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Design of an Android-Based Public Street Lighting (LPJU) Damage Reporting Application

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ABSTRACT

Public street lighting (LPJU) was a vital facility that assisted and supported community activities, especially at night. However, various problems with LPJU were still frequently encountered. Some common problems included lights going out at night, lights that were on during the day, or a specific component of the light being broken. The LPJU fault reporting system in various regions was also still manual. That manual reporting system resulted in a slow and unstructured process for reporting streetlight malfunctions, which in turn caused delays in the repair process. The purpose of this research is to design and develop an Android-based public street lighting damage reporting application to make it easier for the public to submit LPJU damage reports digitally by attaching descriptions, photos, and the location of the incident in real time. This application was developed using the waterfall method. The waterfall method consisted of five stages: requirements analysis, system design, implementation, testing, and maintenance. The research results showed that this application could assist and facilitate the public in digitally reporting LPJU damage. The implementation of this system was expected to improve reporting efficiency, expedite follow-up on LPJU damage, and serve as a model for technology-based public services within local governments.

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1. Introduction

Public street lighting (LPJU) is part of road equipment. Based on Government Regulation Number 34 of 2006 concerning roads, road equipment is a tool or structure provided and constructed with the aim of supporting the smooth, safe, and orderly flow of traffic, as well as making it easier for road users to carry out traffic activities. LPJU is defined as a lighting system or lighting facility provided for the public interest, installed on roads or other public places, and serving as a supporting facility for motorized vehicle users [1]. LPJU is a form of service provided by the regional government that functions to increase the level of safety and comfort of road users, especially in dealing with travel conditions at night, reducing the possibility of traffic incidents and supporting environmental security and preventing crime in risk-prone areas [2], [3], [4]. Furthermore, a long-established link exists between inadequate street lighting and increased crime rates, as offenders tend to move their activities to darker areas when streetlights are not functioning [5]. herefore, public street lights are needed as lighting equipment. Street lighting needs to provide good visibility at night

without causing glare that disturbs road users. The quality of street lighting must meet the established street lighting system planning, including the type of lamp, installation height, and distance between lamp points [6].

Street lighting (LPJU) has its own functions and benefits. The primary function of street lighting is to provide artificial lighting for motorists and road users at night so that people can feel safer and more comfortable while traveling [7], [8]. The presence of street lights helps minimize the risk of traffic accidents. Street lights also play a vital role in supporting community activities at night, whether in residential areas, industrial areas, or urban centers. Street lights contribute to the creation of a comfortable and conducive environment for citizen mobility, even outside of working hours. Street lighting plays a role in supporting the development of remote areas through the use of alternative energy, such as solar power, thus impacting the improvement of the quality of life of communities in areas without access to PLN electricity.

LPJU also offers economic and environmental benefits. Despite its significant benefits, many areas still face challenges in meeting adequate lighting needs. Limited funding, inadequate maintenance, and the use of inefficient technology are often the main obstacles to improving LPJU quality [9]. From an economic perspective, the LPJU system uses LED lights. The use of LEDs can significantly reduce electricity consumption, thereby increasing operational and maintenance costs in the long term. Utilizing LED lighting technology in the LPJU system can be an efficient solution for improving street lighting quality at a more economical cost and with greater environmental friendliness [10]. This aligns with the national energy efficiency program and efforts to reduce carbon emissions. Furthermore, LPJU contributes to urban planning and enhances the aesthetic value of the environment. Optimal lighting not only provides comfort but also encourages social interaction and opens up opportunities for various activities that can strengthen relationships between residents [11].

Public street lighting (LPJU) is a vital part of urban infrastructure. However, its implementation often encounters various technical and non-technical issues. Some common problems include streetlights going out, lights on during the day, damaged components such as ballasts or cables, and a lack of routine maintenance. Furthermore, many roads still lack LPJUs or their installations do not meet lighting standards, endangering road users and creating a sense of insecurity, especially at night. Another problem is the lack of an effective monitoring system. Many areas still rely on manual reports from residents to identify LPJU damage. This condition causes delays in the handling process. Limited budget and human resources also hinder the management and regular maintenance of LPJUs.

Pematangsiantar City is one of the cities that still uses a manual reporting system and has not yet utilized technology to address existing issues. Manual reporting carries a higher risk of data loss, delays in processing, and lower accuracy compared to digital systems, making it less effective in supporting public service performance [12]. Pematangsiantar City is one of the cities that still uses a manual reporting system and has not yet utilized technology to address existing issues. Manual reporting carries a higher risk of data loss, delays in processing, and lower accuracy compared to digital systems, making it less effective in supporting public service performance [13]. In addition, many LPJUs are still managed independently by local communities without proper coordination with the government, and the placement of LPJU poles is inappropriate and not according to planning.

These problems indicate that there is a need for information technology-based solutions to facilitate reporting and handling of LPJU disruptions quickly, efficiently, and in a documented manner. Reporting is the process of carrying out every activity and culminating in a report. A report is a document containing information about an activity and its results, presented in data form. The manual damage reporting mechanism makes the process inefficient, makes it difficult for people living far from the relevant agency offices, and results in not all reports being properly recorded.

Based on these issues, a technology-based system was designed in the form of an Android-based public reporting system. Research on digital reporting systems shows that their effectiveness is highly dependent on infrastructure readiness, user training, and policy support from local governments. Therefore, the implementation of a digital reporting system for LPJU requires thorough preparation, both technically and non-technically, to provide optimal benefits in supporting real-time and efficient LPJU management and maintenance [14]. This application design is expected to make it easier for the public to submit reports and become a practical and efficient digital solution to improve the quality of public services and optimal and responsive management of LPJU infrastructure [15].

There is similar previous research. 1) a study by L. Andrianto and S. Muharni (2023) with the title "Aplikasi Layanan Pengaduan Lampu Penerangan Jalan Umum". The research results show that the application can facilitate administrators, as staff of the Metro City Housing and Settlement Agency, in managing data from public reports regarding damaged public street lighting. Reporters also have the convenience of reporting damage through the application, by phone, or on WhatsApp. The application design process was carried out using the Rapid Application Development (RAD) method [6]. 2) a study entitled

"Rancang Bangun Sistem Aduan Penerangan Jalan Umum (PJU) dengan Menggunakan Mapbox dan Mobile Android" conducted by M. M. Qadafi Y. Sholva, and H. Novriando. The results of the study show that the application successfully met its objective, namely facilitating reporting of street lighting damage that occurred in Pontianak City [2].

The differences between this research and previous research are in terms of: 1) The appearance of the application for reporting damage to public street lighting, 2) The SDLC application development method with a waterfall approach, and 3) The focus is only on making damage complaint reports. The contributions of the research on the Android-based reporting application compared with the previously used reporting system are as follows: 1) Damage reports can be submitted in real time, without time or location restrictions, using a smartphone. 2) Information is conveyed more quickly and effectively, and the handling of damage reports is expedited. 3) The public does not need to visit government offices in person to submit reports, whether in writing or verbally. 4) Local governments receive more complete and accurate information, thereby accelerating verification since reports are accompanied by supporting evidence and clear locations. 5) The system, integrated with WhatsApp, accelerates communication between the public and local government officials. 6) It enhances the efficiency of public services through the digitization of the reporting process. 7) Minimizes the use of physical (paper) documents, reduces the risk of losing report data, replaces the use of storage media or physical storage space, and speeds up the data retrieval process since all information is stored in a centralized database. 8) Contributes to public service accountability and transparency, as the public can directly monitor the status of reports through the application.

2. Research Method

The research was conducted using the waterfall method. A detailed explanation of the waterfall method is discussed in the research stages. The library search method, or literature study, was conducted through internet searches, journal searches on Google Scholar, and books related to system design and development. Meanwhile, the software development, specifically the lighting damage reporting application, used the waterfall method.

2.1 Research Stages

The design of the lamp damage reporting application in this study was carried out by adopting one of the software development methods, namely the waterfall method. The waterfall method is a software development model that emphasizes a systematic and sequential (linear) approach, with stages that must be completed sequentially [16], [17]. The use of the waterfall method helped minimize the risk of errors, as each phase was reviewed and validated before moving on to the next stage [18]. This method offers a clearly structured flow and complete documentation at each stage [19]. The waterfall method consists of five stages: requirements analysis, system design, implementation, testing, and maintenance. The stages of this method are shown in Figure 1.

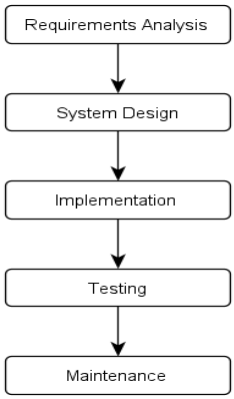


Figure 1. Waterfall method

The explanation of each stage in the waterfall method shown in Figure 1 is as follows: (1) Requirements analysis stage; in this stage, the problem is analyzed to determine what is needed for this research, and then the system is designed by creating a system diagram. (2) System design stage; the stage follows the complete gathering of all requirements in the software development process. During this phase, the application's database is designed, functional and non-functional requirements are defined, and the user interface is designed. (3) Implementation stage; this stage involves translating the program design into code

using the specified programming language. (4) Testing stage; at this stage, the system or program that has been developed and implemented is tested on a unit-by-unit basis. The testing conducted includes black-box testing using pre-prepared scenarios and User Acceptance Testing (UAT) in the form of a questionnaire administered to three respondents. (5) Maintenance stage; this stage involves operating the program in its environment and performing maintenance tasks, such as adjustments or changes to adapt to the actual situation.

2.2 Research Tools

The design of an Android-based public streetlight damage reporting application uses research tools consisting of hardware and software. The tools used are shown in Table 1.

Table 1. Research Tools

Tools	Description
Laptop HP Intel Core-i5	Workstation (Windows 10 64 bit)
Smartphone Android	Workstation (min versi 5.0 Lollipop)
USB Conector	Connector
Android Studio	Code Editor
Sublime Text	Code Editor
XAMPP	Web Server (v3.2.2)
Chrome	Browser
Microsoft Edge	Browser

Android smartphones were used to support the research. Android is the world's most popular operating system with a huge market share due to its open-source nature and support from various other mobile device manufacturers [20]. Android was officially introduced to the public in 2008, and since then has continued to develop rapidly, both in terms of performance, security, compatibility, and the system features offered [21]. Android Studio is software used for development on mobile devices, which includes the operating system, middleware, and core applications [22]. In designing a report of a lamp failure application, Android Studio is used as the primary tool in the interface design process, logic programming, and application testing. Sublime Text is a lightweight and responsive text editor, widely used by developers to write program code. This application supports various programming languages such as HTML, CSS, JavaScript, PHP, and others. Sublime Text is a text and code editor application that can run on various operating systems by utilizing the Python API. [23]. XAMPP is an open-source, cross-platform local server software package designed to simplify the process of developing web applications. XAMPP is open-source software that can be run on various operating systems and consists of a combination of several programs [24]. A web browser is software used to access and display content available on the internet, particularly web pages. A web browser is also defined as software capable of receiving and displaying various information sources from the internet identified by URLs, such as web pages, images, videos, and other types of content [25]. A browser is software that acts as a link between users and web-based information systems. By using a web browser, users can browse the internet, interact with others, obtain information, and enjoy a variety of web services and content easily and efficiently [26]. The browsers used to support the design of the lamp damage reporting application are Chrome and Microsoft Edge.

3. Result and Discussion

The Android-based street lighting (LPJU) damage reporting application was designed to simplify the submission of reports related to LPJU damage, allowing for faster processing and increasing road users' sense of safety. The reporting application was developed using the waterfall method, which consists of five stages. The results of each stage of the research, based on the waterfall method, are as follows..

3.1. Requirements analysis

The first stage in the waterfall method is the process of identifying and collecting (documenting) system requirements from stakeholders [27]. The problem identification process begins with observations and interviews with relevant parties and several community members as potential users. Based on the identified issues, solutions are sought and proposed to address them. Next, a literature review of similar research is conducted to support the development of the application as a solution to the identified issues.

The reporting application system is designed to include the necessary features to facilitate public reporting, such as filling in personal data, describing the damage, uploading photos, and submitting locations. All report data is stored in real time and can be managed through a web dashboard by the administrator. The system requirements analysis includes selecting appropriate hardware and software specifications to support

optimal application development and ensure the system runs smoothly and meets user needs. The hardware and software used are shown in Table 1.

3.2. System design

The next phase is system design. In this phase, the system architecture is designed based on technical specifications (requirements) so the resulting interface is user-friendly [28]. The design of the Android-based public street lighting (LPJU) damage reporting application includes:

3.2.1. Context diagram

A context diagram is a diagram consisting of a process that describes the scope of a system. The context diagram for the Android-based street lighting (LPJU) damage reporting system can be seen in Figure 2.



Figure 2. Context diagram

Based on Figure 2, it can be seen that there are two main entities that interact with the system, namely the public and the admin. The main process in this system is the public street light reporting application that facilitates the process of reporting and managing LPJU damage data. The reporting application works as follows: 1) The public can submit reports of street light damage through the application. After the report is submitted, the system will update the report status periodically so that the public can know the progress of the submitted report. 2) The admin is responsible for verifying incoming reports and correcting the report status according to conditions in the field. In addition, the admin also receives and forwards report data sent by the public for follow-up.

3.2.2. Use case diagram

A use-case diagram is a model of the behavior of the system to be developed. A use case diagram is used to illustrate the interactions between actors (users/the public and admin) and the system. Use cases are used to identify which functions are already present in a system and who is authorized to use the existing functions. The use case diagram for the system is shown in Figure 3.

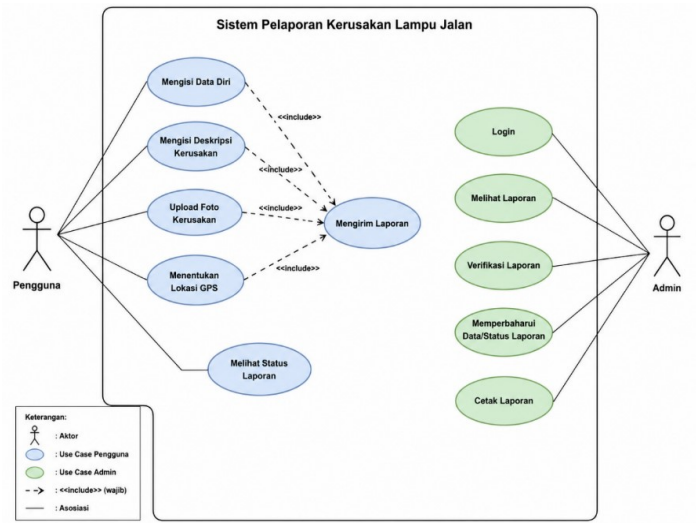


Figure 3. Context diagram

3.2.3. Activity diagram

An activity diagram is a diagram that can illustrate the procedures of an actor's activities, whether in terms of logic or business processes within an application. Figure 4 is an activity diagram for the reporting actors, which in this case are the public and the admin. The activity flow for the user actor (the public) begins with opening the application, followed by creating a report by first filling out the form. If the data is complete, the report can be submitted. The system will save the report to the database, and the application

will respond by displaying a “sent” notification. The user can then view the report status displayed on the reporter interface. As for the admin, the process begins with logging in. If successful, the application responds by displaying the dashboard so the admin can view the list of submitted damage reports. Next, the admin verifies the report and updates the data or the report status. The system will save the changes to the report status. The admin can print the report.

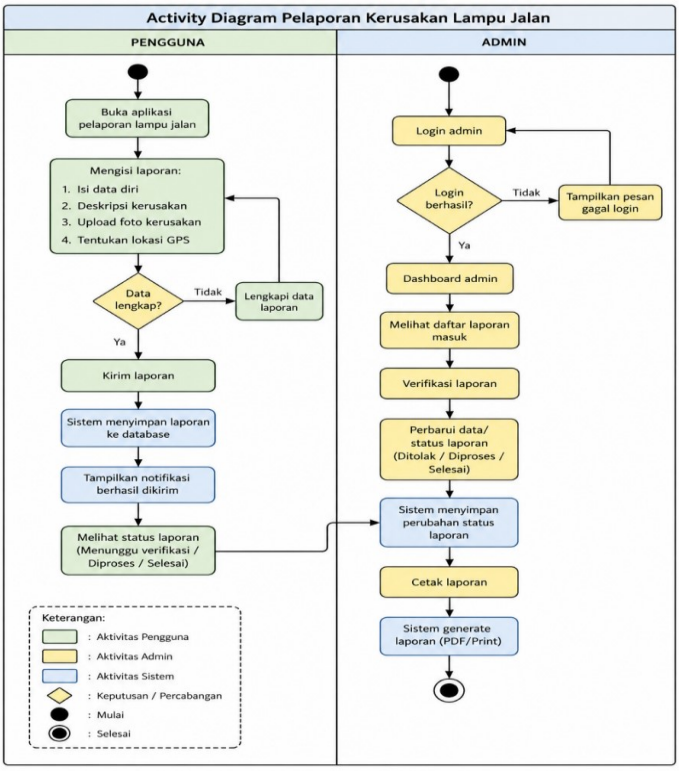


Figure 4. Use case diagram

3.2.4. Database

Database design is the process of creating a design of structure to store and organize data efficiently and effectively. Database design discusses the design of database tables. Database design includes the following: a) Design tables of a database, and b) Design tables for the names of department leaders.

3.2.5. Interface

User interface design is the process of creating the visual appearance and user interaction of a digital product, such as an application or website. Interface design includes designing a web-based admin interface and designing an Android-based user interface. The primary goal of a user interface is to present a system interface that is easy to use, efficient, and comfortable for users.

3.3. Implementation

The implementation phase is the stage for developing program code based on the created design. The implementation phase of this system focuses on applying the designed system to the appropriate programming language to ultimately achieve the desired results. The user interface of the public street lighting damage reporting (LPJU) application consists of two versions: an Android-based version for users submitting reports and a web-based version for administrators. The application interface includes information on how to use the application and how to report damage to public street lights (LPJU). The application interfaces are as follows.

3.3.1. Reporter user interface

3.3.1.1. Display of the homepage menu

This view represents the home page implemented in the application. This menu contains key features such as report submission, report history, information about us, and a button to contact the admin via WhatsApp. The main page menu is shown in Figure 5.



Figure 5. Display of the homepage menu

3.3.1.2. Display of report contents menu

This view allows users to complete and submit streetlight damage reports through the application. Report-related data entered includes: name, report creation date, mobile phone number, sub-district, village, neighborhood association (RT/RW), and a description of the type of damage reported. This menu also provides a "Pilih Foto dari Galeri" button to upload photo evidence of the damage. Once all data has been entered and photos uploaded, the damage report can be submitted by clicking the "Kirim laporan" button. This page will also display a notification that the report has been sent, as shown in Figure 6.

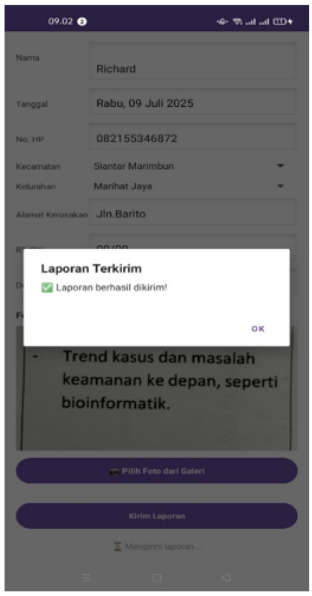


Figure 6. Display of report contents menu

3.3.1.3. Display of the sent report menu

This view displays a list of sent reports that have been successfully sent by the user to the system. Sent reports include the name of the report creator, the date the report was submitted, and the report status. The sent reports menu is shown in Figure 7.



Figure 7. Display of the sent report menu

3.3.1.4. Display of tentang kami menu

Tentang kami menu contains brief information about the street light damage reporting service administrators, including their duties, vision and mission, reporting standard operating procedures, and contact information. The About Us menu is shown in Figure 8.

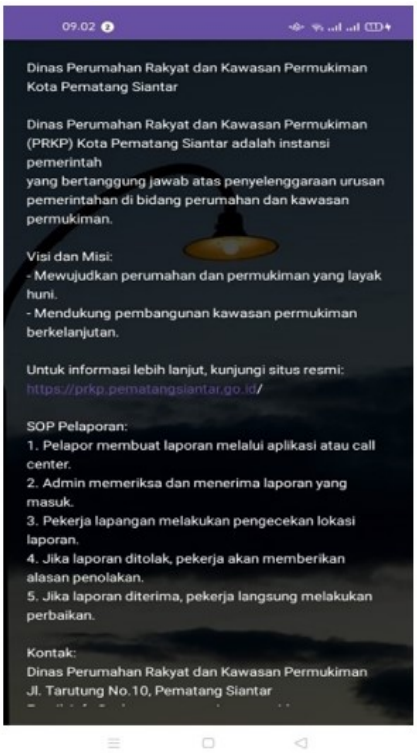


Figure 8. Display of tentang kami menu

3.3.1.5. Display of customer service menu

This view provides a button that users can use to directly connect with the admin via the WhatsApp application. The WhatsApp version of the customer service view is shown in Figure 9.



Figure 9. Display of customer service menu

3.3.2. Admin interface

3.3.2.1. Display of the login page

The login page is used by administrators to log in to the system via the web. Administrators can log in to the system by entering a valid username and password. The login page is shown in Figure 10.

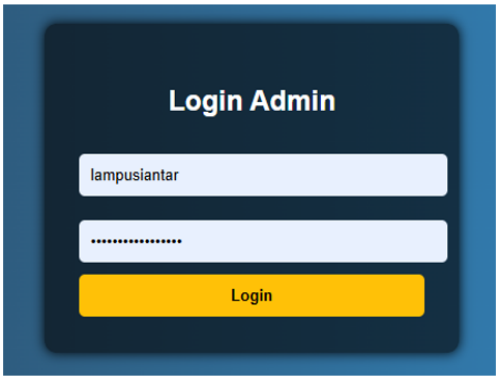


Figure 10. Display of the login page

3.3.2.2. Display of admin dashboard

This view displays a summary of report data, such as the number of reports received, processed, completed, and rejected. When first opened, the system automatically displays a list of all reports without any specific filters. On the admin dashboard, there are submenus labeled "Proses", "Selesai", and "Ditolak". The "Proses" submenu displays a list of reports with the "Proses" status, that means reports are currently being handled by the admin and not yet fully processed. The "Selesai" submenu displays reports that have been processed by the admin and are marked as completed in the system. Meanwhile, the 'Rejected' submenu displays reports with a "Ditolak" status, which means reports that the admin could not process for specific reasons. The admin dashboard view is shown in Figure 11.

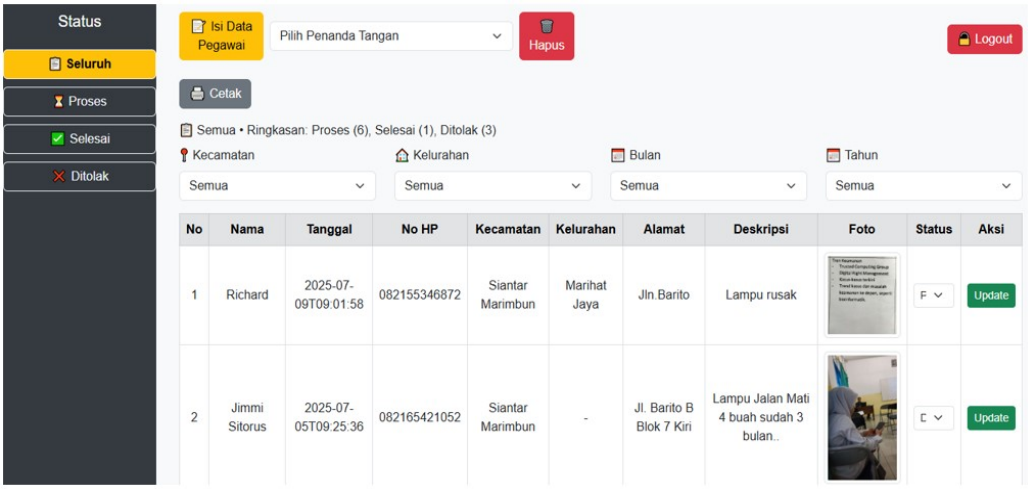


Figure 11. Display of the admin dashboard

The reporting system has several features. The first feature is GPS-based reporting. With the GPS or location integration, the public can automatically submit the location of a streetlight malfunction, allowing staff to pinpoint the exact location more accurately without having to search for it manually. This feature can be seen in the presence of latitude and longitude coordinates in the "Tanggal" data column on the report, as shown in Figure 11. The benefit of the GPS feature is that it reduces the time required for reporting or identifying the location of the damage from an average of several days to less than 5 minutes.

The second feature is the photo upload functionality, which allows users to attach visual evidence of damaged streetlights. The photos submitted help staff verify the extent of the damage and plan appropriate repairs. Based on the user testing results in Table 2, all three users stated that the feature was usable and functioned well. The photo feature helps users clearly illustrate the extent of the damage. The third feature is the report tracking feature. This feature allows users to monitor the progress of reports they have submitted. The status of a damage report can be "Proses", "Selesai," or "Ditolak." According to Table 2, all three users

stated that this feature works well. The presence of this feature serves as evidence of improved service transparency, as status information can be accessed directly through the Android-based application.

3.3.2.3. Display of the data entry menu for department heads

This page is used to enter or update your name, employee ID number, and position. This information will automatically appear in the signature section when the report is printed. Display of the data entry menu for department heads is shown in Figure 12.



Figure 12. Display of the data entry menu for department heads

3.3.2.4. Display of report print menu

The "Cetak" menu is located in the left corner of Figure 11. This menu is used by administrators to print all reports entered into the system without filtering by specific status. The results displayed when clicking the print menu are shown in Figure 13. The documents to be printed can be filtered by report status.


PEMERINTAH KOTA PEMATANGSIANTAR
DINAS PERUMAHAN DAN KAWASAN PERMUKIMAN
Jl. Tarutung No. 10, Pematangsiantar
Telp: (0622) 123456 | Email: disperkim@siantarkota.go.id

DATA LAPORAN LAMPU JALAN UMUM

Laporan Berdasarkan :

Status: Proses | Kecamatan: Semua
Kelurahan: Semua | Periode: Juli 2025

Catatan:
☐ Tim A ☐ Tim B ☐ Tim C Lainnya: _____

No	Nama	Tanggal	No HP	Kecamatan	Kelurahan	Alamat	Deskripsi	Foto	Status
1	Richard	2025-07-09T09:01:58	082155346872	Siantar Marimbun	Marihat Jaya	Jln.Barito	Lampu rusak		Proses
2	David	2025-07-05T09:20:18	085464637678	Siantar Barat	-	Methodist	tiang lampu rusak sudah 7hari		Proses

Pematangsiantar, 30 Juli 2025
Mengetahui,
Kepala Dinas

Nama Pejabat
NIP: -

Figure 13. Display of report print menu

The challenges and limitations in implementing an Android-based reporting system are as follows: 1) The Android-based reporting service relies on an internet connection; the system requires a stable internet connection so that the process of submitting reports, uploading photos of the damage, sending GPS locations, and communicating via WhatsApp can run smoothly and without issues. Residents in areas or locations with poor network quality may experience delays or even failures in sending reports. Additionally, large photo file sizes can also slow down the data upload process. Meanwhile, for administrators, a stable network connection is crucial for receiving real-time report notifications, conducting verification processes, updating the status of damage handling, and ensuring timely responses to public reports; without it, optimal public service efficiency cannot be achieved. 2) User adoption rates for the application system; not all members of the public possess sufficient digital literacy to use Android-based applications. The difficulties they face may include, for example, not knowing how to enable the GPS location feature on their smartphones.

Additionally, people use different types of Android devices, which affects their experience with the application. These conditions can reduce user interest in utilizing the reporting system.

3.4 Testing

The testing phase is the stage during which the system is tested to ensure that its performance and functionality are optimal. The testing ensures the system runs properly and the features can be used according to predetermined specifications and requirements, also free of error. System testing is conducted using the black box testing method. Testing is mandatory to avoid errors in the completed program flow. The system was tested using the black-box testing method [29]. Table 2 shows the results of system trials conducted by users (the public).

Table 2. User Testing Result by Users

Number	User's Name	Homepage Menu	Report Contents Menu	Sent Report Menu	Tentang Kami Menu	Customer Service Menu	Interface Display
1	User 1	√	√	√	√	√	Interesting
2	User 2	√	√	√	√	√	Interesting
3	User 3	√	√	√	√	√	Interesting

System testing for administrative staff was conducted to minimize problems or errors, ensuring that the system functions properly and efficiently and enabling administrators to process data efficiently. Table 3 shows the results of the system testing conducted by the administrator.

Table 3. User Testing Result by Administrator

Number	Feature	Feature Access		Interface Display
		Accessible	Unavailable	
1	Login page	√	-	Interesting
2	Admin dashboard	√	-	Interesting
3	Data entry menu for department heads	√	-	Interesting
4	Report print menu	√	-	Interesting

Based on blackbox testing results on the application system, conducted by both admin staff and users, it was found that the existing features functioned as expected. The application successfully addressed existing issues. Users found it easy to report streetlight damage online on their Android devices. The department also found the application's interface attractive and user-friendly.

3.5 Maintenance

The maintenance stage is the final stage where the system that has been completed is evaluated and system maintenance is carried out, which includes bug fixes, adjustments based on user feedback, and development of additional features if necessary [30]. Maintenance includes checking for system errors and minor improvements, such as bug fixes and extending the lifespan of the system (application). Maintenance is performed routinely to ensure the system remains optimal and responsive to user needs [31].

4. Conclusion

Based on the research results, it can be concluded: 1) The Public Street Lighting (LPJU) damage reporting application is equipped with features for filling in reporter data, damage descriptions, taking or uploading photos, and damage locations. 2) This app makes it easier for local governments to receive information about infrastructure damage quickly and accurately. It also helps local governments monitor conditions, manage report data, and prioritize road repairs based on the severity of damage reported by the public. 3) This app improves the efficiency of public services by enabling digital reporting without the need to visit government offices in person. The system also minimizes the use of manual or physical documents and provides digital storage, thereby speeding up the retrieval of report data and administrative processes. 4) This app helps improve the government's response and enables officials to conduct verification and take corrective actions more quickly and effectively. 5) This application has significant scalability potential because it can be implemented in various other cities or districts and expanded to meet the needs of local governments without having to build a new system from scratch. This reporting application also has the potential to be developed into an integrated public service reporting system. Some suggestions that could be considered as recommendations for further research include: 1) Additions such as real-time report status tracking, integration with the LPJU database, and dashboards for technicians and admins. 2) Conducting socialization and training sessions to support the implementation of this application in the field. 3) Add

automatic notification features for field staff and a public satisfaction rating feature to the reporting app. 4) Integrate the reporting app with the smart city system.

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