A Secure Geotagging Authentication Mechanism Using EXIF Metadata for Digital Public Works Complaint Platforms

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***Abstrak*— Sistem pengaduan publik di lembaga pemerintah daerah sering menghadapi tantangan seperti laporan yang tidak valid, proses verifikasi manual yang lambat, dan ketiadaan integrasi lokasi pelapor. Untuk mengatasi masalah tersebut, studi ini mengembangkan sistem informasi pengaduan publik berbasis web untuk Kantor PUPR Kota Baubau dengan menerapkan mekanisme validasi otomatis menggunakan metadata EXIF yang tertanam dalam foto pengaduan. Sistem ini dikembangkan menggunakan pendekatan Waterfall yang memungkinkan proses perancangan berjalan terstruktur dan terdokumentasi dengan baik. Fitur utamanya mencakup validasi otomatis lokasi dan waktu pengambilan foto, penolakan laporan tidak valid, deteksi format dan ukuran file, serta antarmuka responsif tanpa kebutuhan login. Setiap pengaduan yang berhasil dikirimkan juga akan otomatis masuk ke email petugas terkait untuk mempercepat tindak lanjut. Hasil pengujian fungsional menggunakan metode black box menunjukkan seluruh fitur berjalan sesuai spesifikasi, sementara uji beta menghasilkan skor rata-rata 3,43 dan indeks kepuasan sebesar 85,75% yang tergolong Sangat Baik. Temuan ini menunjukkan bahwa sistem mampu menyaring laporan tidak relevan, mempercepat verifikasi, meningkatkan keakuratan data, serta mendukung akses publik melalui perangkat seluler dan desktop.**

***Kata Kunci* — EXIF Metadata; Geotagging; GIS; Validasi Lokasi Otomatis; Pengaduan Masyarakat; Sistem Berbasis Web**

***Abstract*— Public complaint systems in local government agencies often face challenges such as invalid reports, slow manual verification processes, and lack of integration of the complainant's location. To address these issues, this study developed a web-based public complaint information system for the Baubau PUPR Office by implementing an automated validation mechanism using EXIF metadata embedded in complaint photos. The system was developed using a Waterfall approach that allows the design process to be structured and well-documented. Key features include automatic validation of photo capture location and time, rejection of invalid reports, file format and size detection, and a responsive interface with no login required. Each successfully submitted complaint will also be automatically emailed to the relevant officer to speed up follow-up. The results of functional testing using the black box method show that all features run according to specifications, while the beta test resulted in an average score of 3.43 and a satisfaction index of 85.75% which is classified as Very Good. These findings show that the system is able to filter out irrelevant reports, speed up verification, improve data accuracy, and support public access via mobile devices and desktops.**

***Keywords* — EXIF Metadata; Geotagging; GIS; Automatic Location Validation; Public Complaint; Web-based System**

I. INTRODUCTION

The rapid advancement of information technology (IT) has made the utilization of IT-based media a necessity that cannot be ignored [1]. In the digital era, the development of information technology has transformed the government sector, demanding efficient and transparent public services [2]. The implementation of e-Government is proven to be able to accelerate services and increase community participation through a more structured digital system [3]. In this context, the utilization of website--based information systems is crucial because they are able to store, convey, and disseminate information widely, quickly, and accurately [4]. A well-designed website can present services that are easily accessible and encourage active community participation in the public service process [5]. Research by [6] shows that websites play a vital role in supporting the work of regional authorities and providing access to services for the community.However, in reality, there are still many local government agencies that have not fully adopted digital systems optimally, including the Public Works and Spatial Planning (PUPR) Office of Baubau City.

Until now, the PUPR Office of Baubau City still uses conventional methods in delivering information and managing public complaints. Information such as announcements, news, and licensing services are generally delivered through non-centralized and unstructured notice boards or social media. This causes access to information to be slow, inaccurate, and unaccountable. In addition, the public complaint process is also still carried out manually without location validation, which often makes it difficult to verify reports and slows down the handling of complaints. Problems arose not only from system limitations, but also from user behavior. Many reports are sent from outside the administrative area of Baubau City, use irrelevant or outdated photos, and do not include verifiable location information. In addition, fictitious or prank reports are also often submitted, such as empty reports, duplicates, or images that are not related to infrastructure issues. Without an automated filtering mechanism, these reports continue to enter the system and add to the verifiers' workload. One potential solution to overcome this problem is the implementation of EXIF (Exchangeable Image File Format) metadata-based geotagging, which allows the automatic insertion of geographic information into digital photo files uploaded by users [7].

EXIF geotagging technology works by utilizing the GPS feature on the user's device to embed the location coordinates as well as the time the image was taken automatically [8]. This information can then be extracted by the system and compared with the geographical boundaries of the administrative area where the agency is located, in this case Baubau City [9]. By doing so, the system can automatically reject reports originating from outside the region or from old photos, as well as provide notifications to users. The implementation of this system is essential to improve the efficiency of complaint management and prevent the inclusion of invalid or false reports. In a study by [7], a kite reporting system using Google Maps and geotagging was shown to increase the speed of location tracking in real time. Similarly, a study by [9] which shows that this method successfully verifies road damage reports effectively and accurately. This condition emphasizes the importance of implementing a system that is not only web-based, but also capable of automatically validating incoming reports. By utilizing EXIF metadata, the system can immediately filter out invalid reports based on the location and time the photos were taken, so that fictitious or irrelevant reports can be rejected from the start. This will improve work efficiency, reduce reliance on manual verification, and speed up follow-up on complaints that truly require attention.

In addition, similar systems have also been implemented in various previous studies. The integration of location validation is crucial to ensure that incoming complaints truly originate from within the agency’s area of responsibility, allowing follow-up actions to be more accurate, measurable, and well-targeted. Research by [10] designed a website-based official travel information system that accelerates the submission and reporting of activities through the Waterfall approach. Research by [11] proved that the internship administration information system developed with a similar approach was able to reduce the risk of data loss and improve process accuracy. Research by [12] also applied image geotagging in the PDAM e-reporting system that helps technicians respond to customer reports faster. Research by [13] confirms the importance of digitizing public complaints through mobile applications. Furthermore, research by [14] integrated geotagging and geofencing to verify the location of reports with an accuracy of 96%, proving the effectiveness of this approach for spatial data validation in public services.

From these studies, it can be concluded that the integration of geotagging technology into public information systems has great potential in improving efficiency, accuracy, and transparency of services. However, there are not many studies that specifically develop web-based information systems with automatic location validation through EXIF metadata implemented in regional agencies such as the PUPR Office of Baubau City. The data integration approach in the SIMPELMAS system by [15], demonstrates the importance of accuracy and transparency in academic reporting. Web-based information systems should be able to support automated and real-time data processing to adapt to institutional reporting needs [16]. In certain contexts, such as reporting field activities or public complaints, the use of EXIF metadata (geotagging) as a location verification method can be a strategic complement to ensure the validity of the data collected. This highlights an urgent need for systems that are not only capable of collecting complaints online, but also equipped with intelligent mechanisms to validate the authenticity of reports automatically. In the context of local government, where human resources and verification capacity are often limited, automated rejection of invalid, outdated, or fictitious reports can significantly improve service efficiency and ensure that real issues receive faster

attention. Without such innovation, public complaint systems risk being flooded with unverified data, slowing down resolution processes and eroding public trust..Therefore, this research will design a web-based public service information system that integrates the EXIF geotagging feature to automatically verify the location of complaint reports. This system not only improves the accuracy of report verification, but also accelerates the complaint follow-up process and facilitates centralized information dissemination.

The approach in this research focuses on implementing an automatic location validation mechanism designed to reject invalid reports autonomously, relying on the geographic coordinate data and image capture time listed in the EXIF metadata. The system automatically verifies that the location of the report matches the administrative boundary of Baubau City, as well as ensuring that the photos used in the complaint were taken within the maximum time span of the past week. This technology integration results in increased efficiency and accuracy in the management of community reports, while reducing dependence on manual verification processes by admins. Based on the problems that have been identified and supported by findings from various previous studies, the hypothesis in this study states that the implementation of an EXIF metadata-based location authentication mechanism in a web-based complaint information system can improve location validation accuracy, speed up the verification process, and support the efficiency of public services at the PUPR Office of Baubau City.

II. RESEARCH METHOD

The information system development model used in this research is Waterfall, which is a structured and systematic approach in which each stage is carried out sequentially [17]. This model fits the project well, as the system's objectives, including automatic validation of complaint photos using EXIF metadata and integration with administrative boundaries, were clearly defined from the start. With minimal need for iteration, the linear approach supported organized planning, proper documentation, and systematic implementation. These elements are crucial for ensuring the complaint system delivers accurate and consistent location and time verification. The development stages are shown in Figure 1.

The stages begin with a Needs Analysis, which is a process to identify information, system features, and problems that occur in the manual complaint reporting process at the PUPR Office. Needs are collected through interviews with the agency and literature studies related to EXIF geotagging technology. This analysis includes functional needs such as online complaint forms and automatic validation of photo location and time, a

s well as non-functional needs such as security, ease of use, and system speed. In this study, data collection was conducted through three methods: interviews with PUPR staff to understand the current complaint process and user needs; literature review to identify relevant technologies and best practices related to EXIF-based validation; and questionnaires distributed during beta testing to evaluate system usability, effectiveness of location and time validation, and user satisfaction. The second stage is System and Software Design, which includes system flow, database structure, and user interface design that is friendly to both the public and the admin. The design uses the UML approach to describe the process and interaction between components, including with users [18] . At this stage, an automatic verification system based on EXIF metadata was also created, which matches the location and time of taking photos with the Baubau City boundaries and a maximum time span of 7 days. If it does not match, the report is automatically rejected without admin intervention.

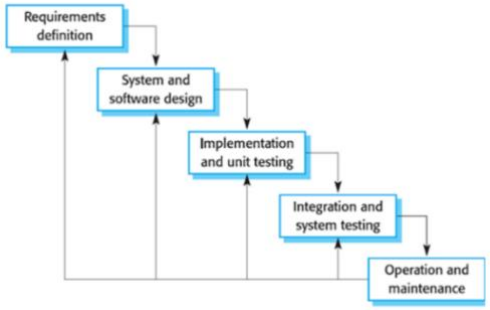

Figure 1. Waterfall Method

In addition, Geographic Information System (GIS) technology is also integrated at this stage to enable spatial visualization of complaints on a digital map. This integration helps the admin monitor complaint distributions, detect concentration areas, and improve service responsiveness through location-based analysis [19]. In addition, the system is also equipped with automatic email notifications that are sent to the agency every time a complaint is successfully sent, as a form of real-time notification to accelerate follow-up.

The system implementation stage is the process of applying the design to the creation of program applications, which generally includes the application of program inputs, processes, and outputs [20]. This stage also includes implementation and unit testing, where the system begins to be developed using appropriate programming languages and tools. The photo upload feature, EXIF metadata extraction, and validation process were built based on the previously developed design. The system was implemented using PHP on a XAMPP environment, with HTML, CSS, and JavaScript for the interface. Location verification is performed by extracting EXIF metadata using the exif-js library, which is then compared with the geographic boundaries and photo time to ensure the validity of complaint reports.

The fourth stage is system integration and testing, where the individual units of the program are combined and tested as a complete system to ensure compliance with software requirements [21]. Testing is carried out thoroughly on the complaint form component, admin dashboard, and notification feature, to ensure that there are no logic errors in the EXIF data verification process or report management. After testing is complete and the system is confirmed to run according to the needs, the software can be prepared for delivery to end users.

The fifth stage is operation and maintenance, which is after the system is tested and declared feasible, the website is submitted to the PUPR Office of Baubau City to be operated. At this stage, monitoring of system performance is carried out as well as periodic software maintenance [22]. Improvements to will be made if bugs are found, and additional changes or developments can be made if there are further requests from the agency or if there are aspects that still need to be refined.

III. RESULTS AND DISCUSSION

Results

This section presents the implementation results of a public complaint system specifically developed for the Public Works and Spatial Planning (PUPR) Office of Baubau City. The system focuses on a website-based reporting mechanism equipped with automatic location and time validation using EXIF metadata. The system aims to facilitate digital infrastructure damage reporting and ensure that submitted complaints originate from the Baubau administrative region.

System Analysis

In information systems that include complaint features, the needs analysis is visualized using UML (Unified Modeling Language) diagrams, which are modeling standards for visually describing system designs. Some of the diagrams used include: Use Case Diagram to show the interaction between actors and the system, Activity Diagram to describe the flow of activities in the complaint process, Sequence Diagram to explain the sequence of messages between objects in the system, and Class Diagram that models the data structure and relationships between classes in the system.

1) Use Case Diagram

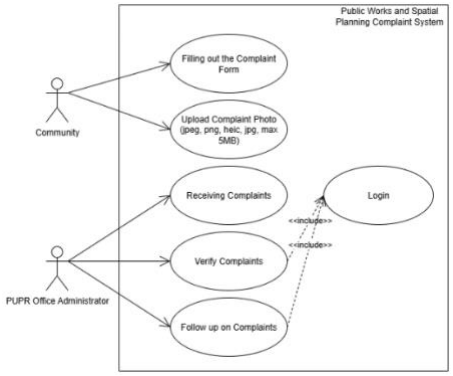

Figure 2. Use Case Diagram

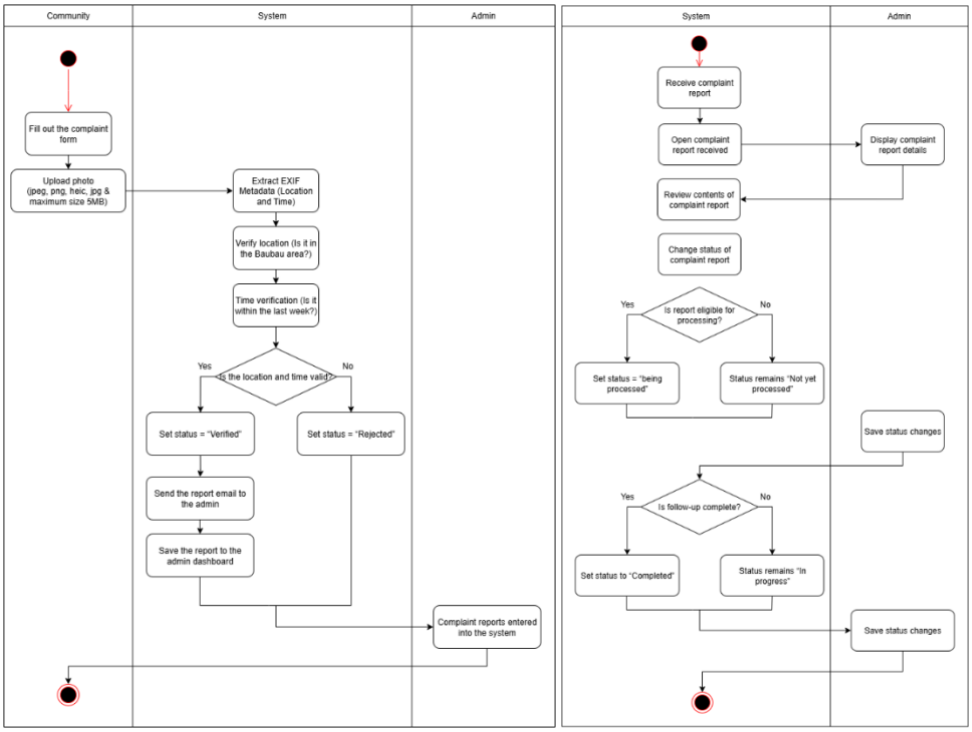

Figure 3. (a) Society Activity Diagram, (b) Admin Activity Diagram

In Figure 2. illustrates the flow of reporting infrastructure complaints by the community directly without logging in. The public can fill out the form and upload a photo of the complaint which will be validated automatically through EXIF metadata. The incoming report will be received by the PUPR Office admin, then further verified if necessary, and followed up according to the complaint category. This diagram represents a simple yet effective process to ensure that incoming complaints are valid and come from the appropriate area.

Activity Diagram

In Figure 3, the activity diagram shows the flow of reporting and handling complaints. Figure 3a shows the process of automatic validation of EXIF metadata by the system to ensure photos are taken in the Baubau area and within one week. Valid reports will be forwarded to the admin, while invalid ones are automatically rejected. Figure 3b illustrates the admin's process of reviewing and updating the report status to "Not in Process", "In Process", or "Completed", with the system saving each change.

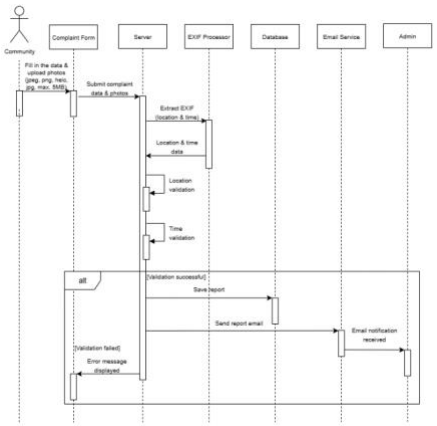

Figure 4. Sequence Diagram

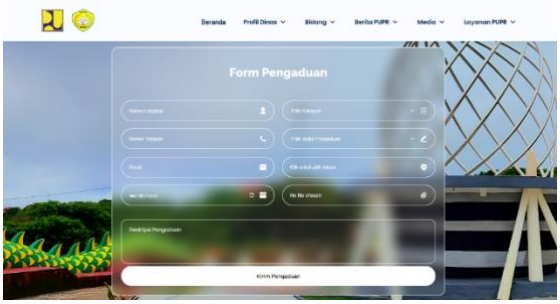

Figure 5. Complaint Form

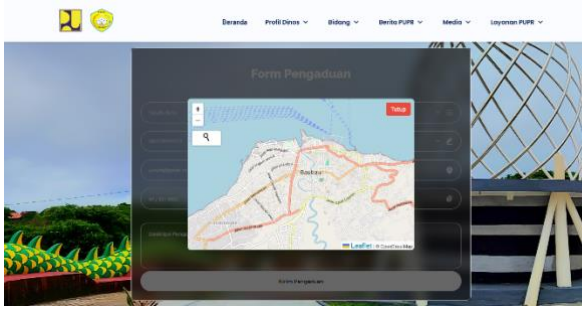

Figure 6. GIS Map View on Complaint Form

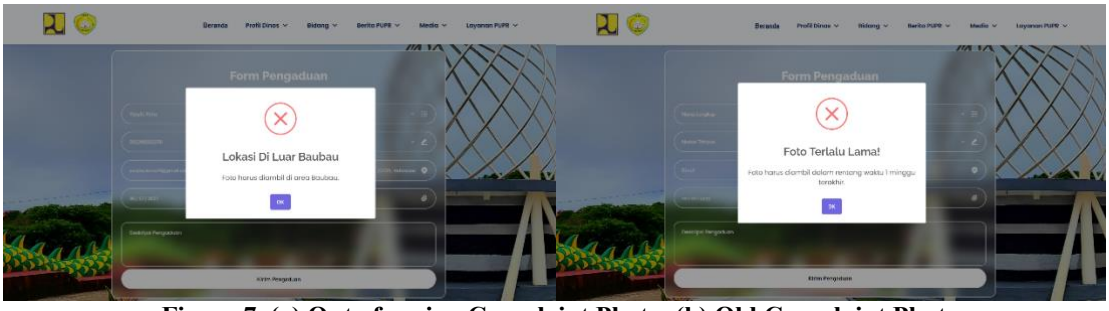

Figure 7. (a) Out of region Complaint Photo, (b) Old Complaint Photo

Sequence Diagram

In Figure 4. illustrates the process of sending reports by the community, starting from filling out the form and uploading photos to verifying EXIF metadata by the system. After the data is sent, the system extracts the location and time of the photo, then validates whether it matches the region and time span of one week. If the validation is successful, the report is saved to the database and a notification is sent to the admin; if it fails, an error message is displayed. This diagram shows the systematic coordination between the frontend and backend in metadata-based automatic verification.

Interface Features

This complaint system is designed with an interface approach that is simple, clean, and easy to use by all people. The page design is made responsive, so it can be accessed both through desktop and mobile devices. The main focus of the user interface is the ease of filling out reports and the clarity of the information displayed. Here are some views of the complaint features in the system:

1) Complaint Form Page: This page is the starting point for the community in submitting complaints. Users only need to fill in some simple data such as the name of the complainant, type of damage, brief description, and upload photos as field evidence. Uploaded photos will be used for location validation through EXIF metadata automatically. The system will display a notification if the uploaded photo does not contain coordinate information or was taken outside the Baubau area.
2) Interactive Map Integration (GIS-based): This feature allows users to visually select or confirm the location of the complaint using an interactive map powered by Leaflet and OpenStreetMap. The map is overlaid with administrative boundaries of Baubau City to help users accurately report the affected area. This GIS integration complements EXIF-based validation and provides an additional spatial reference to ensure that the complaint is indeed located within the city's jurisdiction.

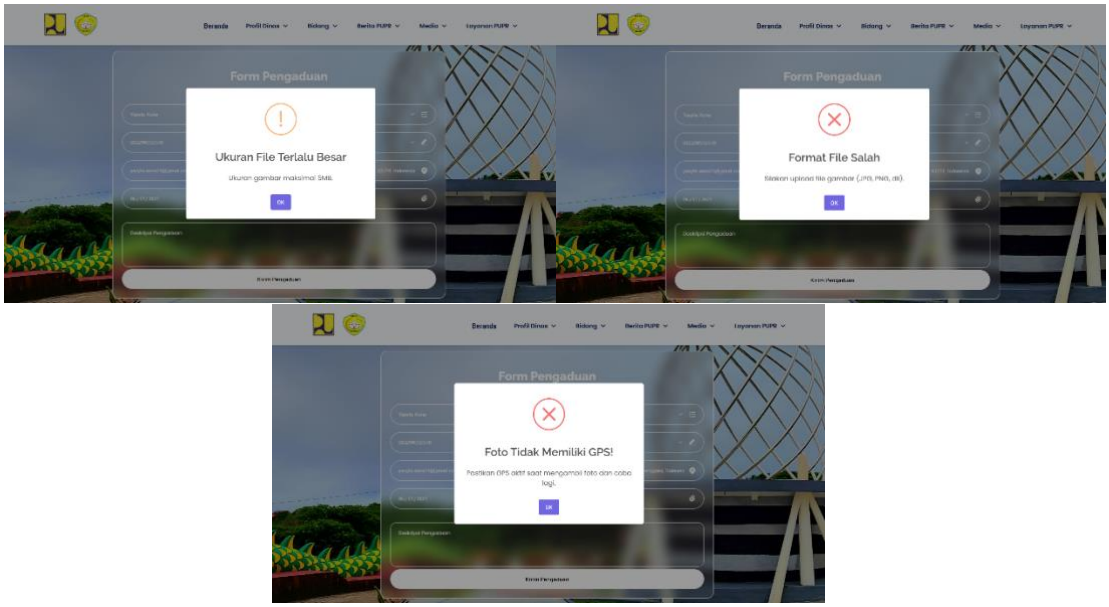

Figure 8. (a) Photo Size Too Large, (b) Incorrect File Format, (c) Complaint Photo Does Not Have GPS

3) Validation of Complaint Location and Time: One of the main features of the system is the automatic validation process of location based on the EXIF metadata of the uploaded photos. When a user submits a report, the system automatically extracts latitude and longitude information from the photo metadata. This location is then compared with the predefined administrative boundaries of Baubau City. Figure 7a is a view if the location is outside the defined area, then the report will be marked as invalid and not forwarded to the admin. Figure 7b is a view if the photo of the complaint is in the Baubau area and the photo was taken within 7 days.
4) Validation of Complaint Evidence Format and Completeness : The system is equipped with an automatic validation feature for the format and completeness of the uploaded proof of complaint file. This validation aims to ensure that the file meets the technical requirements before further processing. Figure 8a shows the condition when the uploaded file exceeds the maximum size limit of 5MB, so the system provides a rejection notification. Figure 8b shows the display when the file sent is not an image, such as a PDF or video, which causes the system to reject the report because the format is not suitable. Meanwhile, Figure 7c shows a warning when the photo does not contain GPS metadata, so the system cannot perform the location validation process automatically.
5) Complaint Confirmation Page: After the validation process is successful, the user will be directed to the complaint confirmation page which displays a summary of the report data that has been sent shown in Figure 9. This page serves to provide assurance that the report has been received by the system and awaits review from the admin. In addition to the confirmation display, the system also automatically sends an email notification to the official address of the agency that has been determined as a notification of a new complaint.

Alpha Testing

The black box testing method is a software testing method that focuses on meeting the functional requirements of the system without looking at the internal structure or program code. This method allows software engineers and testers to define a set of input conditions based on functional specifications, then test whether the system provides the appropriate output [23]. Testing is done only through the system interface, so attention is focused on the interaction of inputs and outputs, not on the way the system works inside. Black box testing, also known as behavioral testing, specification-based testing, or input/output testing, aims to ensure that the software functions properly according to user requirements [24]. This method also includes testing the software in terms of functional specifications without testing the design and program code to find out whether the functions, inputs, and outputs of the software match the required specifications. In practice, this test can involve random data input to obtain certain results, and if the results are not as expected, then the system is declared to contain errors [25]. In addition, this

method is suitable for use by beginners because it does not require mastery of certain programming languages [26]. Table 1 shows the results of black box testing carried out on the system's validation functions. All test scenarios, including location validation, time limitation, file size, and format checking, yielded the expected outputs. The system consistently rejected reports that failed to meet defined technical criteria, and accepted valid reports accordingly.

Beta Testing

Beta testing is an evaluation stage carried out directly by end users in the actual operational environment to ensure aspects of usability, functionality, compatibility, and identify technical obstacles that may still arise when the system is used [27]. In this study, testing was carried out using a questionnaire instrument as a data collection technique, where respondents answered a number of written questions. Each answer is scored using a 4-point Likert scale, namely Less, Fair, Good, and Very Good, without providing a neutral option, thus encouraging respondents to provide a more assertive assessment of the quality of the system being tested. To analyze the data from the questionnaire, the Weigh Means Score (WMS) formula is used as follows :

$$M = \frac{\sum F(X)}{n} \qquad (1)$$

Description :

F is the frequency or number of respondents who choose a scale category, X is the weight of each Likert scale option (Less = 1, Fair = 2, Good = 3, Very Good = 4), n is the total number of respondents, and M is the average value or Assessment Score (AP) obtained from the division of the total value of F multiplied by X by the number of respondents.

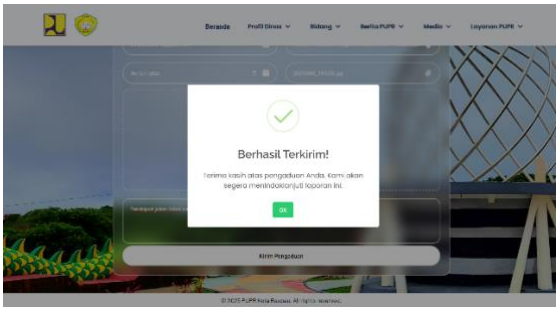

Figure 9. Complaint Sent

Table 1. *Black Box Testing*

No	Test Scenario	Test Input	Expected Output	Result	Description
1	Upload photos with location metadata in Baubau City area	Photo with EXIF: Latitude -5.4697, Longitude 122.6165	Location validation successful, photo uploaded on form	Success	As expected
2	Upload photo with location metadata outside Baubau area	Photo with EXIF: Latitude -5.4697, Longitude 122.6165	Validation failed: "Location outside Baubau"	Success	System rejects the report
3	Upload photo without location metadata	Photo without EXIF data	Validation failed: "Photo has no GPS""	Success	Reject and re-instruct
4	Upload photo with valid location metadata but date more than 7 days ago	Photo with valid location, timestamp 7 days ago	Validation failed: "Photo not too old"	Success	System rejects because it does not meet the time requirement
5	Upload a photo that exceeds the maximum size limit (5MB)	7MB image	Validation failed: "File size too large"	Success	The system rejects files that are too large
6	Upload non-image files	.pdf/.mp4 file	Validation failed: "Incorrect file format"	Success	System rejects non-image files

7	Upload photo with valid location and timestamp metadata	Photo with valid location, today's timestamp	Validation successful, report can continue: "Sent Successfully"	Success	All validation conditions fulfilled
8	Click a location outside Baubau region using the map	Click coordinates on map latitude 5.62, longitude 122.60	Validation failed: "Location outside Baubau region	Success	System rejects manual location outside the region

Table 2. ***Beta Testing***

No	Question	L	F	G	VG	AP	Criteria
1	Is the appearance of this website attractive and easy to understand when used to report complaints?	0	0	15	12	3,44	Very Good
2	Does the location and time validation feature in this system match the needs in handling public complaints?	0	0	15	12	3,44	Very Good
3	Do you find validation of time and location through EXIF metadata helpful in improving the accuracy of complaint reports?	0	0	14	13	3,48	Very Good
4	Does the system successfully validate that the complaint photo was taken in the Baubau City area?	0	0	15	12	3,44	Very Good
5	Can the system automatically detect and reject complaint photos taken more than 7 days ago?	0	0	15	12	3,44	Very Good
6	Do you find the process of uploading photos to quite easy and not confusing?	0	1	14	12	3,40	Very Good
7	Are the results of this validation system considered accurate enough and trustworthy by you as a user or manager?	0	1	14	12	3,40	Very Good
					Avarage	3,43	Very Good
					Index	85,75	Very Good

Table 2 presents the results of user-based beta testing using a Likert-scale questionnaire. The system received consistently high ratings across all seven evaluation indicators. The calculated average index was 3.43, equivalent to 85.75%, placing the system in the 'Very Good' category for all evaluation indicators.

Discussion

The findings from both alpha and beta testing confirm that the objectives of this study have been successfully achieved. The implementation of EXIF-based location and time validation proved effective in filtering relevant and verifiable complaints, ensuring that submitted reports are accurate and reducing the entry of fraudulent or outdated data. System functionality was validated through black box testing, which demonstrated robustness in various scenarios.

User evaluations through beta testing revealed a high satisfaction index of 85.75%, indicating that the system's usability and validation features align with public expectations and the operational needs of the PUPR Office of Baubau City. This reflects the system's ability to address user needs while maintaining technical reliability.

In practical terms, the system streamlines complaint-handling workflows by minimizing manual verification, allowing the PUPR team to focus on credible complaints. The integration of an email notification feature ensures valid reports are directly sent to the agency's inbox for faster response. This improves efficiency, accountability, and transparency, while also offering the potential for replication in other government sectors that require spatial and temporal data validation.

IV. CONCLUSION

This research successfully addressed the problem of unverified and potentially invalid complaint reports by implementing a web-based public complaint information system equipped with automatic

location and time validation using EXIF metadata. The use of the Waterfall model enabled the system to be developed in a structured and sequential manner, while the combination of qualitative (interviews and literature review) and quantitative (black box testing and user questionnaires) methods ensured that both technical accuracy and user experience were thoroughly evaluated.

Alpha testing confirmed that key features including location and time validation, file format checking, automatic rejection of invalid reports, and email notifications to the agency functioned according to design. Beta testing showed high user satisfaction, with an average AP score of 3.43 (85.75%), placing the system in the "Very Good" category and demonstrating that it is effective, user-accepted, and supports better complaint management.

For future development, the system can be improved by adding a real-time complaint tracking feature that allows users to monitor the progress of their submitted reports. Expanding access through a dedicated mobile application is also recommended to make the system more practical and user-friendly in various field conditions. Additionally, reinforcing the system's data security aspects will help maintain reliability and user trust in the long term.

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