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RESEARCH ARTICLE

Development of an Android-Based Geographic Information System for Maneungteung Tourism Area in Cirebon Regency Using Location-Based Service (LBS) Method with Android Studio Version 2024.1.2

Afifudin Nur Cahyawan [1*] | NM Faizah [2] | Widyat Nurcahyo [3]

[1*,2,3] Computer Science Study Program, Universitas Tama Jagakarsa, South Jakarta City, Special Capital Region of Jakarta, Indonesia.

Correspondence

[1*] Computer Science Study Program, Universitas Tama Jagakarsa, South Jakarta City, Special Capital Region of Jakarta, Indonesia.
Email: afifudinxnxcx@gmail.com.

Funding information
Universitas Tama Jagakarsa.

Abstract
The Maneungteung Tourism Area in Cirebon Regency holds strong potential as a local attraction, yet the absence of an integrated information system limits visitor access to reliable tourism data. This study aims to develop an Android-based Geographic Information System (GIS) integrated with Location-Based Service (LBS) technology to enhance information accessibility, spatial accuracy, and management efficiency. The research employs the Agile Software Development approach using the Extreme Programming (XP) model, which emphasizes flexibility, iterative improvement, and continuous collaboration between developers and users. The system was built using Android Studio with Java as the main language, integrating Google Maps API for real-time spatial visualization and Firebase for database management and authentication. Functional and user acceptance testing demonstrated that the application runs reliably, displaying accurate destination information, navigation routes, and booking features. Administrators can manage data dynamically through a synchronized backend system. The integration of GIS and LBS technologies successfully improves tourism service delivery, promotes user engagement, and supports the digital transformation of tourism management in Cirebon Regency, particularly in the Maneungteung area.

Keywords
Geographic Information System; Location-Based Service; Android; Tourism Application; Cirebon.

1 | INTRODUCTION

The Maneungteung Tourism Area in Cirebon Regency represents a promising regional attraction characterized by its diverse natural and cultural assets. Despite its potential, the site remains underdeveloped, primarily due to the absence of an integrated digital information system that can effectively connect visitors with reliable tourism data. Many travelers experience difficulties in locating accurate and up-to-date information about destinations, routes, and nearby facilities, while local management struggles to promote and maintain these attractions efficiently. Such limitations have hindered the area's visibility and its contribution to the regional tourism economy (Suhendi & Ali, 2020). To address these challenges, a Geographic Information System (GIS) integrated with Location-Based Service (LBS) technology is an effective

approach for providing accessible, spatially precise, and user-oriented tourism data. LBS allows mobile devices to detect users' locations and deliver contextual information in real time, enabling tourists to navigate routes, identify points of interest, and plan their visits with greater accuracy (Susanty *et al*., 2019; Huda & Saputra, 2024). In recent studies, Android-based GIS applications have proven to enhance accessibility and engagement within tourism systems by merging digital maps with interactive features (Anggeraeni *et al*., 2021; Made & Silitonga, 2023). Implementing GIS-LBS solutions also aligns with the current trajectory of smart tourism development.

By leveraging mobile technology, tourism applications can offer personalized recommendations, real-time navigation, and dynamic data visualization—capabilities that enhance decision-making for both tourists and managers (Kurniadi & Budianto, 2018; Ginting *et al*., 2017). Furthermore, Firebase-based cloud integration and Android Studio development environments support scalability and reliability, ensuring that tourism information systems remain responsive to user demands (Purnomo *et al*., 2021). Several regional studies have demonstrated the relevance of this approach. For instance, Sodikin and Susanto (2021) successfully implemented GIS for mapping tourist destinations in Tanggamus Regency, while Yuandi (2023) developed an Android-based tourism application for East Kolaka Regency. Similarly, Prasetyo and Al Mawy (2022) employed Dijkstra's algorithm to optimize route-finding in GIS applications, emphasizing efficiency in navigation for mobile users. The application of LBS and GIS in tourism systems has therefore become a key strategy for improving visitor experiences, promoting regional attractions, and supporting local economic growth (Made & Silitonga, 2023). In this context, developing an Android-based GIS application for the Maneungteung Tourism Area is a strategic initiative aimed at improving information accessibility and promoting local destinations through digital innovation. By integrating LBS with user-friendly interfaces and accurate spatial data, the system is expected to enhance tourism services, strengthen destination management, and contribute to sustainable tourism development in Cirebon Regency.

2 | BACKGROUND THEORY

The rapid advancement of information and communication technology has transformed the tourism industry into a data-driven and interactive domain. Geographic Information Systems (GIS) and Location-Based Services (LBS) are among the most influential technologies shaping how tourism information is managed and accessed today. GIS allows users to collect, process, and visualize spatial data through digital mapping, while LBS enables mobile devices to deliver real-time location-aware services by utilizing positioning technologies such as GPS, Wi-Fi, and cellular networks (Susanty *et al*., 2019; Anggeraeni *et al*., 2021). According to Suhendi and Ali (2020), GIS provides a structured method for integrating geographic data to support spatial analysis, navigation, and infrastructure management. In tourism applications, GIS can represent destinations, routes, and amenities in an interactive environment that improves both accessibility and decision-making for visitors. Meanwhile, LBS functions as a key enabler of smart mobility, providing dynamic and adaptive services based on user location (Huda & Saputra, 2024). When integrated, GIS and LBS offer a synergistic framework for developing intelligent tourism systems capable of enhancing user experience through spatial intelligence.

Recent studies have shown that Android-based GIS applications have become increasingly relevant due to the platform's flexibility, cost-effectiveness, and extensive user base. Kurniadi and Budianto (2018) demonstrated that Android integration supports real-time updates and direct user interaction, which are essential for managing tourism data in regions with limited infrastructure. Similarly, Made and Silitonga (2023) emphasized that GIS-based smart tourism systems can significantly improve destination promotion and service quality, particularly when integrated with LBS and cloud-based data management. The use of Firebase as a backend service further strengthens this framework by providing real-time database synchronization, authentication, and scalability (Purnomo *et al*., 2021). Prasetyo and Al Mawy (2022) also highlighted the role of efficient algorithms—such as Dijkstra's algorithm—in optimizing route calculations within GIS-based systems, ensuring accurate and effective navigation for end users.

Beyond the technical dimension, the integration of GIS and LBS in tourism contributes to regional development by enhancing spatial awareness and promoting local attractions. Sodikin and Susanto (2021) noted that GIS-based mapping of tourism destinations enables stakeholders to identify patterns of accessibility and infrastructure needs. Moreover, studies by Yuandi (2023) and Ginting *et al*. (2017) revealed that mobile-based tourism applications facilitate community participation and improve the visibility of less-known destinations. In summary, the theoretical foundation for developing an Android-based GIS application with LBS integration lies in the convergence of spatial information management, mobile technology, and smart tourism principles. This combination not only supports efficient data delivery and route optimization but also fosters sustainable tourism growth through digital innovation and user-centered design.

3 | METHOD

This research was conducted in the Maneungteung Tourism Area, situated in Waled Asem Village, Waled District, Cirebon Regency, West Java (postal code 45187). The study was carried out from March to June 2024 and focused on designing and developing an Android-based Geographic Information System (GIS) that integrates Location-Based Service (LBS) technology. The main objective was to enhance information accessibility, spatial accuracy, and user engagement for both tourists and tourism administrators in the Maneungteung region. To achieve these objectives, the study employed the Agile Software Development methodology, specifically the Extreme Programming (XP) model. This approach was selected because it supports short development cycles, emphasizes continuous collaboration, and is ideal for small- to medium-scale applications that require flexibility and frequent testing (Kurniadi & Budianto, 2018; Susanty *et al*., 2019). Unlike the linear and rigid Waterfall model, XP allows the system to evolve through iterative refinement. As Made and Silitonga (2023) suggest, iterative methods are particularly valuable in technology-driven tourism projects where usability and adaptability are critical. The XP framework implemented in this research consists of four main stages: Planning, Design, Coding, and Testing (Prasetyo & Al Mawy, 2022). Each stage is described as follows.

During the Planning stage, user requirements were gathered through field observations and interviews with local tourism managers and visitors in the Maneungteung area. The purpose was to identify essential information needs such as route details, nearby facilities, and destination accessibility. This process helped define both functional and non-functional requirements to ensure the application addressed real-world challenges in tourism information access (Sodikin & Susanto, 2021). In the Design stage, the system architecture and workflow were modeled using the Unified Modeling Language (UML). The UML served as a blueprint to visualize system behavior and user interactions. The first diagram, the Use Case Diagram for Users (Figure 1), illustrates how tourists interact with the system through features such as viewing destination details, accessing route information via Google Maps, and making reservations through the booking feature. This diagram clarifies the system's functional boundaries and ensures that each use case aligns with user expectations.

Figure 1. Use Case Diagram (User)

Meanwhile, the Use Case Diagram for Administrators (Figure 2) describes how administrative users manage data within the system. Administrators are responsible for updating destination information, verifying bookings, and monitoring user activity through the integrated Firebase database. This diagram ensures that management-level operations remain structured, secure, and synchronized with the user interface.

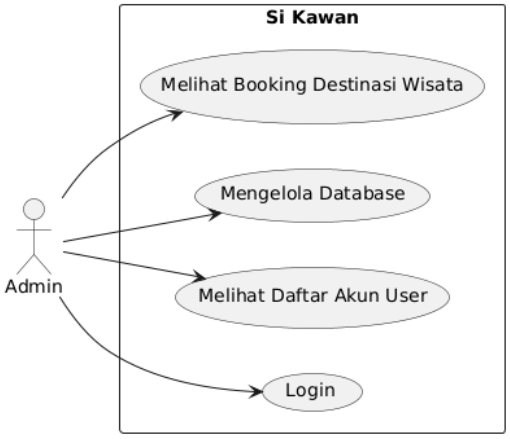


Figure 2. Use Case Diagram (Admin)

In addition, an Activity Diagram (Figure 3) was created to represent the logical flow of system activities. The diagram begins with the login process, followed by selecting a destination, displaying route navigation, and finally storing booking data into the Firebase Realtime Database. Each step is depicted sequentially to reflect how front-end actions connect dynamically with back-end operations. The Activity Diagram demonstrates how information travels through the system in real time, validating the integration between GIS, LBS, and Firebase components.

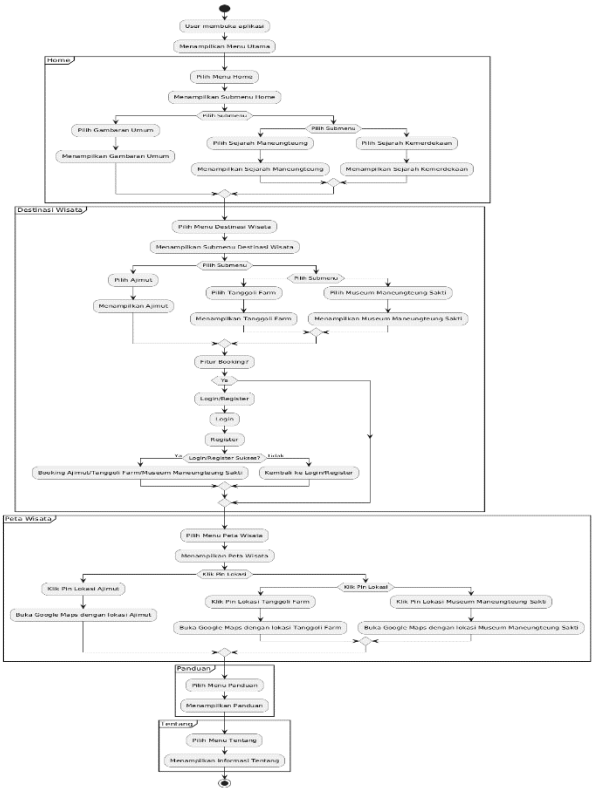


Figure 3. Activity Diagram

During the Coding stage, the system was developed using Android Studio as the primary Integrated Development Environment (IDE), with Java as the programming language. The Google Maps API was integrated to enable interactive map visualization, allowing users to view their location and navigate to various destinations in real time (Anggeraeni *et al*., 2021; Huda & Saputra, 2024). The back-end infrastructure was built using Firebase Realtime Database for real-time data storage and Firebase Authentication for secure login and user management. This integration supports simultaneous data synchronization between tourists and administrators, ensuring that all booking and location data are up to date (Purnomo *et al*., 2021). The Testing stage included two main forms of evaluation: Functional Testing and User Acceptance Testing (UAT). Functional testing verified that each feature—

such as map navigation, booking forms, and data retrieval—performed as intended without errors. User Acceptance Testing involved direct trials by local visitors and tourism staff, who evaluated the system's accuracy, responsiveness, and ease of use. Feedback from this phase was analyzed and incorporated into iterative updates to enhance performance and usability (Yuandi, 2023). Overall, this research applied a structured yet flexible development process that combined iterative testing and continuous improvement. The integration of GIS and LBS technologies successfully supported spatial visualization and navigation functions, while the adoption of the XP model ensured adaptability and user-focused refinement. The resulting system provides tourists with accurate, accessible information and supports local authorities in managing tourism data efficiently. This methodology contributes to the advancement of digital tourism infrastructure in Cirebon Regency and serves as a scalable model for similar regional tourism initiatives.

4 | RESULTS AND DISCUSSION

4.1 Results

The implementation of the Android-based Geographic Information System (GIS) application for the Maneungteung Tourism Area produced a fully functional mobile platform that integrates spatial information, historical narratives, and interactive navigation tools. The system was built using Android Studio with the Java programming language and was supported by the Google Maps API and Firebase Realtime Database to enable location-based features and dynamic data synchronization.

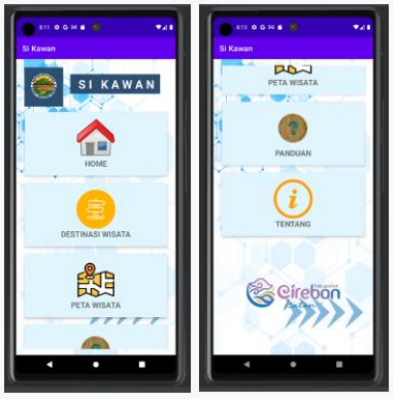


Figure 4. The main interface

Figure 5. Home Menu

Figure 6. General Overview submenu

Figure 7. History of Maneungteung submenu

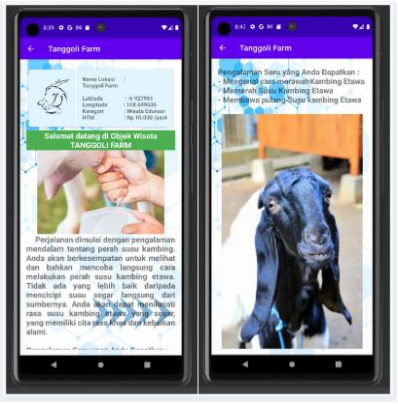
Figure 8. History of Independence submenu

The main interface of the application, shown in (Figure 4) displays the *Home Menu* containing several submenus—*General Overview*, *History of Maneungteung*, and *History of Independence*. Each submenu provides information relevant to the cultural and historical background of the Maneungteung region. The design includes an action bar, the application logo, and the official tagline *Kabupaten Cirebon Katon*, which strengthens local branding and visual identity. The Home Menu interface (Figure 5) allows users to navigate intuitively through content with clearly labeled icons and a consistent layout. In the General Overview submenu (Figure 6), textual and visual information

introduces the Maneungteung area, providing users with essential background about the region's tourism potential. The History of Maneungteung submenu (Figure 7) contains the origin story of the Maneungteung site, local folklore such as the *Sangkuriang* legend from eastern Cirebon, and the lyrics of the traditional song *Pasir Waled*. Meanwhile, the History of Independence submenu (Figure 8) presents historical accounts of the Indonesian independence struggle in the Maneungteung hills, highlighting the site's cultural and historical significance.

Figure 9. Tourist Destination Menu

Figure 10. Ajimut Destination Page



Fugure 11. Tanggoli Farm

Figure 12. Museum Maneungteung Sakti

The Tourist Destination Menu (Figure 9) showcases three primary destinations: *Ajimut*, *Tanggoli Farm*, and *Museum Maneungteung Sakti*. Each destination features its location name, latitude, longitude, and tourism category. The Ajimut Destination Page (Figure 10) displays descriptive information and images designed to attract visitors. Similarly, the Tanggoli Farm (Figure 11) and Museum Maneungteung Sakti (Figure 12) pages present concise details supported by visual elements and category labels.

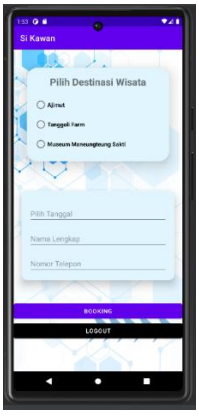


Figure 13. Booking Feature

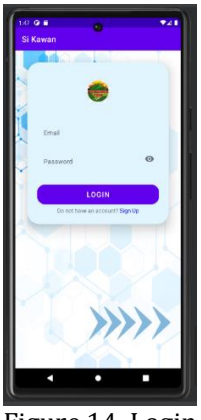


Figure 14. Login

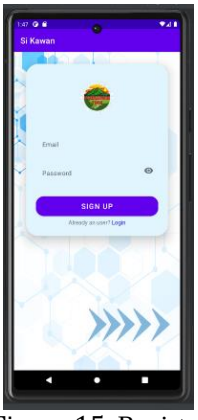


Figure 15. Register

Figure 16. Map Menu

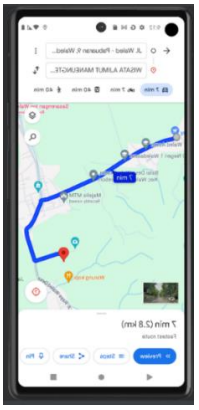


Figure 17. Google Maps Navigation

Figure 18. Guide Page

Figure 19. About Page

The application also includes an integrated Booking Feature (Figure 13), allowing users to reserve visits by entering their name, phone number, and preferred date. Submitted data are automatically stored in the Firebase Realtime Database Figure 21 and can be reviewed by administrators. Authentication and user registration are handled through the Login (Figure 14) and Register (Figure 15) interfaces, which require email and password verification for system access. The Map Menu (Figure 16) displays the geographical distribution of the three tourist sites using Google Maps markers. When a marker is selected, the system provides an option to view routes. Selecting the *Route* icon redirects users to Google Maps Navigation (Figure 17), which generates the optimal path based on the user's current location. Additional menus include the Guide Page (Figure 18), containing user instructions for operating the map and navigation tools, and the About Page (Figure 19), which provides an overview of the "Si Kawan" application, along with contact information such as email, phone number, and address.

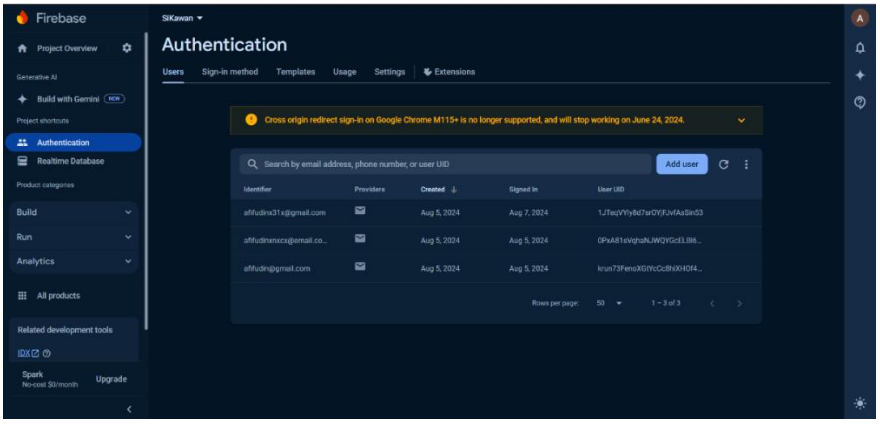


Figure 20. Firebase Authentication

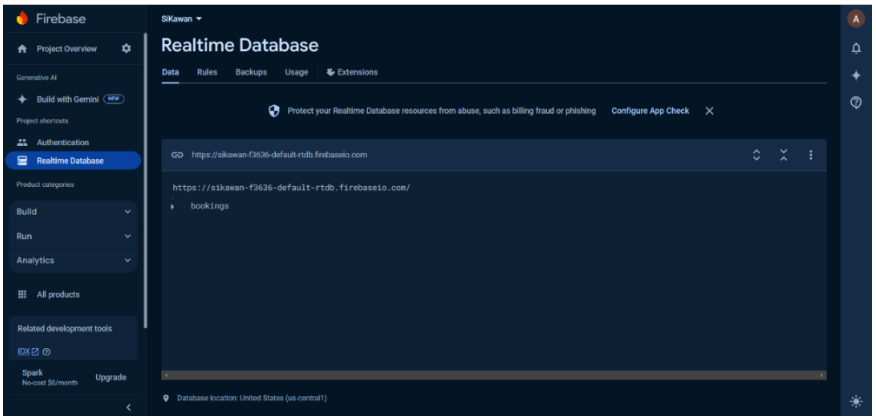


Figure 21. Firebase Realtime Database

From the administrative side, Firebase Authentication (Figure 20) enables the administrator to manage registered user accounts securely. The Firebase Realtime Database (Figure 21) stores booking data and user interactions in real time, providing a reliable platform for system monitoring and data management. Functional testing confirmed that all application features operated smoothly, with accurate location detection, responsive interface transitions, and stable data synchronization. The overall system successfully met the planned design objectives by integrating tourism information, real-time mapping, and user interactivity into a single mobile platform.

4.2 Discussion

The results indicate that the developed GIS application effectively integrates geospatial technology and mobile information systems to enhance the tourism experience in the Maneungteung area. The system allows users to access detailed destination data, navigate efficiently, and make bookings without the need for third-party applications. The interactive map and LBS integration provide an engaging and practical tool for visitors, aligning with Anggeraeni *et al.* (2021) and Huda and Saputra (2024), who emphasize that location-based systems improve the accessibility and precision of tourism data delivery. The inclusion of historical and cultural submenus within the interface adds a contextual dimension to the user experience, turning the application into both a navigation tool and an educational resource. This multidisciplinary design approach supports Digital (2023), who stresses that UI/UX-centered applications should not only deliver information but also sustain user engagement through aesthetic and functional coherence. From a technical standpoint, the Firebase backend proved crucial for ensuring real-time synchronization between users and administrators. As demonstrated in the tests, updates to booking data and user registration were reflected immediately in the database, confirming the reliability and scalability of Firebase as reported by Purnomo *et al.* (2021). The integration of Google Maps API facilitated dynamic visualization, consistent with the studies of Made and Silitonga (2023), who found that geospatial data integration enhances the efficiency of mobile-based tourism systems.

The use of the Extreme Programming (XP) model throughout the development process ensured flexibility and rapid iteration. Continuous feedback from field testing allowed developers to refine interface design, navigation responsiveness, and feature stability in each cycle. This iterative improvement process aligns with the agile philosophy promoted by Kurniadi and Budianto (2018) and Susanty *et al.* (2019), reinforcing the suitability of XP for small-scale tourism technology projects. In terms of practical impact, the Maneungteung GIS application contributes to the digital transformation of local tourism management in Cirebon Regency. By providing an accessible mobile platform, it helps local administrators promote destinations and manage visitor data efficiently. This outcome supports the findings of Sodikin and Susanto (2021) and Yuandi (2023), who noted that GIS-based applications can strengthen local tourism ecosystems by improving destination visibility and operational coordination. In conclusion, the developed Android-based GIS application for the Maneungteung Tourism Area successfully demonstrates the synergy between LBS, GIS, and cloud computing technologies. The system not only enhances user experience and information accessibility but also provides a digital infrastructure that supports sustainable tourism development. The effectiveness of the application validates the methodological approach used and sets a foundation for expanding similar systems to other regional tourism areas in Indonesia.

5 | CONCLUSIONS

Based on the design, implementation, and analysis conducted in the study entitled *"Development of an Android-Based Geographic Information System for the Maneungteung Tourism Area in Cirebon Regency Using the Location-Based Service (LBS) Method"*, several conclusions can be drawn as follows. First, the Geographic Information System (GIS) Application for the Maneungteung Tourism Area has been successfully developed as a digital platform that facilitates tourists in locating and visiting destinations within the Maneungteung area. By integrating Location-Based Service (LBS) technology, users can obtain accurate and real-time information regarding destination locations and navigation routes through interactive mapping features. This functionality enhances trip planning efficiency and provides a more convenient and engaging travel experience for visitors. Second, the implementation of Geographic Information System (GIS) technology within the application ensures high spatial data accuracy for all listed destinations. Each tourist site is precisely mapped based on verified latitude and longitude coordinates and connected to Google Maps for real-time route visualization. This level of precision benefits not only visitors—by delivering reliable location information—but also assists tourism managers in monitoring, updating, and managing destination data more effectively. Third, the application provides significant advantages for tourism administrators in developing and managing the Maneungteung Tourism Area. Through its integration with Firebase Realtime Database and Firebase Authentication, administrators can access visitor data, manage destination content, and monitor booking activities instantly. This administrative functionality promotes more efficient, transparent, and technology-driven tourism management practices. In summary, the integration of GIS and LBS technologies within an Android-based mobile application has proven effective in enhancing information accessibility, supporting destination promotion, and strengthening the digital transformation of the tourism sector in Cirebon Regency, particularly in the Maneungteung Tourism Area.

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