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POWER PLANTS PERFORMANCE MONITORING SYSTEM

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***Abstract*— Electricity has a big role in human life, this can be seen from the developments experienced by humans before and after the use of electrical energy. In fact, we can see that electricity cannot be separated from industrial activities, commercial activities and in everyday household life. Therefore, a facility that can convert mechanical energy into electrical energy such as a power plant is very important as an effort to provide electrical resources. PT PLN (Persero) plays an important role in the distribution of electricity throughout Indonesia. Therefore, PT PLN (Persero) needs to provide good services in the distribution and management of electricity resources. One of the efforts is by conducting periodic monitoring and maintenance of the power plant so that the performance of the power plants can be optimal and maintained in generating electricity. But over time, the number of power plants continues to grow especially in the area of Madura Island and its surroundings which is under the control of PT PLN (Persero) UP3 Pamekasan . So that creates a new problem with the power plants performance monitoring system which causes maintenance not to be optimal. On the other hand, the efficiency of the system is also reduced because it still uses manual methods and data management that is not centralized. To overcome these problems, one of the objectives of this system development project is to design and develop a proposed web-based application named Power Plants Performance Monitoring System for PT PLN (Persero) UP3 Pamekasan to replace the current existing system which is still using manual methods. The project only focuses on power plants in PT PLN (Persero) UP3 Pamekasan, which are located in Pamekasan Regency, East Java, Indonesia. In this project, the system development methodology used is Agile with six sequential phases. Besides, this proposed system will be developed with Laravel as the framework. Meanwhile, MySQL will be used for the database management system, and some network security technology such as authentication will be applied to enhance and secure the proposed system. At the end of this project, the proposed system is able to replace the manual operation of existing systems and thus provide an optimal, efficient and systematic way to monitor the performance of power plants in Madura Island and its surroundings.**

I. INTRODUCTION

The widespread availability of electricity is a fundamental requirement for modern society, enabling various industrial and domestic activities to function smoothly. However, in many parts of the world, including Indonesia, there are still significant gaps in electricity access, particularly in remote areas. To address this issue, PT PLN (Persero), the Indonesian government-owned corporation responsible for electricity distribution, has undertaken initiatives to expand access to electricity by increasing the number of power plants.

While the focus has been on increasing the generation capacity, it is equally important to ensure the proper maintenance and efficient operation of these power plants. Monitoring the performance of power plants plays a crucial role in identifying issues, predicting future challenges, and ensuring the sustainability of the plants. In this context, this paper examines the case of PT PLN (Persero) UP3 Pamekasan, a branch located on Madura Island in East Java, Indonesia.

Currently, the monitoring of power plant performance in PT PLN (Persero) UP3 Pamekasan relies on a manual system, which poses several challenges. This includes data collection through WhatsApp Groups, leading to confusion due to various formats. Additionally, the data checking and validation process lacks proper documentation, causing ambiguity in the approval or rejection status. The classification of data for each power plant is done manually, and raw data is processed using Excel spreadsheets, resulting in inefficiencies and potential human errors. Furthermore, the absence of a centralized and real-time system prevents stakeholders from accessing and tracking the progress of data input.

To address these issues, this paper proposes the development of an automated monitoring system for power

plant performance in PT PLN (Persero) UP3 Pamekasan. The system aims to streamline the data gathering, checking, verification, and processing processes, enhancing the efficiency and manageability of the monitoring process. By implementing a web-based approach and a centralized database, the proposed system will provide real-time access to authorized personnel, including operator staff, PIC staff, and system administrators, enabling them to work collaboratively and with focused attention.

The significance of this project lies in its potential to transform the power plant monitoring process from a manual to an automated system, improving efficiency while ensuring convenience in implementation. The inclusion of additional features and enhanced data management capabilities will contribute to better monitoring, tracking, and securing of power plant performance data. Ultimately, the proposed system aims to provide PT PLN (Persero) UP3 Pamekasan with a comprehensive and centralized solution that addresses the challenges associated with monitoring power plant performance.

II. Literature Review

The Power plant performance monitoring plays a crucial role in ensuring the efficient operation of power generation facilities. This section provides an overview of the existing literature related to power plant performance monitoring systems, focusing on their implementation and the challenges faced in the industry.

Several studies have highlighted the significance of adopting advanced monitoring systems in power plants. According to Smith et al. (2018), traditional manual monitoring methods have limitations in terms of efficiency and accuracy. They argue that the integration of digital technologies can enhance performance monitoring by providing real-time data collection, analysis, and reporting.

In the case of PT PLN (Persero) UP3 Pamekasan, the current monitoring system faces various issues, such as inefficiency and inconvenience in data collection and verification. This necessitates the development of a new system that can handle the monitoring process for an increasing number of power plants. To address these challenges, it is essential to review similar systems implemented in other contexts.

Avnet's Smart Diesel Generator Monitoring Solution System is a mobile application designed to remotely monitor diesel generators. The system provides real-time access to generator performance data, enabling operators to monitor key parameters and identify potential issues [1]. This system showcases the advantages of remote monitoring and highlights the potential for implementing similar technologies in power plant performance monitoring.

Technoton's Diesel Generator Monitoring System offers a comprehensive solution for fuel monitoring, engine diagnostics, and remote control of diesel generators [2]. This web-based application enables the collection and analysis of generator data, providing insights into performance and maintenance requirements. The use of such systems can enhance the efficiency and reliability of power plant monitoring processes.

Sekawan Media's Logistics Delivery Monitoring System is a web application used for managing and monitoring logistics fleets [3]. Although designed for a different industry, this system shares similarities with power plant monitoring requirements, such as data collection, verification, and reporting. Exploring the features and functionalities of this system can provide insights into adapting and customizing monitoring systems for power plants.

TABLE I. Comparison Between Existing System

System Feature	S1	S2	S3	S4
Multiple User Role Type Access	No	No	Yes	Yes
Downloadable excel-based report	No	No	Yes	Yes
Displaying data in a chart form.	Yes	Yes	Yes	Yes
Centralized Database	Yes	Yes	Yes	Yes
Admin Console	No	No	Yes	Yes
Data Verification / Approval	No	No	Yes	Yes

S1 - Avnet's Smart Diesel Generator Monitoring Solution System
S2 - Technoton's Diesel Generator Monitoring System
S3 - Sekawan Media's Logistics Delivery Monitoring System
S4 - Power Plants Performance Monitoring System

By comparing the existing systems mentioned above with the specific requirements of PT PLN (Persero) UP3 Pamekasan, we can identify valuable features and functionalities to be incorporated into the proposed Power Plants Performance Monitoring System. These include cross-platform availability, multiple user role access, centralized database management, data verification and approval mechanisms, and the ability to generate downloadable reports and display data in a chart format.

III. Methodology

The Agile methodology was selected based on its suitability for meeting the system requirements of the Power Plants Performance Monitoring System for PT PLN (Persero) UP3 Pamekasan. Agile breaks the project into small user functionality pieces, prioritizes them, and delivers them in iterations or sprints. This approach allows for quick implementation of consumer feedback, resulting in improved software quality and increased customer satisfaction. The Agile software development life cycle consists of several phases, including requirements analysis, design, development, testing, deployment, and review. Each phase contributes to the overall development process, ensuring systematic and efficient software creation.

The proposed system utilizes various tools and technologies such as macOS Monterey as the operating system, Google Drive for cloud storage, Draw.io for UML diagram editing, Figma for UI and UX design, Visual Studio Code as the code editor, DataGrip for database management, and Laravel, Vue JS, Tailwind CSS, Inertia JS, and MySQL for software development. These technologies support the development of a robust and efficient system.

System requirement analysis is a crucial aspect of the development process. The hardware requirements include Intel Pentium 4 or later (for Intel processors), AMD Athlon or later (for AMD processors), or Apple M1 or later (for Apple processors), with a minimum of 2 GB RAM and an internet

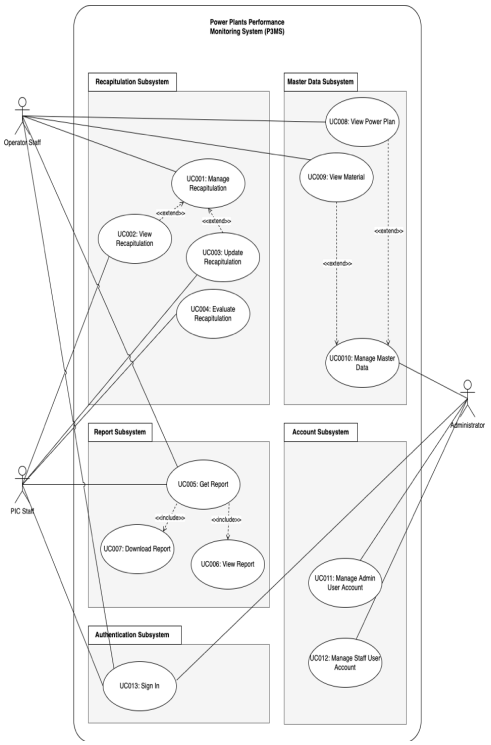
connection. The software requirements encompass Windows 8 or later, macOS Sierra 10.12 or later, or Ubuntu 14.04+ 64-bit, along with compatible web browsers.

IV. Requirement Analysis and Design

The functional requirements for the proposed system, which is the Power Plants Performance Monitoring System (P3MS) for PT PLN (Persero) UP3 Pamekasan, describe the features that the system ought to have and the way those features ought to be carried out. It is essential to have a good understanding of the functional requirements to identify the primary features and functionalities of the system. This requirement carried out and formulate based on the information gathered from the stakeholder before.

A. Use Case

In a use case diagram, the key features and functions of the proposed system are represented graphically. The use case model of the Power Plants Performance Monitoring System (P3MS) for PT PLN (Persero) UP3 Pamekasan illustrates and describes the relationship between the system and the actors that make up the system as shown in Figure 4.1.

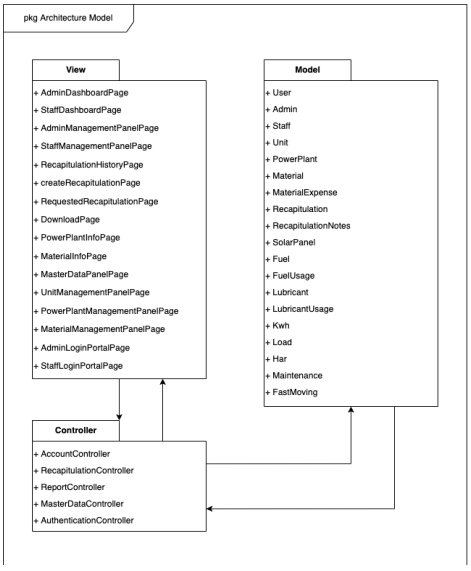


There are three actors involved in the Power Plants Performance Monitoring System (P3MS) which are Operator Staff, PIC Staff and Administrator. It's also consist of 13 use cases that incudes manage recapitulation, view recapitulation, update recapitulation, evaluate recapitulation, get report, view report, download report, view power plant, view material, manage master data, manage admin user account, manage staff user account and sign in.

B. Project Design

The In terms of architecture, this system follows the Model-View-Controller (MVC) design pattern. Model, view, and controller are the three interconnected parts of this architecture model's conceptualization of implementation code. Data storage and retrieval from a database are handled by a component called the model that serves as a bridge between the view and controller. For the end user, views are the interfaces that serve as visual representations of the entire system. Using the user interfaces, the end-user can input data, and then the system will display the corresponding result. It is the job of the controller to call the appropriate functions in the model and then carry out the necessary tasks. Following that, the pertinent information or result is then transferred before being presented by the user interfaces in View.

In the process of developing the Power Plants Performance Monitoring System (P3MS), the MVC architecture design pattern is an extremely important component. This is especially true for the system's implementation and maintenance. As a result of breaking the code into separate models, developers can easily make changes to the code without affecting other models. MVC makes it easier for developers to understand the code for different functions and apply good practices of code arrangement and management because it clearly shows the separation of codes. Figure 4.2 illustrates the architecture design of the Power Plants Performance Monitoring System (P3MS).

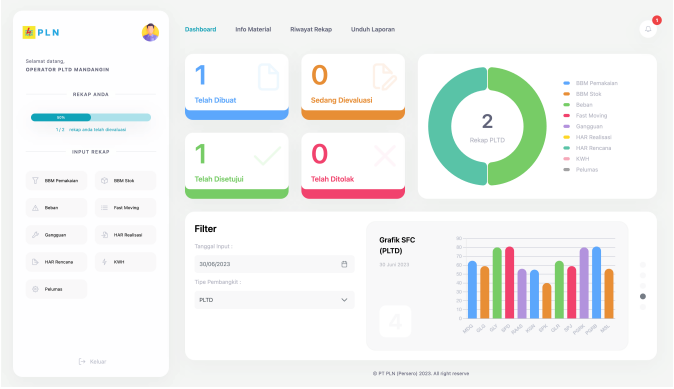


V. Implementation and Testing

Power Plants Performance Monitoring System (P3MS) for PT PLN (Persero) UP3 Pamekasan uses a MySQL database where all data is placed in one database called p3ms-psm2 which we can monitor through the database client named TablePlus. The definitions of field names, data types and primary keys for tables are determined through the database migration feature which is an innate feature of the Laravel framework itself. In addition, relationships between tables are also established.

After everything regarding the database has been settled, then the functions on the Power Plants Performance Monitoring System (P3MS) for PT PLN (Persero) UP3 Pamekasan are made with the aim of later being able to help the process of running the system such as connecting the interface with the database that we have prepared previously also helping process the required input and output. These functions will later be found in the controller of each existing module and later the controller will have access to the Model so that it can access the database. The existence of this Model is not mandatory, but Laravel itself has an ORM feature called Eloquent and can only be accessed by creating a model for each table, so we need to prepare it first. In this program there are 5 controllers that handle various functions.

The user interface is an important factor in system development because it functions as an intermediary between the user and the system. User-friendly and easy-to-understand interfaces play an important role in production as they indirectly reduce costs by reducing training time for users. The development of the user interface for this system is carried out using the VueJS Frontend Framework with the help of InertiaJS for integration with the Laravel Framework. We also use PrimeVue, a UI component library for Vue.js which uses TailwindCSS, a utility-first CSS Framework for styling purposes. Figure 5.1 shown one of the snippet user interface previews.



After the Power Plants Performance Monitoring System (P3MS) for PT PLN (Persero) UP3 Pamekasan was developed, system testing was carried out to test and identify errors. Testing is an important phase in the development of any system so that it can identify code problems before it is fully deployed. System testing is to identify system improvements that need to be made and to identify whether the system being developed is in accordance with the goals and objectives of system development. The testing consist of black box testing and white box testing.

Black box testing is carried out at the module interface. This test does not touch on the performance of the program but emphasizes that the output produced must match the user's needs. This test attempts to identify errors such as incorrect or missing functionality, interface errors, structural or database access errors, presentation errors, and startup or termination errors.

The system flow of black box testing refers to the sequence of inputs and outputs within the module or software being tested. It outlines how the system processes inputs and generates corresponding outputs. The specific steps and logic involved in the system flow are not visible to the tester, as they are considered internal to the module. The focus of black box testing is on evaluating the correctness of the outputs produced based on given inputs, without considering the internal workings of the system.

In black box testing, input-output verification aims to ensure that the output produced by the module matches the expected output for a given set of inputs. Test cases are designed based on the requirements and specifications of the system. The tester provides inputs to the module and checks whether the outputs generated are correct and meet the desired expectations. This verification process helps identify errors such as missing or incorrect functionality, interface issues, and other discrepancies between expected and actual outputs.

During black box testing, error messages play an essential role in providing feedback to the user or tester when an error or exceptional condition occurs within the system. Error messages should be informative, clear, and concise, helping users or testers understand the cause of the error and take appropriate action. Black box testing includes verifying that error messages are displayed correctly, contain relevant information, and guide users in resolving the issue. This ensures that users receive meaningful feedback when errors occur, improving the overall user experience and assisting in troubleshooting.

While white box testing is a detailed check of the internal program i.e., about the logic flow. White-box testing will test all the logical results of a program whether they are correct or vice versa. Usually involves testing the loop portion of the program to detect errors. User testing was performed to determine if users find the system easy to use while system testing was done to verify the absence of the error in the system. The results of the tests obtained based on the average user satisfaction with the system. A user testing has been conducted to test this system.

System testing encompasses both user testing and system testing. User testing aims to evaluate whether users can easily use the system, while system testing verifies the absence of errors in the system. The test results are obtained based on the average user satisfaction with the system. A user testing process was conducted specifically for this system, and Table 5.1 displays the testing outcome.

TABLE II. TESTING RESULT

User Acceptance Testing Result	
Question	**Average Answer**
Is the system easy to understand and use?	4/5
Is the system interface designed to make it easy for users?	4/5
Is the main menu of the system helpful?	4/5
Is the system responsive in a timely manner?	3.5/5
Is the security of the stored data trustworthy?	3/5
Is the system fully utilized?	4/5

VI. Conclusion

Power Plants Performance Monitoring System (P3MS) for PT PLN (Persero) UP3 Pamekasan has successfully accomplished all the objectives outlined in Chapter 1. The specific achievements include:

1) The system enables the admin to manage user including staff and admin itself in the manage user module.
2) The admin can manage all master data including unit, power plant and material through the manage master data module.
3) PIC staff could approve or reject created recapitulation through the system.
4) The system can generate a repost in form of excel from the recapitulation data that created by operator staff and already approved by PIC staff.
5) Operator staff has ability to create and manage a recapitulation with ten available recapitulation type.

However, along the way, several challenges were encountered during the development of Power Plants Performance Monitoring System (P3MS) for PT PLN (Persero) UP3 Pamekasan:

1) The project has the potential to include a downloadable Excel feature, which may require the use of a third-party extension. This enhancement will allow users to generate Excel files directly from the system, providing a convenient way to export and manipulate data.
2) To optimize system performance, file compression techniques can be employed to reduce the size of the build. This will help the system run faster, especially in areas with limited internet connectivity such as remote islands. Despite these optimization efforts, the system will still prioritize a user-friendly interface and experience.
3) Efforts will be made to minimize the time taken for database indexing. Managing a single type of recapitulation often involves complex relationships between more than four tables simultaneously. Streamlining the indexing process will improve the overall efficiency of the system, reducing the time required for data retrieval and management.

To address the existing problems and weaknesses in the system, several improvements can be implemented over time. These enhancements aim to make job management faster and easier. Here are some suggestions for improving the system:

1) Introduce a feature that allows users to upload evidence for each newly created recapitulation. This feature will enable users to provide supporting documentation or proof for the recapitulation, enhancing the accuracy and reliability of the data. Additionally, it will facilitate better record-keeping and auditing processes.
2) Increase the implementation of email notifications to keep track of system activities and updates.
3) Integrate a plugin or feature to schedule jobs, enabling the monitoring, automatic status updates, and data backup of the system. This helps ensure efficient system management and maintenance.

By implementing these suggestions, the system can be enhanced to overcome current limitations and provide a more streamlined and effective user experience.

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Lastly, I realize that this thesis is still far from perfect. Therefore, suggestions and constructive criticism are expected for the perfection of this thesis.

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