for determining optimal routes or multi-criteria analysis for evaluating tourism potential, as developed in the VIDA-HTL study [41]. Third, the study area is limited to Makassar City with 20 tourist spots, thus not representing the broader cultural and historical tourism potential in South Sulawesi Province as a whole [42]. Fourth, this system does not yet integrate participatory features such as a collaborative hub that allows users to provide feedback or contribute to data enrichment, as implemented in the study by Hidalgo-Sanchez et al. (2024) to increase interactivity and community involvement.

3.1. Current System

Based on a system analysis conducted at the Makassar City Culture and Tourism Office, it was identified that the existing information system still had several limitations in terms of accessibility and usability. Individuals seeking information about cultural and historical tourism locations were required to request permission from the data administrator before accessing the data. Although the system had been computerized, it was primarily

designed for internal use and lacked a user-friendly interface for the general public [43]. The available information was mostly presented in textual form and was not integrated into an interactive digital map. Consequently, this condition created barriers to wider tourism promotion and limited public access to accurate spatial information.

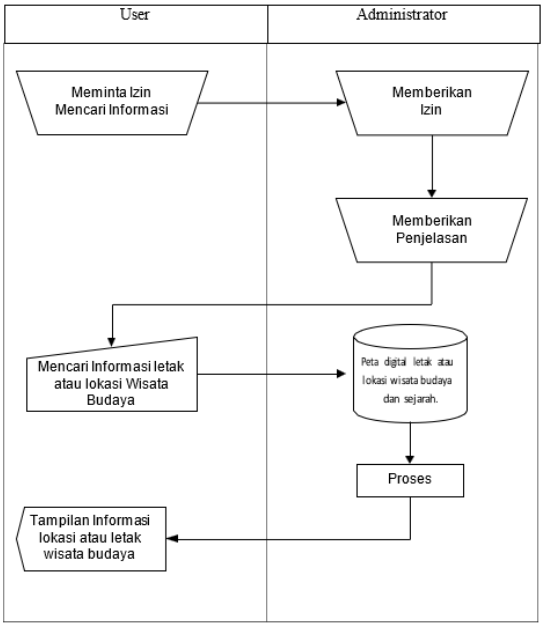

Figure 1. Current System Flow Chart

3.2. Proposed System

The proposed system is a web-based Geographic Information System (GIS) application that can be accessed online by the public. The system is designed to display the distribution of cultural and historical tourism potential in Makassar City through an interactive digital map [44]. Users are provided with navigation features such as zoom in, zoom out, pan, recenter, and query information to explore spatial and non-spatial data simultaneously [45]. Unlike the previous system, the proposed platform enables open access through a web browser without requiring special permissions. This design aims to improve information transparency, accessibility, and effectiveness in tourism promotion.

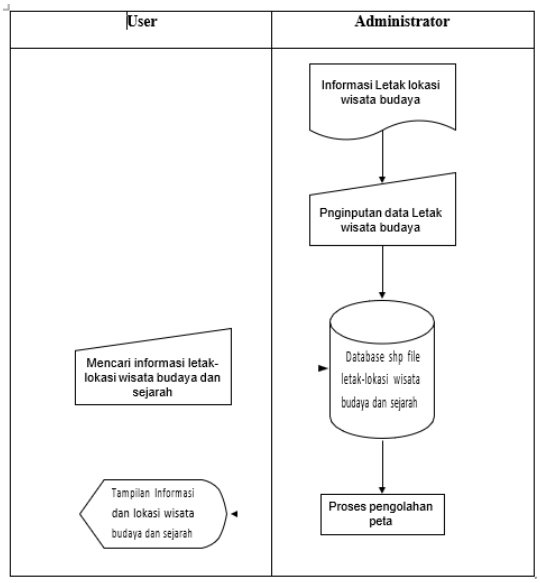

Figure 2. Proposed System Flowchart

3.3. System Implementation

3.3.1. Map Page

The map page serves as the main interface of the WebGIS application and displays a digital map of Makassar City. Users can select and activate specific spatial layers through the legend panel by checking the

desired options. The available layers include sub-district boundaries, village boundaries, main roads, rivers, and cultural and historical tourism locations [46]. The system provides navigation tools such as zoom in, zoom out, pan, recenter, full extent, and query features to facilitate interactive exploration of spatial data. Through the query function, users can retrieve detailed information about selected tourism objects, including names, coordinates, and descriptive information.

Figure 3. Map Page Display

3.3.2. Tourism Object Data

Based on the collected data, the system includes 20 cultural and historical tourism objects distributed across Makassar City. These objects consist of forts, museums, monuments, historical tombs, places of worship, and other heritage buildings [47]. Each tourism object has been digitized and georeferenced to ensure accurate coordinate representation on the digital map. In addition to spatial location, each object is complemented with descriptive information to support tourism promotion and educational purposes. This integration of spatial and descriptive data enhances the completeness of tourism information presented to users [48].

3.3.3. Supporting Spatial Data

The system also incorporates supporting spatial data layers to provide comprehensive geographic context. These layers consist of 14 sub-districts, 143 villages, 20 major road segments, and river networks within Makassar City [49]. Each administrative layer includes relevant attribute information such as area size and administrative classification. Road data are enriched with information regarding direction, condition, and administrative location. The inclusion of these supporting spatial elements strengthens the analytical value and usability of the WebGIS application.

4.4. System Testing

System testing was conducted using the black-box testing method, which focuses on evaluating system functionality and user interface performance. The testing process verified whether each feature operated according to its intended function without examining the internal program code. Functional components tested included data input, tourism object display, layer activation, query tools, navigation features, and administrative content management [50]. The results indicated that all system functions operated properly and produced outputs consistent with user requirements. Therefore, the developed WebGIS application met the defined functional specifications and was considered ready for public use.

4. CONCLUSION

This research successfully achieved its objective of designing and developing a web-based Geographic Information System for cultural and historical tourism in Makassar City. The developed WebGIS integrates spatial and non-spatial data, presenting 20 tourism objects along with supporting administrative and infrastructure layers in an interactive digital map accessible to the public [51]. The system effectively addresses the limitations of the previous internal information system by improving accessibility, transparency, and usability. Functional testing confirmed that all system components operated according to the defined requirements, demonstrating the reliability of the developed platform [52].

Overall, this study contributes to strengthening the role of WebGIS in supporting tourism promotion and spatial information management at the regional level. The integration of multi-layer spatial data with dynamic

content management provides a practical solution for improving public access to tourism information. Future research may focus on enhancing coordinate accuracy, integrating mobile-based applications, and incorporating advanced spatial analysis features such as route optimization and location-based services. Expanding data coverage to include additional tourism sectors and implementing intelligent recommendation systems may further improve system effectiveness [53]. Therefore, the developed WebGIS has strong potential to support sustainable tourism development and local economic growth in Makassar City.

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