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Research Article

Implementation of Web Technology in Occupational Health and Safety Management in the Electrical Distribution Sector

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Abstract.

The implementation of web-based technology in occupational health and safety (OHS) management is essential for improving operational efficiency, data accuracy, and decision-making, particularly in high-risk sectors such as electrical distribution. In this study, a web-based system was developed to enhance the management of first aid kits (FAK) at PT. PLN (Persero) within the South and Central Kalimantan Distribution Unit. The manual process currently used for inspecting and maintaining FAKs is prone to human error, data loss, and delays, which can significantly impact response times in emergencies and compromise workplace safety. To address these issues, a system was designed using the waterfall development methodology and built with PHP, MySQL, and the Laravel framework. The system enables real-time data access and management, ensuring that inspections are logged accurately and efficiently. Blackbox testing was conducted to ensure the functionality and reliability of the system. The results showed that the web-based system drastically reduced manual data entry errors, improved the timeliness of FAK inspections, and provided easier access to inspection records. This solution also enhanced the overall efficiency of monitoring and reporting, allowing management to make faster, more informed decisions regarding workplace safety.

Keywords: web-based technology, occupational health and safety (OHS), waterfall development methodology, monitoring and reporting efficiency

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1. INTRODUCTION

The rapid advancement of web technologies has significantly impacted the management practices of various industries, including the electrical distribution sector, where ensuring employee safety is paramount. Occupational health and safety (OHS) management plays a critical role in mitigating risks associated with electrical hazards, including injuries from high-voltage equipment and operational failures. In such high-risk environments, quick access to accurate safety data and reliable health measures is essential for protecting both workers and the public (Hutahaean, 2018) .

PT. PLN (PERSERO), as the primary electricity provider in Indonesia, recognizes the need to enhance its OHS protocols to ensure compliance with regulatory standards and

to safeguard its workforce. The manual process of inspecting and maintaining first aid kits (P3K) at PT. PLN's South and Central Kalimantan distribution units has long been prone to inefficiencies such as human error, delayed updates, and limited accessibility to critical information in emergency situations (Mitasari, Subekti, & Khairansyah, 2018). These shortcomings pose risks to effective OHS management, particularly in time-sensitive situations where safety equipment needs to be available and functional.

To address these issues, a web-based information system has been implemented, utilizing PHP and MySQL technology and following the Waterfall development model (Tersiana, 2018). The system automates the inspection of P3K equipment, replacing the outdated manual record-keeping with real-time, centralized data access. This not only reduces the risk of human error but also improves response times in emergencies, ensuring that critical safety equipment is maintained and monitored efficiently. By integrating web technology into its safety management system, PT. PLN enhances its overall health and safety framework, providing a more effective way to manage occupational hazards in the electrical distribution sector (PT PLN, n.d.).

This paper examines the development and implementation of the web-based system, highlighting its contributions to improving OHS practices and its potential for broader application in other sectors where safety management is crucial.

2. METHODOLOGY/MATERIALS

The development and implementation of the web-based system for Occupational Health and Safety (OHS) management in the electrical distribution sector involved several stages. The research method used is a combination of system development and applied research, focusing on practical problem-solving through technology.

1. Research Design

The study utilizes the Software Development Life Cycle (SDLC) methodology with the Waterfall model (Arisantoso, Harjanti, Wira, Yulianti, & Dewi, 2022). The waterfall model can be seen in Fig 1.

This method ensures systematic development through the following phases:

a. Requirement Analysis: Identifying the functional and non-functional requirements based on observations and interviews.

b. System Design: Construct a logical and physical design of the system, including database architecture and user interfaces.

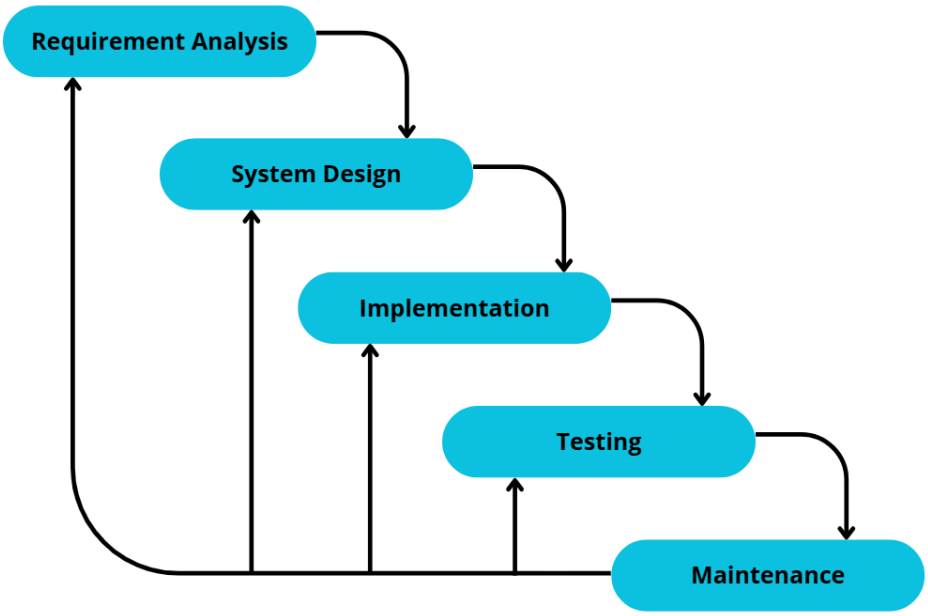

Figure 1: Waterfall Model.

c. Implementation: Developing the system using PHP programming language and Laravel framework.

d. Testing: Employing Blackbox Testing to validate functionality against predefined criteria.

e. Maintenance: Ensuring ongoing system performance and incorporating user feedback.

2. Data Collection

Data collection is the systematic process of gathering and measuring information relevant to a specific research question or objective. It involves using defined methods and tools to ensure the data collected is accurate, reliable, and valid for analysis. (Creswell, 2014)

Data were collected using three primary techniques:

a. Observation: Directly observing the manual OHS management processes at PT PLN (Persero) South Kalimantan and Central Kalimantan Distribution Main Unit.

b. Interviews: Conducting structured interviews with stakeholders to gather insights on system inefficiencies and expectations.

c. Documentation: Reviewing existing records and documents related to OHS processes.

3. RESULTS AND DISCUSSIONS

The results and discussions section of this study aims to present the findings from the implementation of web technology in Occupational Health and Safety (OHS) management, specifically in the electrical distribution sector. This section outlines the key improvements observed, analyzes the effectiveness of the proposed web-based system, and discusses its impact on enhancing operational efficiency, data accuracy, and overall safety outcomes. By comparing the performance of the new system against traditional, manual methods, the section highlights how web technology addresses critical challenges such as human error, data loss, and delayed decision-making processes.

1. Requirement Analysis

The requirement analysis phase identified significant inefficiencies in the manual management system for First Aid Kits (P3K) at PT PLN (Persero) South Kalimantan and Central Kalimantan Distribution Main Unit. The manual system, which relied heavily on physical record-keeping, was prone to human error and delays in data access. Functional requirements included centralized data management, role-based access control, real-time verification, and detailed reporting. Non-functional requirements emphasized system reliability, security, and compatibility with various devices to ensure accessibility and scalability.

Key findings during this phase include:

a. Functional Requirements

The functional requirements included centralized data management to enable effective tracking and monitoring of First Aid Kits (P3K), role-based access controls for admin, supervisor, staff, and visitor.

1) Admin

The admin has the following capabilities: managing user data, viewing and printing user data, managing room data, viewing and printing room data, viewing and printing QR codes, managing the inspection menu, viewing and printing the inspection menu, validating inspection results, viewing and printing verified items, viewing and printing activity logs, and managing account profiles.

2) Supervisor

The supervisor role has extensive capabilities within the system. Supervisors can view the dashboard, manage user data (excluding admin data), and view or print

user information. They are also able to manage room data, as well as view and print room details. Additionally, supervisors can access and print QR codes, manage the inspection menu, and validate inspection results. Furthermore, they have access to view and print verified items, activity logs, and manage their account profiles, ensuring comprehensive oversight and operational support.

3) Staff

The staff role focuses on operational tasks. Staff can view the dashboard, access and print user data, and manage room information. They are also able to view and print room details and QR codes, manage the inspection menu, and view or print verified items. Moreover, staff can access activity logs and manage their account profiles, enabling them to contribute to the system's day-to-day operations effectively.

4) Visitor

The visitor role has limited access, designed for transparency and information-sharing. Visitors can view the inspection results of First Aid Kits (P3K), providing them with a straightforward way to monitor safety compliance.

b. Non-Functional Requirements

In terms of non-functional requirements, the system needed to demonstrate high reliability and robust security to protect sensitive data. It also had to be accessible from various devices, including smartphones and PCs, to accommodate the needs of a diverse user base. Furthermore, the architecture had to be scalable to support future enhancements and expansions, ensuring the system could adapt to evolving operational demands effectively.

2. System Design

The system design phase resulted in a structured blueprint using the Waterfall model. This included logical and physical system designs.

a. Logical Design:

1) Data Flow Diagram (DFD)

A Data Flow Diagram (DFD) is a logical model of data or processes designed to illustrate the origin of data, its destination within a system, where it is stored, the processes that generate the data, and the interactions between stored data and the processes applied to it. (Shelly, Cashman, & Rosenblatt, 2012)

Figure 2 shows the DFD of the information system created, which consists of admin, supervisor, staff, and visitor roles.

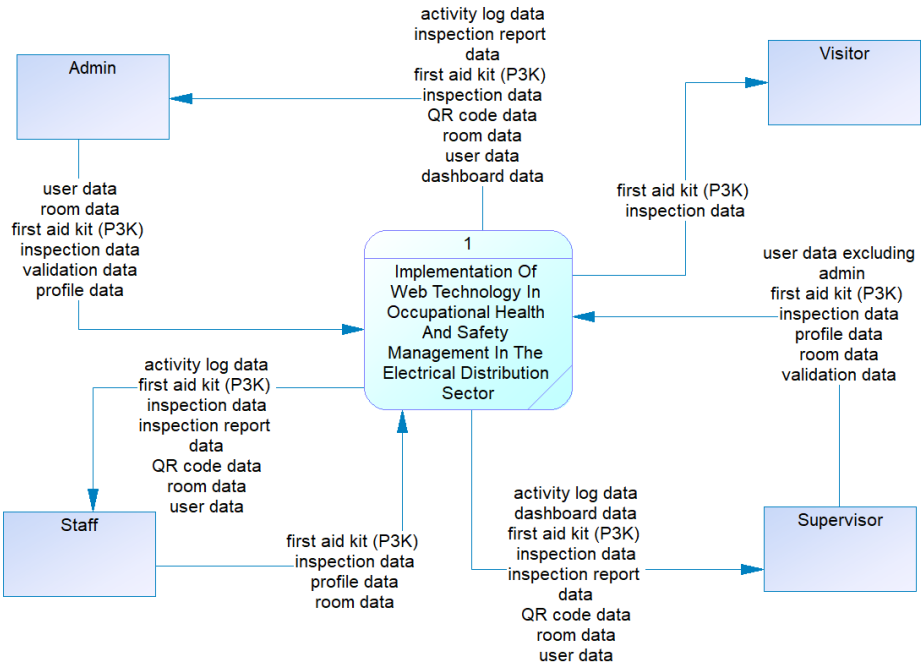

Figure 2: Context Diagram.

2) Enhanced Entity Relationship (EER)

An Enhanced Entity-Relationship (EER) is an extension of the Entity-Relationship (ER) model used in designing information system databases. EER expands on the ER model by incorporating more advanced features such as generalization, specialization, and aggregation. Generalization is the process of abstracting entities with similar attributes into a more general entity, while specialization involves breaking a general entity into more specific entities based on certain characteristics. Aggregation combines relationships between entities into a single entity to simplify complex models. EER enables database designers to capture and model more detailed and complex real-world information, resulting in a more representative and flexible database that supports the application needs of information systems. (Elmasri & Navathe, 2016)

Figure 3 illustrates the EER of the created information system.

b. Physical Design

In the physical design phase, the proposed system is illustrated using a website mockup. A website mockup is a visual representation or simulation of how a website will look. It presents the structure and logic of the wireframe, along with images, graphics,

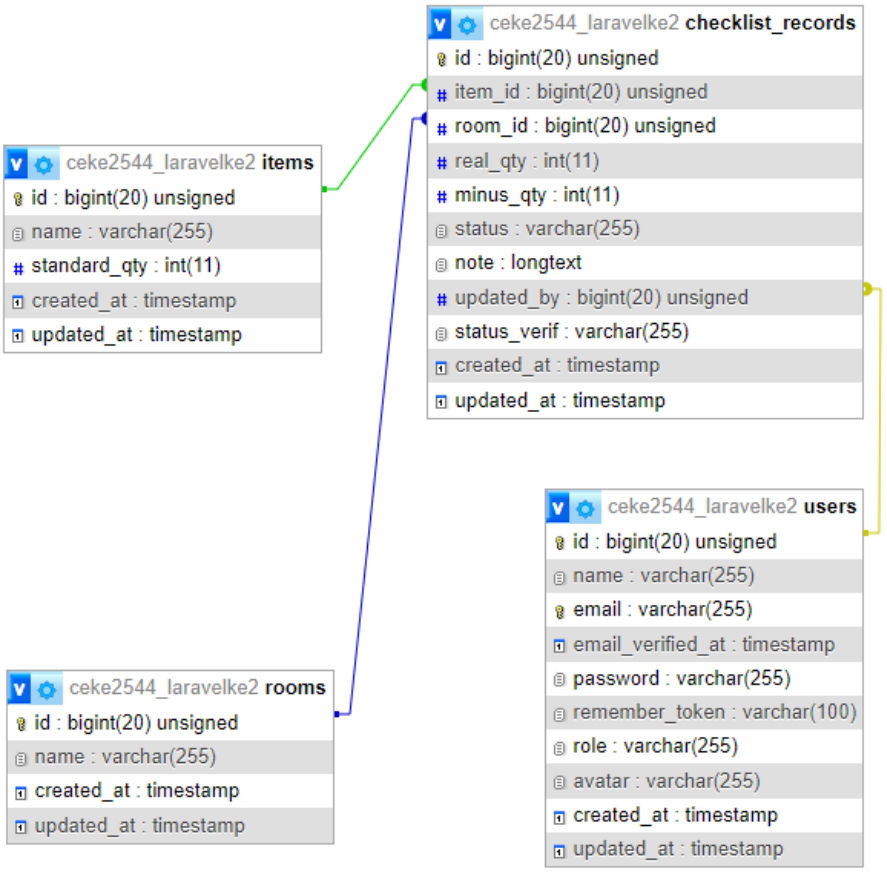

Figure 3: EER of the Designed Information System.

and UI elements that will appear in the final design of the website. (Brown & Smith, 2018)

The dashboard page is the main page that displays a summary of information from various features within the system. Figure 4 shows the physical design of the dashboard page.

3. Implementation

Implementation is the stage where the system is applied to its actual environment. However, during this phase, the system is first tested to ensure it can operate or function as planned. (Sharp, Rogers, & Preece, 2019)

Figure 5 shows the dashboard page, which serves as the main page displaying a summary of information from various features within the system.

Figure 6 depicts the room data page. This page is used to manage information about the available rooms, including adding, modifying, and deleting room data.

Figure 4: the physical design of the dashboard page.

The profile page displays and allows users to update their personal information, such as name, email, and password. The profile page is shown in Figure 7.

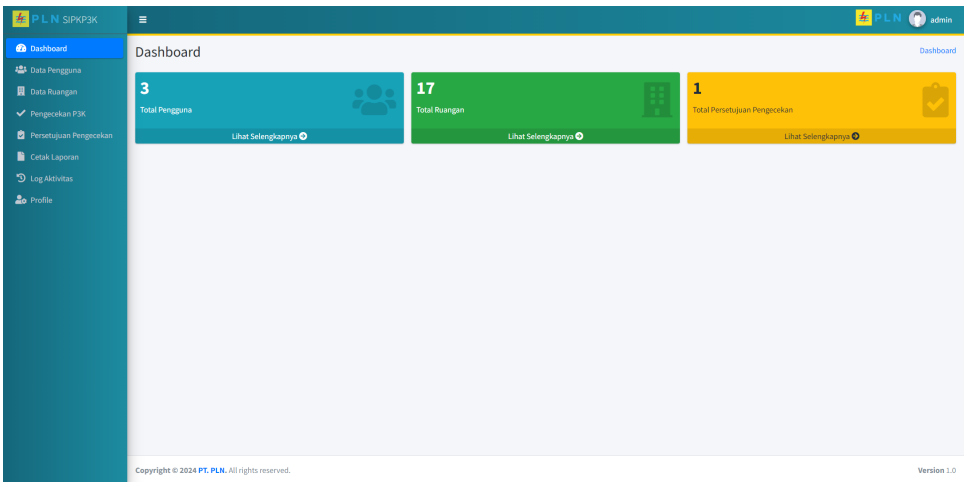

Figure 5: Dashboard Page.

4. Testing

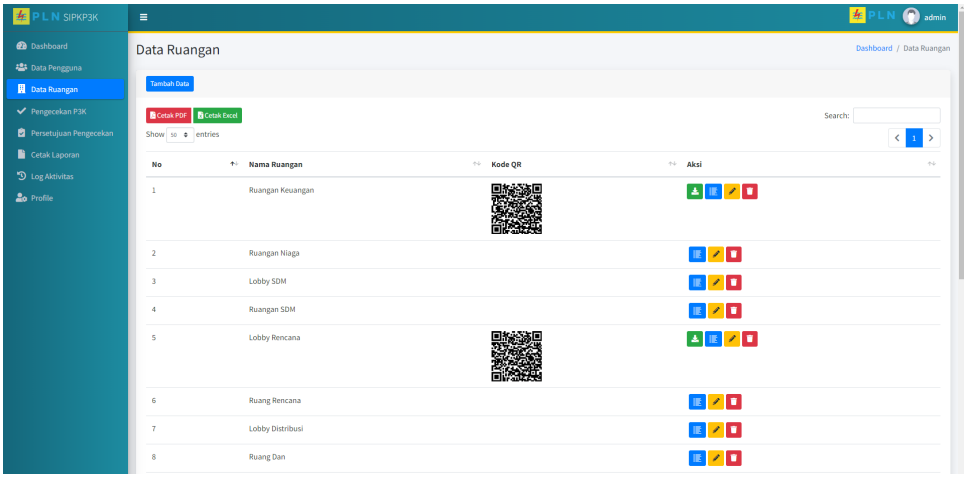

Figure 6: the Room Data Page.

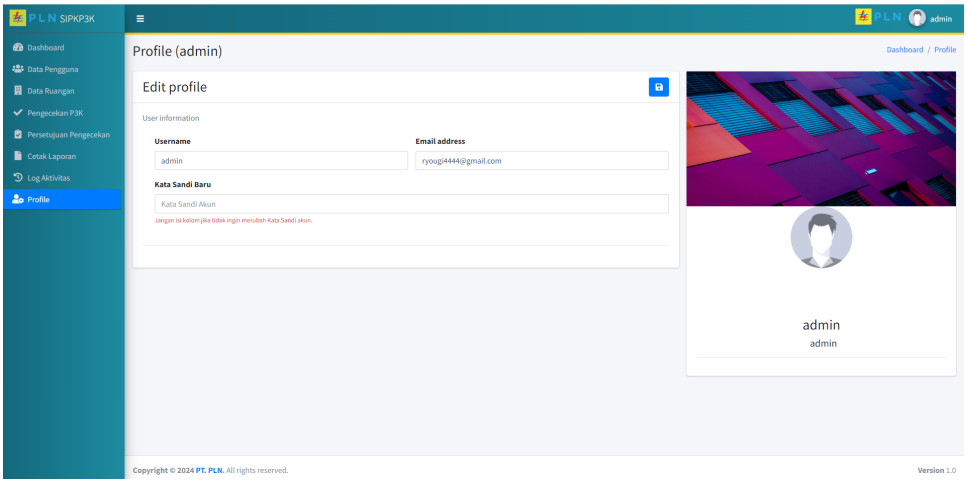

Figure 7: Profile Page.

At this stage, testing was conducted on all system features to ensure they functioned as expected. The testing utilized the Blackbox Testing method, a software testing technique focused on verifying the functionality of a system based on specified requirements, without considering the internal structure or implementation of the software. (Sugiyono, 2018)

In this method, testers examined the system's inputs and outputs to ensure that all functions operated as intended and that there were no errors in data processing. Blackbox Testing helps ensure that the information system operates effectively and efficiently, with all required functions implemented correctly.

Table 1 shows the results of the Blackbox Testing method conducted.

TABLE 1: Blackbox Testing Result.

Feature	Test Case	Expected Result	Actual Result	Conclusion
User Authentication	Testing login functionality with valid credentials.	Users can log in successfully.	Successfully logged in for all roles.	Passed
User Management	Adding, editing, and deleting user data.	User data is managed without errors.	Data was added, modified, and deleted successfully.	Passed
Room Management	Adding, editing, and deleting room data.	Room data operations are executed successfully.	Data was added, modified, and deleted successfully.	Passed
Inspection Management	Inputting and validating inspection results.	Staff can input data, and results can be validated by admin or supervisors.	Data input and validation were successful.	Passed
QR Code Generation	Generating and printing QR codes for items.	QR codes are generated and printed accurately.	QR codes were generated and printed as expected.	Passed
Report Generation	Generating and printing inspection reports.	Reports are generated and printed successfully.	Reports were generated and printed without issues.	Passed

4. CONCLUSION

The document outlines the development of a web-based system to manage First Aid Kits (P3K) at PT PLN (Persero) South Kalimantan and Central Kalimantan Distribution Main Unit. The system addresses inefficiencies in the manual process, such as errors, delays, and difficulty accessing data, by providing a centralized, real-time solution.

Key requirements included centralized data management, role-based user access (admin, supervisor, staff, visitor), real-time updates, and secure data storage. The system was designed with user-friendly interfaces using Laravel and Bootstrap and supported by PHP and MySQL for backend development.

The system was tested using Blackbox Testing to ensure features like login, data management, QR code generation, and reporting worked correctly. All tests passed, showing improved efficiency, reduced errors, and better decision-making capabilities. Future enhancements, such as advanced security and predictive analytics, are recommended to expand its functionality further. This project demonstrates how web technology can improve workplace safety and operational management.

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