

# A location-based application for public facility damage reporting in Manado City

Kenneth Palilingan<sup>1</sup>, Salaki Reynaldo Joshua<sup>2</sup>, Salvius Lengkong<sup>3</sup>  
<sup>1,2,3</sup>Informatics, Faculty of Engineering, Universitas Sam Ratulangi, Indonesia

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## ABSTRACT

This study presents the design and development of a Location Based Service (LBS)-based public facility damage reporting application for Manado City to address limitations in conventional public reporting mechanisms. The novelty of this research lies in the integration of real-time spatial reporting with the Rapid Application Development (RAD) method, enabling iterative and user-centered prototype development tailored to local government public service workflows. The RAD approach was implemented through iterative stages of requirement analysis, system design, prototyping, and evaluation involving user participation. The developed prototype enables users to submit damage reports with automatic GPS-based location detection, photographic evidence, and report status tracking. Functional evaluation using black box testing showed that all core user-side features operated successfully according to the defined requirements. Scenario-based testing involving six respondents indicated that report submission, location detection, and information display functions executed correctly under normal operating conditions. The results demonstrate that the proposed prototype improves the accuracy of reported locations and simplifies the public reporting process. Overall, this study highlights the potential of integrating LBS technology with the RAD approach to support responsive digital public service management and strengthen community participation in urban infrastructure monitoring within the local context of Manado City.

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### Corresponding Author:

Kenneth Yosua Palilingan,  
Faculty of Engineering,  
Universitas Sam Ratulangi,  
Bahu, Kec. Malalayang, Kota Manado, Sulawesi Utara, 95115, Indonesia  
Email: [kennethpalilingan@unsrat.ac.id](mailto:kennethpalilingan@unsrat.ac.id)

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## 1. INTRODUCTION

Information has become a primary necessity in modern society as individuals increasingly rely on timely and accurate data to support daily activities (Dwi Prasetyo et al., 2022). Rapid advances in information technology have significantly improved the accessibility of information through internet-based digital media platforms (Riinawati, 2021). The development of information technology and communication media has also transformed how information is produced, distributed, and consumed in various sectors (Sriwati Sriwati, 2023). This transformation has accelerated the shift from conventional print media toward digital media as the dominant channel for information dissemination (Suganda, 2022). Digital media enables faster information delivery while also supporting interactive and multimedia-based communication (Chen Chamiao, 2022). As a result, digital mass media platforms have become an integral part of public information consumption across different age groups (Kencana, 2020).

Public facilities are essential infrastructure provided by governments to support social activities, public mobility, and overall urban functionality (Laura Tri Agustin, 2024). The availability and quality of public facilities are widely recognized as key indicators of sustainable and smart

urban development (Almira Deandra et al., 2024). Municipal governments are responsible for managing various public facilities, including roads, sidewalks, street lighting, parks, and other shared urban assets (Carpline Sitorus, 2023). However, many cities continue to face challenges related to facility degradation due to delayed maintenance and limited monitoring mechanisms (Herdiansyah Harahap, 2022). One of the primary causes of these issues is the lack of efficient public complaint and reporting systems that can operate in real time (Falasyfa & Avianto, 2024).

Citizen participation plays a crucial role in assisting governments to identify and respond to public facility issues more effectively (Mutiarin & Lawelai, 2023). Community-based reporting systems allow citizens to directly contribute information based on actual field conditions (Nuraeni et al., 2023). The integration of digital government initiatives has further encouraged public engagement through technology-enabled communication channels (Shabnam Sharmin, 2025). Mobile applications, in particular, provide an effective medium for submitting public facility damage reports in a structured and documented manner (Wang, 2021). Through mobile platforms, users can submit reports accompanied by photographic evidence, improving data reliability and transparency (Hashem et al., 2023).

Location Based Service (LBS) technology has become a fundamental component in mobile reporting applications due to its ability to provide spatial context (Rohman, 2024). LBS utilizes geographic location data to deliver services that are relevant to the user's current position (Jiang et al., 2022), with accuracy supported by Global Positioning System (GPS) technology embedded in modern mobile devices (Li et al., 2021). Accurate location data enhances the quality and credibility of reported information in public service systems and supports faster response by local authorities (Wu et al., 2024). Several studies have shown that LBS-based applications improve public complaint handling efficiency and urban service management (Rudiarto, 2023). In addition, crowdsourced geographic information generated through citizen participation has proven valuable for identifying urban problems and supporting spatial decision-making processes (Huang et al., 2024). However, despite these advantages, many existing public reporting systems still face limitations in adapting to user feedback and evolving operational needs, which highlights the importance of selecting an appropriate development methodology (Joko Prayogi, 2022). The Rapid Application Development (RAD) method is therefore considered suitable for addressing these challenges, as it enables rapid prototyping, iterative refinement, and strong user involvement throughout the development process (Riadi et al., 2024).

Although various public reporting applications have been implemented in different cities, including several regions in Indonesia, many of these systems still exhibit significant limitations. Previous studies report that existing applications often focus on basic reporting functionality without optimal integration of real-time location data into comprehensive report management workflows at the local government level (Kencana & Meisyanti, 2020). In addition, many systems are developed using rigid development models that limit flexibility in accommodating user feedback and evolving administrative requirements. As a result, several public reporting applications fail to fully support effective coordination between citizens and municipal authorities, particularly in localized urban contexts.

To address these limitations, this study proposes the design and development of a public facility damage reporting application that integrates Location Based Service (LBS) technology with the Rapid Application Development (RAD) method in the local context of Manado City. The novelty of this research lies in the combination of real-time spatial reporting and an iterative, user-centered development approach tailored to municipal public service workflows. By applying RAD, the system is designed to rapidly adapt to user feedback while maintaining functional accuracy and usability. This research aims to analyze and design a prototype that supports more responsive digital public service management and strengthens citizen participation in urban infrastructure monitoring.

## 2. RESEARCH METHOD

This research adopts the Rapid Application Development (RAD) method, a software development approach that emphasizes rapid development cycles, iterative prototyping, and intensive user involvement throughout the entire development process. By engaging users continuously at each phase, the RAD method enables early identification of requirements, frequent feedback, and progressive refinement of system functionalities. This approach allows developers to quickly adapt to changing user needs, reduce development risks, and improve system quality through repeated

evaluation and enhancement. The overall stages and workflow of the RAD method applied in this study are illustrated in Figure 1.

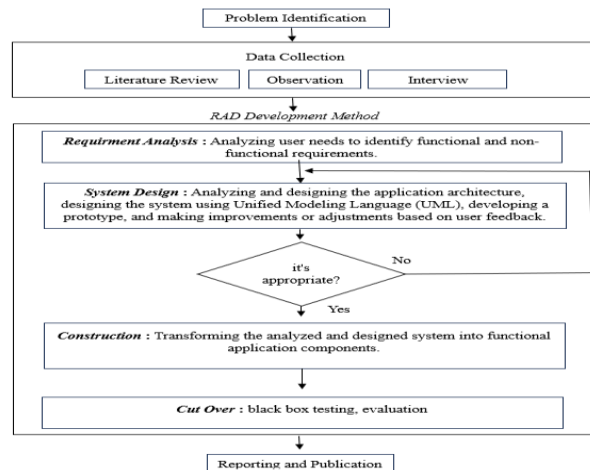


Figure 1. Research procedure based on the rapid application development (RAD) method

As shown in Figure 1, the research begins with problem identification to define key issues in public facility damage reporting in Kota Manado and to identify limitations in existing reporting mechanisms. Data collection is then conducted through literature review, observation, and interviews to obtain theoretical insights, understand real conditions, and gather user needs and expectations.

The collected data are analyzed in the requirement analysis stage to define the functional and non-functional requirements of the system. These requirements serve as the foundation for the system design stage, which includes application architecture design and system modeling using Unified Modeling Language (UML), such as use case diagrams, activity diagrams, and database design. A prototype is developed and refined iteratively based on user feedback following the RAD approach. The construction stage implements the approved design into a functional application prototype. Finally, the cut-over stage involves black box testing and system evaluation to ensure that the developed prototype meets the defined requirements before reporting and publication.

User involvement in the RAD iteration process includes six respondents selected using purposive sampling, consisting of four community members who frequently use public facilities and two representatives from the local government responsible for public facility management. Community members participate in requirement validation and prototype evaluation, while government representatives provide input related to report verification and administrative workflows. User feedback is collected during the prototyping and evaluation stages to refine system functionality and usability. Prototype evaluation is conducted using task-based testing and black box testing. Task-based testing requires users to perform key system functions such as registration, login, submitting damage reports, uploading photos, and viewing report status. Black box testing is applied to verify whether each functional requirement operates according to its specification without considering internal system logic. User feedback is documented using evaluation checklists and qualitative comments to identify usability issues and functional improvements.

The success criteria of the developed prototype are defined operationally as follows: (1) all main functional requirements can be executed without system errors, (2) users are able to complete reporting tasks successfully, including location capture and photo upload, and (3) evaluation results indicate that the system is easy to use and supports the reporting process effectively. These criteria ensure that the proposed prototype meets functional expectations and supports reproducibility of the research.

### 3. RESULTS AND DISCUSSIONS

In this research, system requirement identification was conducted using two approaches: interviews with community members as prospective application users and government

representatives involved in public facility management, as well as a literature review related to public facility reporting services and the implementation of Location Based Service (LBS) in mobile applications. The interviews were conducted with six respondents selected using a purposive sampling technique. The respondents consisted of community members who had encountered damaged public facilities and representatives of the city government responsible for public facility management. The selection of respondents was based on the relevance of their experience and involvement in the issues being studied. In addition, a literature review was carried out by examining previous studies on public complaint applications, local government public service standards, and the concept of LBS utilization in reporting systems. This literature review aimed to complement the information obtained from interviews and to ensure that the designed system requirements align with sound application design principles and best practices in digital complaint services. Based on the data collected through interviews and the literature review, system requirements were identified as the foundation for application design. These requirements consist of functional and non-functional requirements, which are described in the following sections.

Functional requirements: a) Users can register and log in to the application; b) Users can submit reports of public facility damage through the application; c) The system can automatically detect and retrieve the user’s location (GPS) when a report is submitted; d) Users can upload photos of the damage as supporting evidence; e) Users can view the status of their reports (Submitted, Verified, In Progress, Resolved, Rejected); f) Users can access information or news provided by the system; g) Administrators can view a list of incoming reports; h) Administrators can verify reports (accepted or rejected); i) Administrators can update the handling status of reports until completion; j) The system sends notifications to users when the report status changes; k) The system displays the user’s report history; l) The system displays the location of reported damage on a map using Location Based Service (LBS).

Non-Functional Requirements: a) Usability: The application interface must be easy to use for the general public. Application navigation must be simple and intuitive; b) Performance: The system must load report data in less than 3 seconds. GPS location retrieval must not exceed 5 seconds under normal conditions; c) Security: User data must be stored securely. Administrator access must be protected using special authentication. Data communication must use secure protocols (HTTPS); d) Compatibility: The application must run on Android devices with a minimum version of Android 8.0. The application must be compatible with various screen sizes; e) Availability: The system must be accessible 24/7 as long as an internet connection is available; f) Reliability: The application must function properly even under unstable internet connections. The system must be able to process at least 50 reports per day without errors; g) Maintainability: The system must be easy to update and allow the addition of new features in the future; h) Scalability: The system must be able to handle an increasing number of users without significant performance degradation.

Based on the identified functional and non-functional requirements, a system modeling stage is conducted to represent the interactions between users and the application. To visualize these interactions and system functionalities, a use case diagram is developed, as shown in Figure 2.

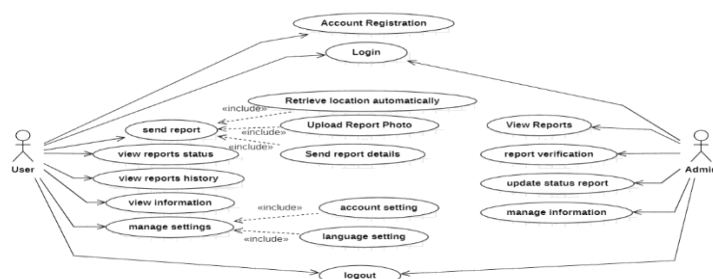


Figure 2. Use case diagram of the public facility damage reporting application

The use case diagram illustrates the interaction between two main actors, User and Admin, in the public facility damage reporting system. The User is responsible for submitting reports, viewing report status and history, accessing information, and managing account settings, while the

Admin verifies incoming reports and updates their handling status. The include relationship represents mandatory processes within certain use cases, such as GPS-based location acquisition and photo upload during report submission. Overall, the diagram provides a clear overview of system functionality and actor responsibilities based on the defined functional requirements.

Activity diagrams are used to illustrate the workflows of the system, showing the sequence of activities and interactions between the User, Admin, and the system. These diagrams describe processes such as user authentication, report submission, location capture, photo upload, report monitoring, and administrative verification. Figures 3–9 present the activity diagrams for each main functionality, ensuring that the system behavior aligns with the defined requirements and the RAD methodology.

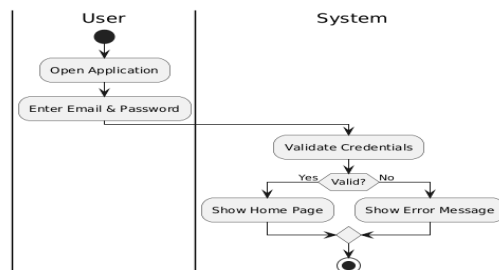


Figure 3. Login activity diagram

This activity diagram illustrates the user authentication process when accessing the application. The process begins with the user entering an email and password, followed by system validation. If the credentials are valid, the user is directed to the main page; otherwise, an error message is displayed. The diagram highlights the interaction between the user and the system to ensure secure access.

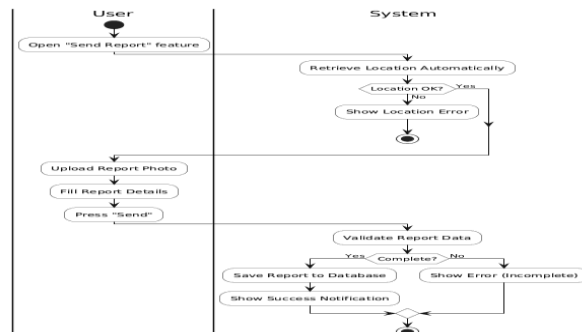


Figure 4. Activity Diagram for Submitting Public Facility Damage Reports

This activity diagram illustrates the workflow when users create and submit public facility damage reports. The process starts by accessing the reporting feature, followed by automatic location retrieval using LBS. Users upload photos and complete report details, then submit the report. The system validates the data before saving it to the database. Complete data are successfully submitted, while incomplete data trigger an error message.

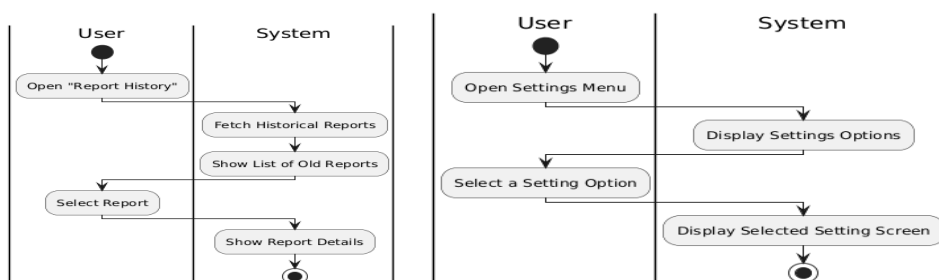


Figure 5. Activity Diagrams of: (a) Report status monitoring and (b) Application settings

Figure 5(a) illustrates the workflow for viewing report status, where the system retrieves and displays report statuses such as *new*, *verified*, *in progress*, and *completed*, and allows users to view detailed information. Figure 5(b) describes user interaction with the application settings menu, including account settings, language options, Terms & Conditions, Privacy Policy, and About App. These workflows demonstrate system transparency and support features for user information and personalization.

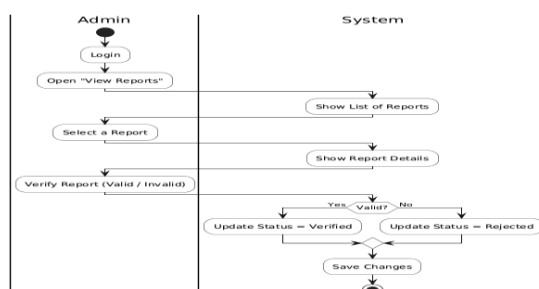


Figure 6. Activity diagram for submitting public facility damage reports

This activity diagram illustrates the admin workflow for viewing and verifying incoming reports. The process begins with admin login, followed by accessing the report list menu. The system displays all reports submitted by users. The admin selects a report to view its details and determines whether the report is valid. This decision is then stored by the system. The diagram highlights the admin’s role in maintaining report quality before further processing.

After describing the system workflows through the activity diagrams in Figures 3–6, the data structure of the system is modeled using an Entity Relationship Diagram, as shown in Figure 7.

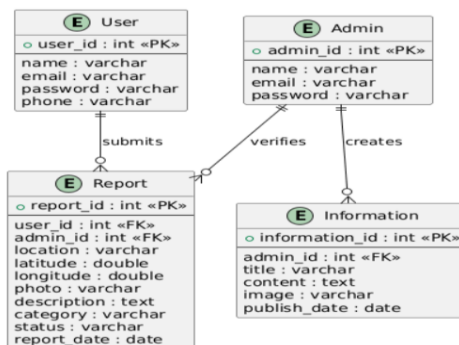


Figure 7. Entity relationship diagram

The Entity Relationship Diagram (ERD) illustrates the database structure used in the public facility damage reporting application. The system consists of four main entities: User, Admin, Report, and Information. The User entity has a one-to-many relationship with the Report entity, indicating that a user can submit multiple damage reports. The Admin entity also has a one-to-many relationship with the Report entity in the verification and status update process. In addition, the Admin entity is related to the Information entity, which stores information or announcements displayed to application users. After completing the system design phase, the user interface of the application prototype is presented in Figures 8–11



Figure 8. Application: (a) Login page and (b) Home page

Figure 8(a) shows the login page of the application. Users can register an account (sign up) if they do not already have one, sign in using email or a Google account, and use the forgot password feature if they forget their password. Figure 8(b) presents the main (home) page of the application, where users can view a list of reports submitted by other users along with their report statuses. Users can also search for reports. At the bottom of the page, a navigation menu is provided, consisting of My Reports, Information, Profile, and a menu for creating a new report.



Figure 9. Page (a) Report detail and (b) My reports

Figure 9(a) displays the report detail page that appears when a user selects a report. This page presents complete report information, including damage images, report creation date, report identity, address or problem location, report status, and report description. The report location is also shown on a map to help users identify the damage location geographically. Figure 9(b) shows the My Reports menu, which contains a list of reports submitted by the user. In this menu, users can view the status of each submitted report and use the search feature to easily find reports when the number of reports is large.



Figure 10. Page (a) Report detail and (b) My reports

Figure 10(a) shows the Information menu, which contains important information or announcements that can be accessed by application users. Figure 10(b) displays the Create New Report page, where users are required to log in before submitting a damage report.



Figure 11. Profile and application settings page

Figure 11 shows the Profile or application settings menu. This page allows users to view account information, such as the username, and access various settings, including language preferences (Indonesian–English), About App, Terms and Conditions, Privacy Policy, and the logout feature.

After presenting the application prototype, system testing is conducted using the Black Box testing method, focusing on client-side functional requirements based on the features implemented and displayed in the application prototype. Functional requirements on the admin side are not tested directly, as they are not included within the scope of the prototype implementation in this research.

Table 1. Black box testing results

No	Functional Requirement	Test Scenario	Expected Result	Result
1	Users can register and log in to the application	The user registers and logs in using valid account data	The system displays the main (home) page	Passed
2	Users can create public facility damage reports	The user fills in the report form and submits the report	The report is successfully submitted and stored in the system	Passed
3	The system can automatically detect and retrieve the user's location (GPS)	The user creates a report with GPS enabled	The system automatically displays the report location	Passed
4	Users can upload photos of the damage as report evidence	The user uploads a photo in the report form	The photo is successfully uploaded and stored	Passed
5	Users can view the report status	The user opens the report details	The report status is displayed (Submitted, Verified, In Progress, Resolved, Rejected)	Passed
6	Users can view information/news	The user opens the Information menu	The system displays the list of information/news	Passed
7	The system displays the user's report history	The user opens the My Reports menu	The system displays the list of reports created by the user	Passed
8	The system displays the damage location on a map using LBS	The user opens the report details	The map displaying the damage location is shown	Passed
9	The system sends notifications when the report status changes	The report status is updated	The user receives a notification about the status change	Passed

The system testing results provide a basis for evaluating the fulfillment of functional requirements and the overall performance of the developed prototype. Black box testing indicates that all core user-side functionalities, including registration and login, public facility damage reporting, automatic GPS-based location acquisition, photo uploads, and report status tracking,

functioned correctly according to the defined specifications. From the six respondents involved in the prototype evaluation, five users (83%) stated that the application was easy to use and helped simplify the reporting process, while one user (17%) indicated minor usability issues related to navigation clarity. In addition, system response time for report submission and location retrieval was observed to be under five seconds under normal network conditions, indicating acceptable performance for a prototype-stage application.

Compared to previous studies on public complaint reporting applications, this research demonstrates several improvements. Earlier systems often focused on basic reporting functionality without strong integration of real-time spatial data and adaptive development processes (Kencana & Meisyanti, 2020). In contrast, the integration of Location Based Service (LBS) in this prototype enables accurate spatial identification of damaged public facilities, consistent with findings by (Rudiarto, 2023) and (Huang et al., 2024), which emphasize the value of spatial data in urban problem identification. Furthermore, the application of the Rapid Application Development (RAD) method allows iterative refinement based on user feedback, addressing limitations reported in studies that employed more rigid development models (Joko Prayogi, 2022). This combination positions the present study as a practical contribution to LBS-based public service applications developed using a user-centered and adaptive methodology.

From a practical perspective, the proposed system has the potential to support local governments, particularly in Manado City, by providing a structured and location-accurate reporting mechanism that enhances coordination between citizens and municipal authorities. Although the current study is limited to a prototype and does not fully implement administrative features or extensive non-functional testing, the results indicate that the LBS–RAD integration is a promising approach for developing responsive digital public service systems. Future work may extend this research by involving a larger number of users, implementing full administrative workflows, and conducting more comprehensive performance and security evaluations.

#### 4. CONCLUSION

Overall, the results of this research demonstrate that the developed prototype is capable of supporting digital and location-based public facility damage reporting. The successful integration of Location Based Service (LBS) technology enables accurate identification of damage locations, while the application of the Rapid Application Development (RAD) method facilitates rapid prototyping and iterative refinement based on user needs. The prototype fulfills the defined functional requirements and shows that the combination of LBS and RAD is suitable for developing public reporting applications in an urban context.

From a practical perspective, this prototype has the potential to support local governments, particularly in Manado City, by providing an initial digital platform that encourages community participation in reporting public facility damage. By enabling citizens to submit reports accompanied by location data and photographic evidence, the system can assist municipal authorities in obtaining more accurate and timely information, which may contribute to more responsive public facility management and support smart city initiatives.

Nevertheless, this research is limited to prototype development and functional testing. Future research is recommended to focus on full system implementation, broader user evaluation involving a larger number of respondents, and more comprehensive testing of non-functional aspects such as security, performance, scalability, and system integration with existing government information systems. Further development in these areas is expected to strengthen the practical applicability and sustainability of the proposed system in real-world public service environments.

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