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Design and Implementation of A Web-Based and or Code-Based Fire Extinguisher Management Information System: A Case Study at PT Botto Global Mandiri

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Abstract
PT Botto Global Mandiri is a company engaged in fire safety systems with a focus on procurement, inspection, and management of Light Fire Extinguishers (APAR). The management of customer data, fire extinguishing data, and refill data that is still done manually using paper forms causes data inaccuracies, service delays, and difficulties in tracking fire extinguishing history. This research aims to analyze the conditions of fire extinguisher data management, design and build a web-based information system with QR Code integration, and implement and evaluate the system in improving fire extinguisher documentation. The research uses an applied research approach with the Waterfall development method which includes needs analysis, system design, implementation, and testing. Data collection was carried out through observation, interviews, and literature studies. The system is built using the PHP programming language and MySQL database and includes three interintegrated user modules, namely Admin, Customer, and Technician. The results of the study show that the system successfully integrates customer data management, generates a unique QR Code for each fire extinguisher unit, scheduling inspections, filling out digital inspection forms through QR Code scanning, report verification, and reporting to management in real-time. Testing with the Black Box Testing method shows that all features are valid according to the specifications of the needs. Thus, the application of web technology and QR Codes has been proven to increase data accuracy, inspection process efficiency, and ease of tracking fire extinguishing history at PT Botto Global Mandiri.

INTRODUCTION

The Government of Indonesia has established regulations, such as the Regulation of the Minister of Manpower No. 04 of 1980 which requires the provision and maintenance of Light Fire Extinguishers (APAR) in the workplace to ensure safety according to the potential fire hazard. Compliance with this regulation requires effective management of fire extinguishers, where the development of information technology is the main pillar in improving the efficiency of business operations, including in the inspection and maintenance of fire extinguishers (Ekunke et al., 2024; Loboichenko et al., 2025; Negi et al., 2024; Xu et al., 2024). According to Sofian et al. (2023), an efficient fire extinguisher inspection system can overcome data inaccuracies and poor document management on manual methods, which is essential to maintain customer trust, support customer retention, and increase company profitability according to the standards of the Occupational Safety and Health Management System

(SMK3). In Indonesia, especially in Bekasi Regency, the fire extinguisher business is growing rapidly, as reflected by companies such as PT Mutiara Safetyndo (IndoNetwork, 2026) and PT Tulip Tonata Indonesia (PT Tulip Tonata Indonesia, 2026) that not only supply fire extinguisher tubes and refill services, but also expand their portfolio to integrated safety equipment for industry, offices, and construction projects.

PT Botto Global Mandiri (BGM) is a company engaged in the field of *General Supplier & Contractor* with a main focus on *Fire Safety System* services, located in Bekasi Regency, with a focus on the procurement of *dry chemical powder*, CO2, and *foam* fire extinguishers, as well as the installation and maintenance of fire protection installations. However, amid fierce competition and pressure to improve service quality, such as precision inspections and responsiveness to customers, companies need to optimize operations to maintain customer confidence and capitalize on turnover growth opportunities in a dynamic market.

Based on observations while working at PT Botto Global Mandiri, it was found that the company's business faced challenges that indicated unhealthy conditions (Chang, 2024; Syah et al., 2026). With a monthly turnover of IDR 50 million, the company recorded sales of around 20 new fire extinguishing tubes and 200 *refill* services per month from 80 active customers (Katko et al., 2025; Kebut, 2024). However, every month two customers leave due to slow service response, while only four new customers join, indicating low customer retention and acquisition. This condition is mainly due to suboptimal operational management, including lack of coordination in fire extinguishing inspections and inability to meet customer expectations for fast and accurate service.

Referring to the theory that data management efficiency is the key to improving fire extinguishing business operations (Sofian et al., 2023) and field findings that show unhealthy business conditions due to operational inefficiencies, the analysis shows that the company's main weakness lies in its weak documentation management system. The management of customer data, refill data, fire extinguishing data, and checking data is not well organized, leading to information inaccuracies, service delays, and loss of customer trust. To overcome this weakness, this study proposes the application of QR Code technology in the fire extinguisher checking process, as supported by the research of Hasibuan & Winarno (2024), which shows that QR Code can improve the accuracy and efficiency of data management. This approach is expected to improve the documentation system, support service responsiveness, and increase PT Botto Global Mandiri's competitiveness in the competitive West Java market.

The novelty of this research lies in the integration of web-based technology with QR Code technology in a single platform that serves three user roles (Admin, Customer, and Technician) with interintegrated features for customer data management, unique QR Code generation for each fire extinguisher unit, inspection scheduling, digital inspection forms through QR Code scanning, report verification, and real-time management reporting. Unlike Android-based solutions (Hasibuan & Winarno, 2024; Pane & Putra, 2023), this study opted for a more accessible web-based approach without additional app installation, making it easier to adopt and maintain. The application of the Waterfall method also provides empirical evidence of its effectiveness in management information system development projects with clearly defined needs (Bayu et al., 2024; Marques et al., 2023; Mokhtar & Khayyat, 2022; Rahman et al., 2024; Zwart, n.d.).

From this background, the formulation of this research problem is: (1) What are the conditions of customer data management, fire extinguishing data, and refill data currently

running at PT Botto Global Mandiri and the factors that cause data inaccuracy? (2) How to design and develop a web-based information system with QR *Code integration* to improve the efficiency of the data collection, checking, and monitoring process of fire extinguishers? (3) How is the application of web-based information systems and QR *Codes* in improving the documentation system and making it easier to track the history of fire extinguishers?

The purpose of this study is to analyze the management conditions of customer data, fire extinguishing data, and rechargeable data and identify the causes of data inaccuracies; design and build a web-based information system with QR *Code integration* to improve the efficiency of the data collection, checking, and monitoring process of fire extinguishers; and implement and evaluate web-based information systems and QR *Codes* in improving documentation and making it easier to track the history of fire extinguishers.

METHOD

Overview

This research was an applied research that aims to design and build a new information system as a solution to the problem of managing fire extinguishing data. The approach used is software engineering, where systems are developed to support operational processes to run more effectively and structured. The research is focused on developing a system that is able to help the process of data collection, monitoring, and computerized management of fire extinguisher information.

Objects of Research

The object of the research is PT Botto Global Mandiri, a company engaged in *fire safety system services*, especially procurement, inspection, and management services for fire extinguishers. The selection of this company is based on the need for an information system that is able to support the management of fire extinguisher data in a more effective and integrated manner, because the manual data management process has the potential to cause information delays and suboptimal monitoring of fire extinguisher conditions.

Data Collection Methods

Data collection was carried out directly at the research site through three methods. *Observation* was carried out by directly observing the data collection process and checking the fire extinguisher which is still manual. *Interviews* were conducted with admins and technicians to obtain information about obstacles, system needs, and user expectations. *Literature studies* are carried out by studying books, scientific journals, and other written sources related to information systems, fire extinguishing management, the use of QR Codes, and *Waterfall development methods*.

System Development Method (Waterfall)

The system development method used is the Waterfall method, which is a software development model that is carried out systematically and sequentially, where each stage must be completed before proceeding to the next stage (Sommerville, 2016).

- *System Needs Analysis*, to identify problems and system needs through observation, interviews, and documentation studies on the manual fire extinguisher inspection recording process.
- *System Design*, by designing system flows, data structures, and user interfaces in the form of *flowcharts*, *use case diagrams*, *activity* diagrams, ERDs, and interface display designs.

- *Implementation*, which is the translation of the design results into application programs using the PHP programming language and MySQL database.
- *System Testing*, to ensure that all system functions run both from the side of admins, technicians, and customers.
- *System Maintenance (Maintenance),* to correct errors and make further adjustments or developments according to user needs.

Analysis

The analysis was carried out to understand the condition of the running system and identify problems in the APAR data management process based on the results of observations and interviews. Based on these results, it is known that the process of data management and checking of fire extinguishers is still carried out manually using paper forms that are stored as physical documents. This condition causes the data from the inspection results to potentially be lost or damaged, the search for data takes a long time, and the recapitulation of the report cannot be obtained in *real-time*, so that the monitoring and management of fire extinguishing data is less than optimal.

The analysis of system needs includes hardware needs (computers/laptops and *smartphones* for QR Code scanning, as well as internet connections), software needs (PHP, MySQL, *web browsers*, and supporting operating systems), information needs (*customer data*, fire extinguishing data, placement locations, pressure conditions, content types, tube types, expiration dates, and periodic inspection processes), and user needs consisting of from Admins, *Customers*, and Technicians. The feasibility analysis shows that the system is feasible in terms of technology, legal, operational, and economic, because it is developed with flexible web-based technology, manages non-sensitive operational data, replaces manual recording, and does not require large investment costs.

System Planning

The design of the system began with the creation of a diagram model which included *a Flowchart*, *Use Case Diagram*, *Activity Diagram*, *Sequence Diagram*, and *Entity Relationship Diagram* (ERD). Each diagram has specific functions to help developers understand the system's needs thoroughly and ensure no business process is missed, while also considering the integration of QR *Code technology* to make it easier to identify and check fire extinguishers.

The flowchart (Figure 1) visualizes the system workflow involving three main actors, namely Admin, *Customer*, and Technician. The flow starts from the *login* process, submission of inspection requests by *customers*, scheduling and creating QR *Codes* by admins, carrying out checks by technicians through QR Code scanning, to report verification and billing by admins.

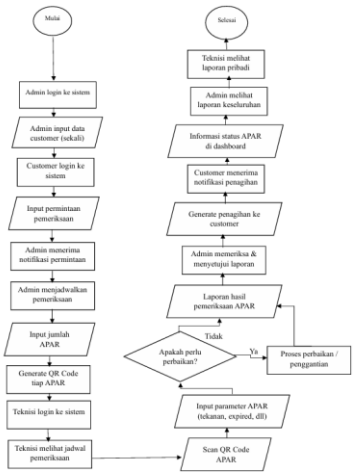

Figure 1. System Flowchart

The Use Case Diagram (Figure 2) illustrates the functionality of the system from the user's point of view. Admins manage *customer* data and fire extinguishers, schedule inspections, verify reports, and create bills. Technicians conduct inspections in the field, input the results of the inspection after scanning the QR *Code*, and submit reports. *The customer* submits an inspection request and monitors the status and results of the fire extinguisher inspection.

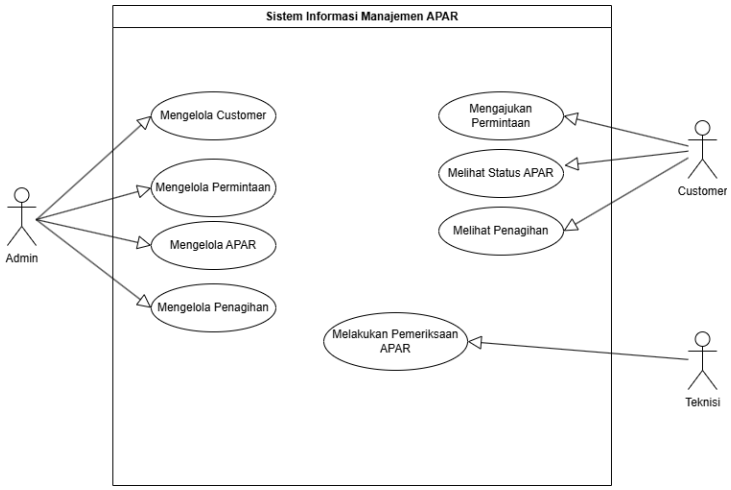

Figure 2. Use Case Diagram

The Activity Diagram (Figure 3) models the business process in detail, describing the flow of activities from one process to the next along with the division of tasks between actors through *swimlane*, from submitting inspection requests by *customers*, scheduling by admins, to the execution of inspections and reporting of results by technicians.

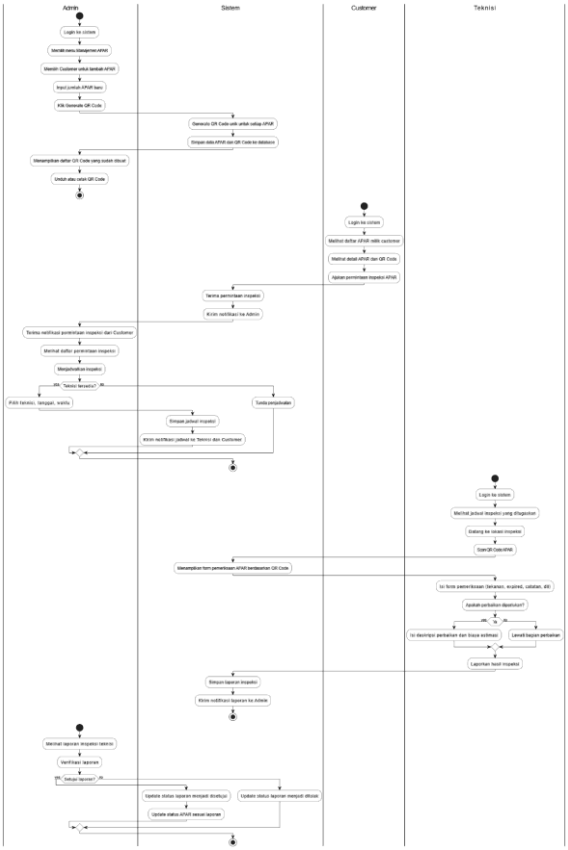

Figure 3. Activity Diagram

The Sequence Diagram (Figure 4) depicts the interactions between objects in sequence based on time. The process starts from *the customer* logging *in* and submitting an inspection request, the system stores data and sends notifications to the admin, the admin manages the fire extinguisher data and creates a QR *Code* and schedules the inspection, the technician checks by scanning the QR *Code* and sending a report, then the admin verifies the report and makes a bill.

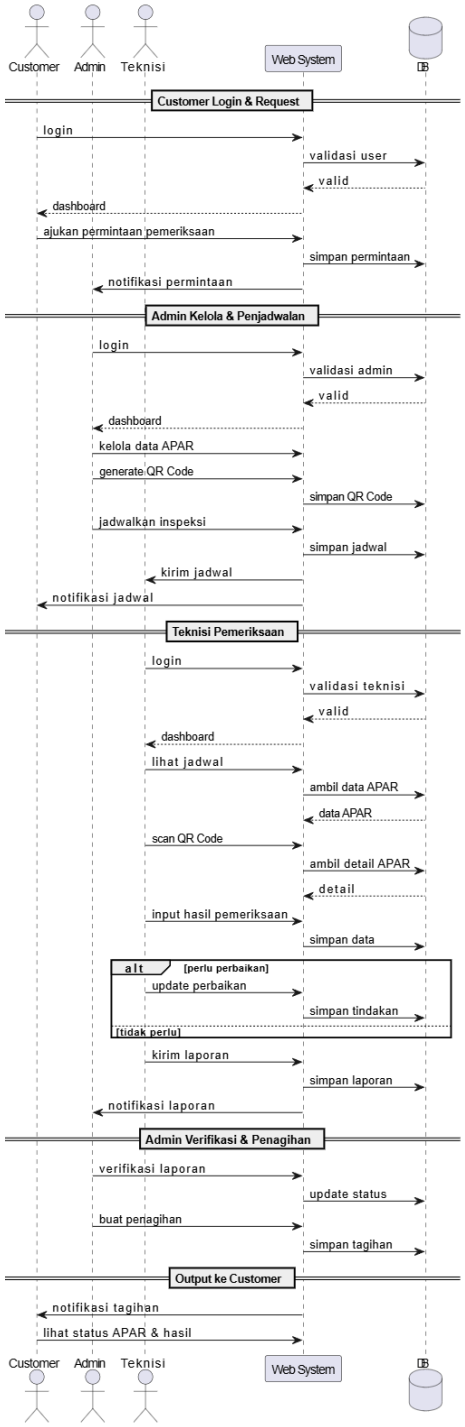

Figure 4. Sequence Diagram

The Entity Relationship Diagram (ERD) in Figure 5 designs the database structure by visualizing the entities, attributes, and relationships between entities. The system consists of the main entities, namely *User*, *Customer*, Fire Extinguisher, QR *Code*, Inspection Schedule, Inspection Report, Billing, and Billing Items. The relationships between entities are presented in Table 1.

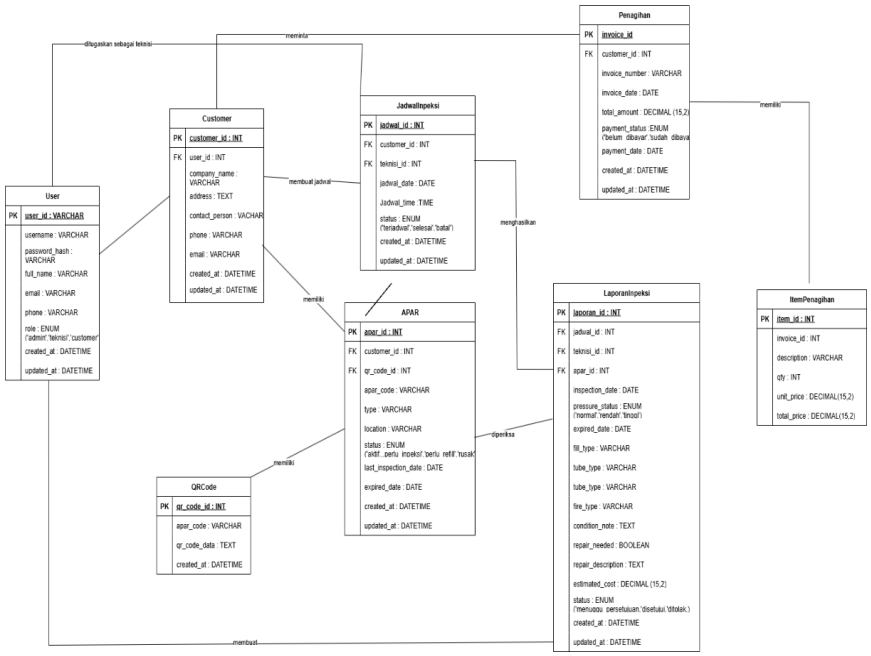

Figure 5. Entity Relationship Diagram (ERD)

Table 1. Entity Relations

Entity 1	Relationship	Entity 2	Remarks
User:StuRat	1 : 1	Customers	One user customer represents one company.
Customers	1 : N	Fire extinguisher	Customers can have multiple fire extinguishers.
Fire extinguisher	1 : 1	Powered by E-Mail	Each fire extinguisher has a unique QR Code.
Customers	1 : N	Inspection Schedule	Customers can create multiple inspection schedules.
User (Technician)	1 : N	Inspection Schedule	One technician can be assigned to multiple schedules.
Inspection Schedule	1 : N	Inspection Report	A single schedule can generate multiple reports.
User (Technician)	1 : N	Inspection Report	One technician can make multiple reports.
Fire extinguisher	1 : N	Inspection Report	Fire extinguishers are inspected in many inspection reports.
Customers	1 : N	Billing	Customers receive multiple billings.
Billing	1 : N	Billing Items	A single billing consists of multiple service items.

RESULTS AND DISCUSSION

System Implementation Results

This research resulted in a web-based Fire Extinguisher Management Information System and QR *Code* developed for PT Botto Global Mandiri using the PHP programming language and MySQL database. The system includes three main user modules that are integrated with each other, namely Admin, *Customer*, and Technician.

The *login* page (Figure 6) is the main gateway of the system. The user enters *a valid username* and *password*, then the system automatically directs the user to the *dashboard* according to *their role*.

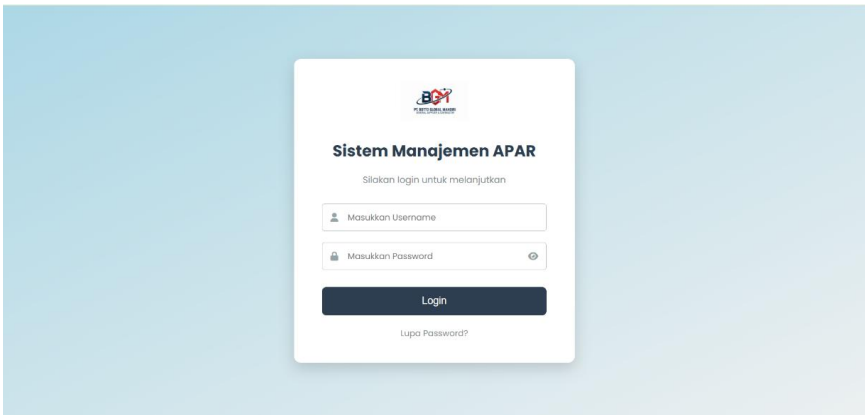

Figure 6. Login Page View

The Admin Dashboard (Figure 7) displays a comprehensive summary of system information, including the number of *active customers*, total registered fire extinguishers, the schedule of nearby inspections, and the status of technician reports awaiting verification, making it easy to monitor operational conditions in *real-time*.

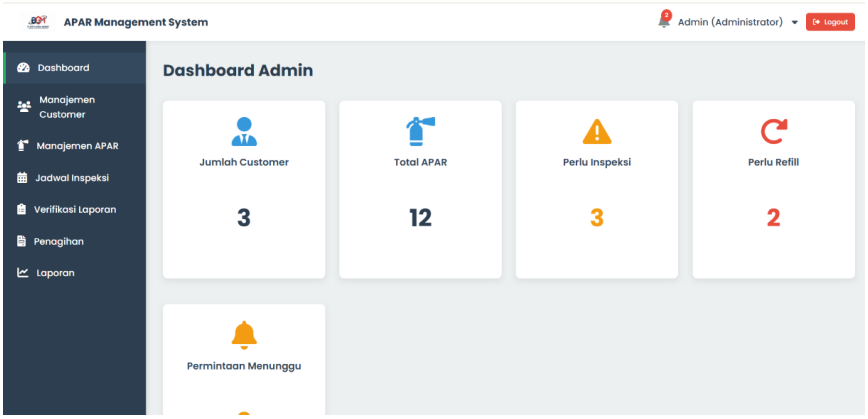

Figure 7. Admin Dashboard Page View

The Fire Extinguisher Management and *Generate* QR *Code* pages (Figure 8) allow Admins to manage the data of each fire extinguisher unit, including the fire extinguisher code, type, placement location, pressure, expiration date, and status. The *generate* QR *Code* feature automatically generates *a unique QR Code* for each fire extinguisher unit which can then be printed and pasted on a physical tube.

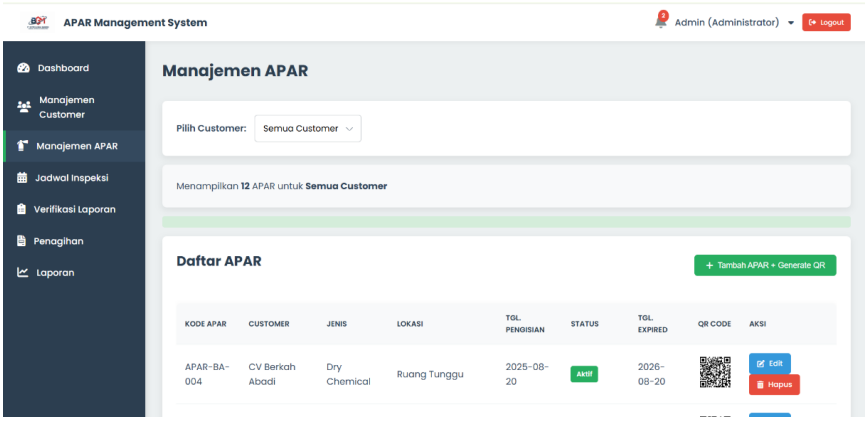

Figure 8. Fire extinguisher Management Page and QR Code display

The Inspection Scheduling page (Figure 9) is used by Admins to create and manage inspection schedules based on *customer* requests, by selecting technicians on duty, specifying dates and times, and confirming schedules. An automatic notification will be sent to the assigned technician.

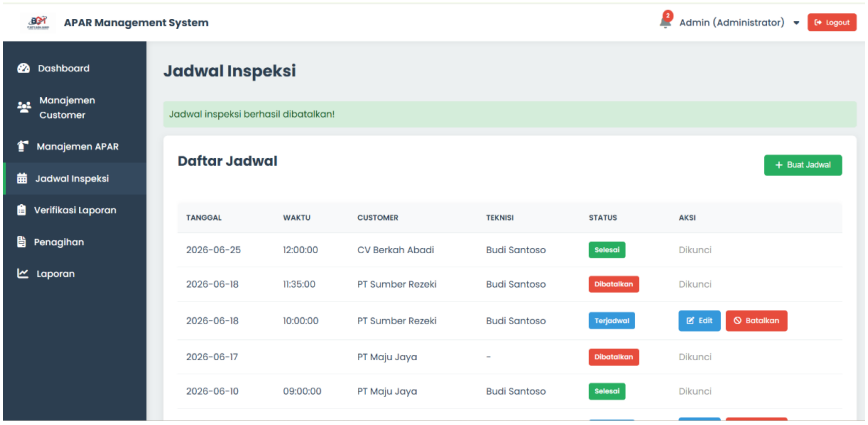

Figure 9. Inspection Scheduling Page View

The Technician Report Verification page (Figure 10) displays two report statuses: "Pending Approval" which appears automatically when the technician submits the report, and "Approved" after the Admin validates all the inspection data. After approval, the system updates the data on the condition of the fire extinguisher and the Admin can make a bill to the *customer*.

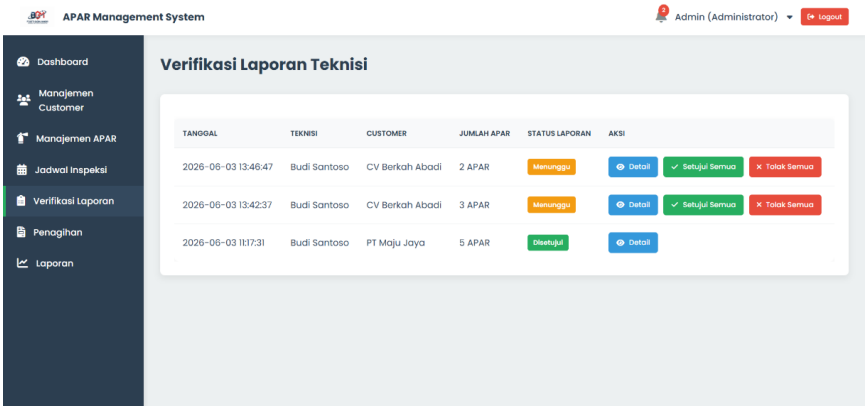

Figure 10. Technician Report Verification Page View

The Customer Dashboard (Figure 11) displays information on the number of fire extinguishers owned, the latest inspection schedule, and the status of the bill. *Customers* can submit inspection requests independently through the system without having to contact the admin manually.

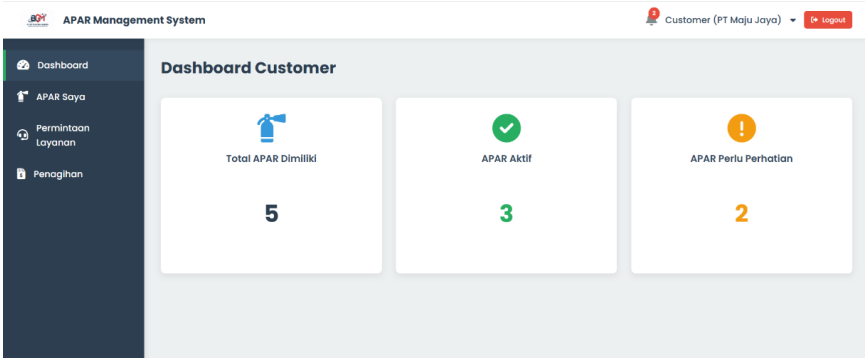

Figure 11. Customer Dashboard View

The *Fire* Extinguisher Inspection Form page by the Technician (Figure 12) opens automatically after the technician scans the QR *Code* on the fire extinguisher tube using *a smartphone*. The technician fills in the inspection parameters such as tube pressure, physical condition, expiration date, and action record, and then sends the report to the system.

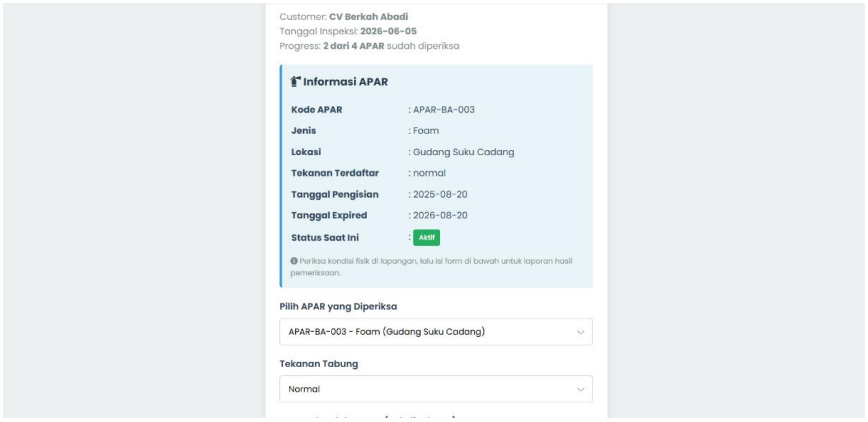

Figure 12. Display of the Fire Extinguisher Inspection Form Page by Technician

The Report to Management page (Figure 13) presents a comprehensive recap of the inspection results and the condition of all verified fire extinguisher units, including the number of inspections completed, the status of fire extinguisher conditions per customer, and action recapitulation, so that leaders can monitor service performance in *real-time* without relying on paper reports.

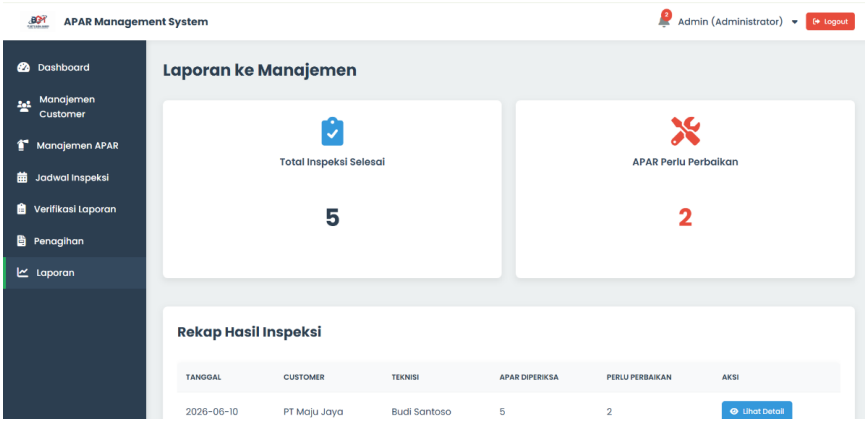

Figure 13. Report Page View to Management

System Test Results (Black Box Testing)

System testing is carried out using *the Black Box Testing method*, which is a functional test that focuses on the suitability of the *output* produced by the system against the specified use scenario, without considering the internal structure of the program code. Testing was carried out on the Admin module (Table 2), *the Customer module* (Table 3), and the Technician module (Table 4).

Table 2. Black Box Testing Admin Module Results

Yes	Test Name	Test Scenarios	Expected Results	Results
1	Login Admin	Enter the correct username and password	System redirects to admin dashboard	Valid
2	Admin Login (Failed)	Entering the wrong username/password	System displays error messages	Valid
3	Add Customer Data	Admin inputs new customer data and saves	Data is stored and appears in the customer list	Valid
4	Generate QR Code	Admin presses the generate QR Code button on the fire extinguisher data	QR Codes are uniquely created and can be downloaded/printed	Valid
5	Create an Inspection Schedule	Admin selects technicians, dates, and saves schedules	Saved schedules and notifications sent	Valid
6	Report Verification	Admin approves the technician's report	Report status approved and fire extinguisher updated	Valid
7	Create Billing	Admin creates a bill based on the results of the inspection	Billing data is saved and customers are notified	Valid

Table 3. Black Box Testing Results of Customer Module

Yes	Test Name	Test Scenarios	Expected Results	Results
1	Login to Login	Customer enters valid credentials	System redirects to customer dashboard	Valid
2	Submit an Inspection Request	Customer fills out the request form and sends it	Requests saved and admins notified	Valid
3	View My Fire Extinguisher Data	Customer access the My Fire Extinguisher menu	List of fire extinguishers and their status appear	Valid
4	View Bills	Customer access the billing menu	Billing details and payment status are displayed	Valid

Table 4. Black Box Testing Technician Module Results

Yes	Test Name	Test Scenarios	Expected Results	Results
1	Technician Login	Technician enters valid credentials	System redirects to the technician dashboard	Valid
2	View Inspection Schedule	The technician opens my schedule menu	A list of assigned inspection schedules appears	Valid
3	Scan QR Code Fire Engine	Technician scans QR Code on fire extinguisher tube	The system opens the appropriate inspection form	Valid
4	Input of Inspection Results	Technician fills in the parameters and sends a report	Reports saved and admins notified	Valid
5	View Report History	Technician opens my inspection report menu	List of reports that have been sent appears	Valid

Based on *the results of Black Box Testing* on all system features, all test scenarios produce the *expected output*. This shows that the system has been functioning properly and in accordance with the requirements specifications set at the analysis stage.

Before the system was developed, PT Botto Global Mandiri managed all fire extinguisher data, *customer data*, inspection process, and documentation using a manual method based on paper forms which caused data inaccuracies, service delays, and difficulty tracking fire extinguisher history. After the implementation of the new system, data management is carried out digitally and centrally in one *platform* that can be accessed by Admins, *Customers*, and Technicians at the same time. The use of QR Codes as the unique identity of each fire extinguishing unit allows technicians to access data and fill in the inspection results directly from the field, in line with the findings of Hasibuan & Winarno (2024) that the application of QR Codes improves checking efficiency and reduces human error.

All three research objectives have been achieved. The first goal was achieved through observations and interviews that revealed the weaknesses of the manual system. The second goal is realized by the development of a system that has three user modules that are integrated with each other. The third goal is achieved through Black Box Testing which shows Valid results in all test scenarios. These results are consistent with Sofian et al.'s (2023) research that a web-based fire extinguisher inspection system is able to overcome the data inaccuracies caused by manual recording methods.

This research contributes in the form of an implementation model of the fire extinguisher management information system that integrates web technology with QR Code as a practical

solution for medium-scale fire safety companies. In contrast to the Android-based research by Hasibuan & Winarno (2024) and Pane & Putra (2023), this study opted for a more accessible web-based approach without additional app installation. The application of the Waterfall method also provides empirical evidence of its effectiveness in management information system development projects with clearly defined needs, as practiced by Darmawan et al. (2024) and Hikmah et al. (2022).

System Maintenance

After the system is implemented and handed over, a planned maintenance strategy is needed to keep the system running optimally in the long term. The recommended routine maintenance plan is presented in Table 10. In addition to regular maintenance, training for Admins, Technicians, and Customers is required, as well as further development plans such as mobile application development, automatic notification integration via *WhatsApp*/*email*, reporting and analytics features, and the implementation of HTTPS and data encryption.

Table 5. System Maintenance Plan

Yes	Maintenance Aspects	Frequency	Remarks
1	Database Backup	Daily / Weekly	Automatic backup of MySQL data to prevent data loss.
2	System Security Updates	Monthly	Update PHP libraries, frameworks, and security patches.
3	Server Performance Monitoring	Weekly	Monitor CPU, memory, and server disk usage.
4	User Activity Log Audit	Monthly	Checks activity logs to detect unfair usage.
5	QR Code Data Update	As needed	Regenerate the QR Code if there is a change in fire extinguishing data.
6	System Functionality Evaluation	Stuttgart	Evaluate the suitability of features with operational needs.

CONCLUSIONS

Based on the results of the study, the condition of data management of fire extinguishers at PT Botto Global Mandiri was previously manual using paper forms, causing data inaccuracies, service delays, and decreased customer trust due to the absence of digitally organized recording. A web-based fire extinguishing management information system with QR Code integration has been successfully designed and built using the PHP programming language and MySQL database, including three interintegrated user modules, namely Admin, Customer, and Technician, with customer data management features, generate unique QR Codes, schedule inspections, fill out digital inspection forms through QR Code scanning, report verification, as well as real-time reporting to management. The implementation of the system has succeeded in improving the extinguishing documentation because all data is stored centrally and in real-time so that it is easier to track history, and the Black Box Testing test shows that all features are valid according to the specifications of the needs. It is recommended that PT Botto Global Mandiri immediately implement this system in full accompanied by user training, perform regular maintenance including database backups and security updates, and use reliable hosting with the HTTPS protocol. For future developers, it is recommended to

develop a special mobile application for the Technician module including offline mode, add automatic notifications via WhatsApp or email, develop a report and analytics module, and conduct User Acceptance Testing with real users. For educational institutions, this research can be a reference for the development of a web-based management information system in the field of fire safety and encourage further research that integrates Internet of Things technology for automatic monitoring of fire extinguishing conditions.

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