



A Web-Based Material Quality Monitoring Information System for Manufacturing Quality Assurance Based-On Rapid Application Development Framework

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Abstract

This research investigates the construction of a web-based Material Quality Monitoring Information System for PT MBR using the Rapid Application Development method. This study was undertaken because recording incoming materials, defect monitoring, and supplier assessment are still manual processes using Microsoft Excel, resulting in less efficient performance, time-dependent reporting requirements, and higher risk of data input errors and duplication. This research aims to create a system to perform material quality monitoring activities more efficiently, and that is integrated, rather than single task. Methods of data collection which are considered for our study include observation, interviews, and literature reviews. It encompasses requirements, design analysis, implementation, and testing. The development process is to design the system using the Unified Modelling Language and implemented with Laravel, Bootstrap, Chart.js framework and MySQL DB. The system produced has capabilities for handling incoming material data handling, documentation and managing defect data, material quality monitoring dashboard and defect percentage dashboard by suppliers for defect performance assessment. Further, the system can display material quality information in graphs and reports that can be accessed online in real time for ease of monitoring and decision-making of users. The work outcomes indicate that the system developed demonstrates the system integration in that all the material quality information can be integrated in one structured and easy-to-use web platform accessible more seamlessly to the users. Using the black box test results, all the system functions worked according to user requirement. And as such, it can be used by PT MBR for material quality monitoring and supplier evaluation.

Keywords: Material Quality Monitoring, Information System, Rapid Application Development, Web-Based System, Bootstrap.

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1. Introduction

The development of information technology in the digital era has driven significant changes in business processes across various industry sectors. The use of technology in data processing, information visualization and decision making has become a key requirement to improve the operational efficiency and competitiveness of companies. Research shows that implementing a digital platform for quality management can integrate process data and production results, supporting faster data driven decision making [1].

PT MBR, a food industry company, still uses Microsoft Excel to record incoming materials. This method has limitations in the manual process of monitoring material defects and evaluating supplier performance, which is time consuming and potentially leads to recording errors. This results in material quality information not being obtained quickly and accurately, hindering the decision making process. Therefore, a web based material quality monitoring information system is needed that can effectively integrate the recording, monitoring, and evaluation processes [2]. A web-based material quality information system is a solution to improve the effectiveness of quality control. This system can replace error prone and time-consuming manual processes with more structured,

integrated digital records that can be accessed in real time. Previous studies have shown that web-based systems can improve data accuracy and speed up the reporting process compared to conventional methods [3]. In its development, the Rapid Application Development (RAD) method was chosen because it is iterative, fast, and actively involves users, making it more flexible [4].

Previous research on developing monitoring information systems and web based systems generally uses the Waterfall method as a system development approach and shows that implementing a web-based system can improve the efficiency and effectiveness of data management [5]. The Waterfall method helps the design process at an early stage. However, this method has limitations due to its linear nature, meaning that each stage must be completed before proceeding to the next stage. This makes the Waterfall method less responsive to changing user requirements or system adjustments that arise during the development process [6].

Research shows that the RAD method can produce a more efficient system that meets user needs in a shorter time [7]. These limitations require a system development approach that is more in line with changing user requirements. The Rapid Application Development method was chosen because it

emphasizes a fast, iterative development process and active user involvement in each phase of development.

2. Research Method

The method used in developing this system is Rapid Application Development (RAD). The RAD method was chosen because it has a fast and iterative system development approach and actively involves users in every stage of system development. This approach is able to adapt to user needs throughout the development process [8]. The research stage conducted consisted of several processes, namely data collection, system requirements analysis, system design, system implementation, and system testing. Data collection techniques were carried out through direct observation of the material quality monitoring process at PT MBR, interviews with relevant parties, and literature review from journals and past studies related to monitoring systems and RAD methods [9]. In the requirements analysis stage, problems in the current system were identified, such as manual and unintegrated material defect monitoring processes. The results of this analysis were used as a basis for designing a web-based material quality monitoring information system that could integrate the processes of incoming material recording, defect monitoring, and supplier performance evaluation more effectively and efficiently [10]. This system was developed using the Laravel framework as the backend, Bootstrap for the interface and Chart.js to display the monitoring dashboard in graphical form [11]. The database used is MySQL with XAMPP support as a local server during the system development process [12]. System design is carried out using Unified Modeling Language (UML) as a system modeling tool. UML is used to describe the structure and flow of the system through several diagrams, such as Use Case Diagram, Activity Diagram, Sequence Diagram, and Class Diagram [13]. The diagrams used include on Figure 1.

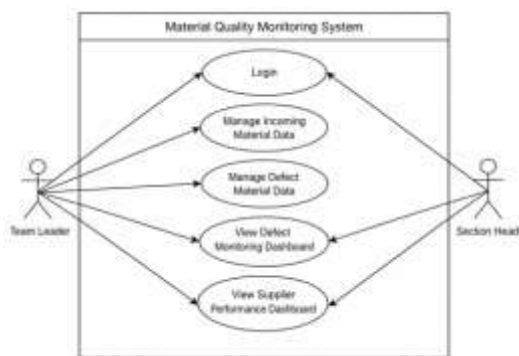


Figure 1. Use Case Diagram

A Use Case Diagram is a diagram that shows the interaction between a system and external parties or users [14]. Visually, this diagram depicts who will use the system and how they interact with it. A use case or use case diagram is a form of behavioral modeling of the information system to be developed, by describing the interactions between one or more actors with the system [15]. Next Activity Diagram Login on Figure 2.

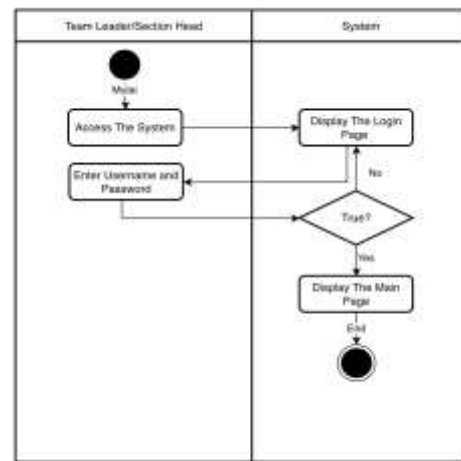


Figure 2. Activity Diagram Login

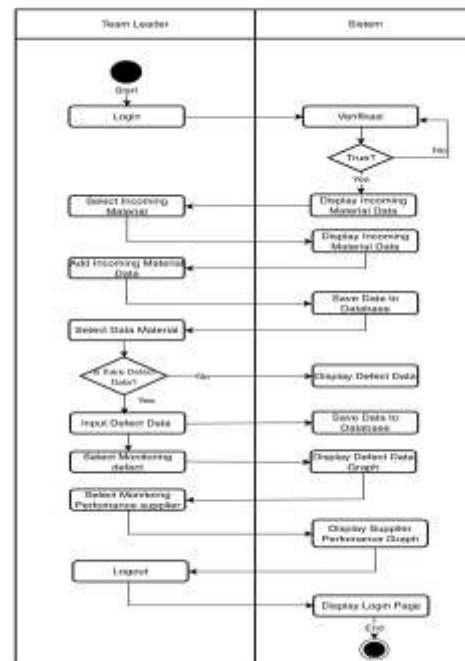


Figure 3. Activity Diagram Team Leader

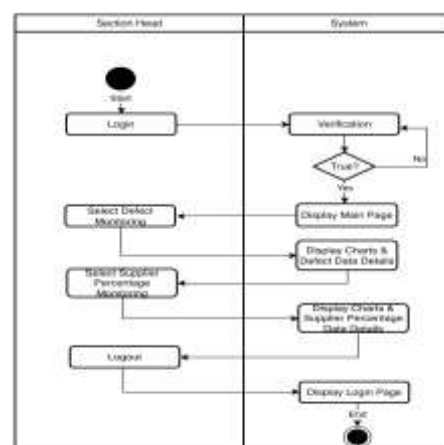


Figure 4. Activity Diagram Section Head

This diagram models the various activity flows in the system under development, depicting how each flow starts from a possible decision and showing how each activity ends [16]. Next Sequence Diagram Login on Figure 5.

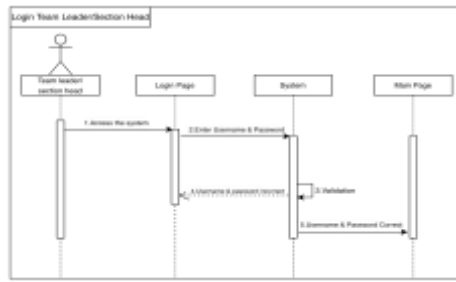


Figure 5. Sequence Diagram Login

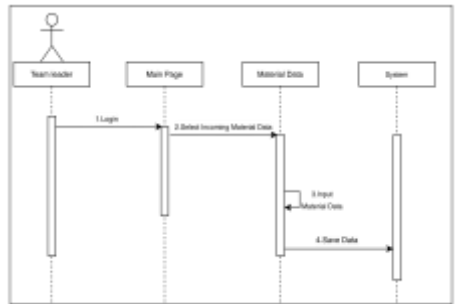


Figure 6. Sequence Diagram for Managing Incoming Materials

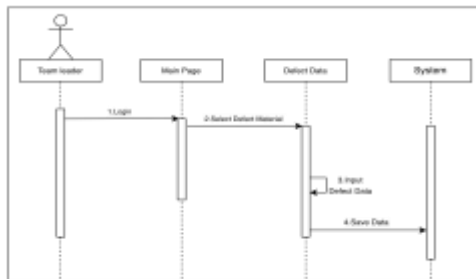


Figure 7. Sequence Diagram for Managing Material Defects

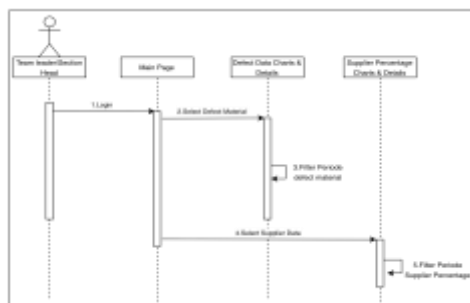


Figure 8. Sequence Diagram Monitoring

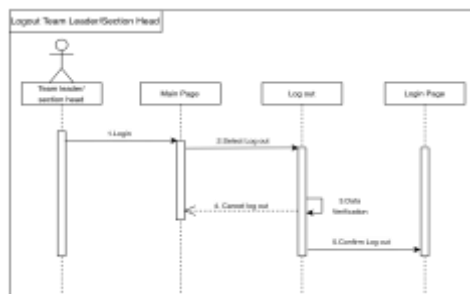


Figure 9. Sequence Diagram Logout

The sequence diagram is a dynamic modeling tool in UML that illustrates over time how various objects or system components interact with one another to accomplish specific processes or functions [17]. This

diagram is mainly to visualize the sequence of communication between objects, providing the order in which messages are exchanged and how each interaction can enable the execution of a particular business process or system operation. A sequence diagram emphasizes the temporal sequence of events, presenting a detailed representation of the behavior of the system at runtime, helping analysts and developers understand how requests are initiated, processed, and completed [18]. Next Class Diagram on Figure 10.

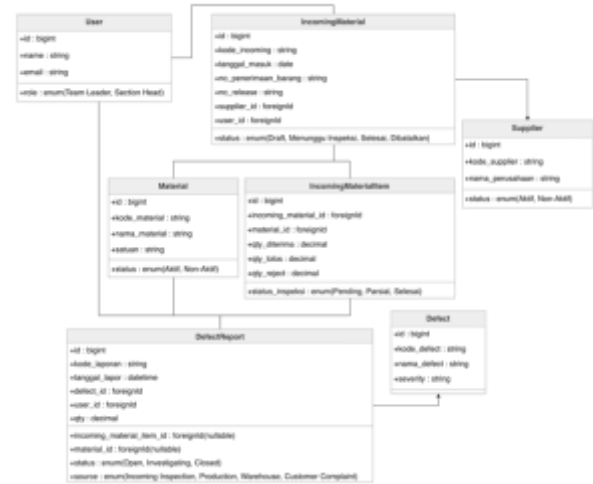


Figure 10. Class Diagram

A class diagram is a representation of the database structure in a program. This diagram plays an important role in explaining the relationships between classes and their attributes, so it is a mandatory part of a system report [19].

3. Result and Discussion

This research produced a web-based Material Quality Monitoring Information System that can replace the manual recording process previously used in Microsoft Excel at PT MBR. This system is used to record incoming material data, record material defects, and automatically store all data in a database. This system streamlines the previous manual data processing process and reduces the risk of recording errors. Furthermore, the system is able to present real-time information on material defect monitoring and defect percentage by suppliers via a dashboard. This information facilitates Quality Control and management in assessing material quality and supplier performance more efficiently. Next User Interface Login on Figure 11.



Figure 11. User Interface Login

User interface login this is the first page users use to access the Material Quality Monitoring Information

System at PT MBR. On this page, users are asked to enter their registered email address and password. There's also a remember this device feature to simplify the login process for subsequent use, as well as a show password icon to verify the password entered is correct. Next Dashboard Team Leader on Figure 12.



Figure 12. Dashboard Team Leader



Figure 13. Dashboard Section Head

The dashboard (Figure 12 and 13) is the main page displayed after a user successfully logs into the system at PT MBR, where users can view a summary of information related to material defect data in a comprehensive, informative and easy to understand visual form. At the top of the dashboard, there is an information card (summary card) that displays the number of Total Defects, Total Qty Defects, Incoming Defects, and General Defects, then below it is displayed a Defect Trend graph that shows the development of the number of defects over time as well as a Severity Distribution diagram that illustrates the severity of the defect. In addition, there is a By Category graph to view defects based on category and a Top Suppliers table that displays the number and percentage of defects from each supplier, so that through this dashboard users can monitor material quality and evaluate suppliers quickly, accurately, and in real-time without the need for manual calculations. Next User interface for Manage Incoming Material Data on Figure 14.

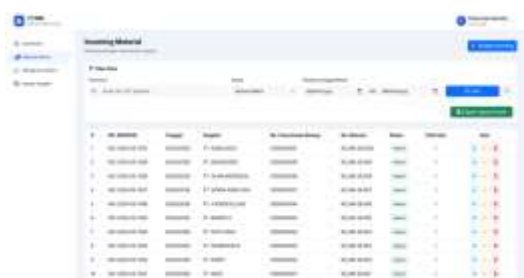


Figure 14. User interface for Manage Incoming Material Data

The user interface for Manage Incoming Material Data is used by Team Leaders to view and manage all material data received from suppliers at PT MBR, where at the top of the page there is a Data Filter feature that allows users to search based on keywords, status, and the date range of incoming material, as well as an Add Incoming button to add new material data and an Export Excel Report button to download the saved data. Next Material Data Input User Interface on Figure 15.



Figure 15. Material Data Input User Interface

This page is an Incoming Material form used by Team Leaders to input data on newly received materials from suppliers at PT MBR, where in the Main Information section the user fills in the Incoming Date, Goods Receipt No., Release No., Supplier, Status, and Additional Notes as information on material receipt, then in the Material List section the user can add items received by selecting the material name, filling in the Qty, Production Date, Expiration Date, and notes if necessary, using the Add Item button if there is more than one material in one receipt and the delete icon to delete the item row, then after all the data is filled in the user presses the Save Data button to save the information into the system or Cancel to cancel the input process so that the incoming material recording process is complete, structured, and in accordance with the conditions of receipt in the field. Next User interface for Manage Data Defects on Figure 16.

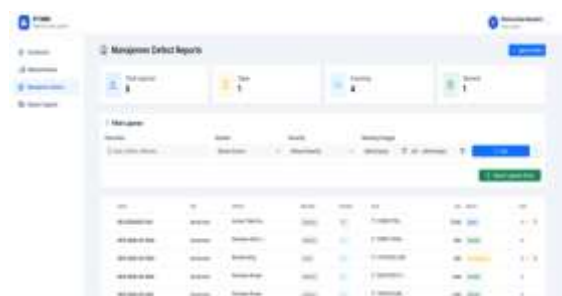


Figure 16. User interface for Manage Data Defects

The user interface for Manage Defect Data is used by Team Leaders in the PT MBR Material Quality System to manage and monitor all material defect reports that occur in the material receipt and use process, where at the top of the page there is summary information on the Total Report, Open, Incoming, and General numbers which function to display the defect report conditions quickly, then in the Report Filter section users can search for data based on report code, defect name, or material, select the defect source, determine the severity level, and filter data based on the date range so

that reports are easier to find. Next User interface for Manage Data Defects on Figure 17.



Figure 17. User interface for Manage Data Defects

This page is an Defect Report form used by the Team Leader in PT MBR Material Quality System to submit material defect reports found during the material receiving and use process. On this form, the user fills in several important data such as Report Date to determine the date the defect report was created, then selects Defect Source to determine the origin of the defect, selects Defect Type according to the category of the problem that occurred, and fills in Quantity for the amount of defective material. Next User interface for Manage Data Supplier on Figure 18.



Figure 18. User interface for Manage Data Supplier

This page is the Manage Supplier Data page used by Team Leaders to manage and monitor data on material suppliers who collaborate with the company. At the top of the page there is summary information in the form of Total Suppliers, Total Defects, Problematic Suppliers, and Clean Suppliers which function to quickly display supplier conditions based on the number of defects that occur. Then in the filter section, users can search for supplier data by code, company name, or PIC, select Status, determine Defect Level, and sort supplier data by certain categories to make data easier to find. Next User interface for Manage Data Supplier on Figure 19.



Figure 19. User interface for Manage Data Supplier

This page displays the Add Supplier form used to enter new supplier data into the PT MBR Material

Quality System. At the beginning of the form, users are asked to fill in the supplier's main information such as Supplier Code, Company Name, and Complete Company Address, there are columns for City, Province, Postal Code, and Country to complete the supplier's location data so that company information is stored clearly and neatly in the system. In the Company Contact section, users can input company communication information in the form of Telephone Number, Email, and Supplier Website which will later be used for communication needs and supplier data documentation. Next User interface View Defect Report on Figure 20.

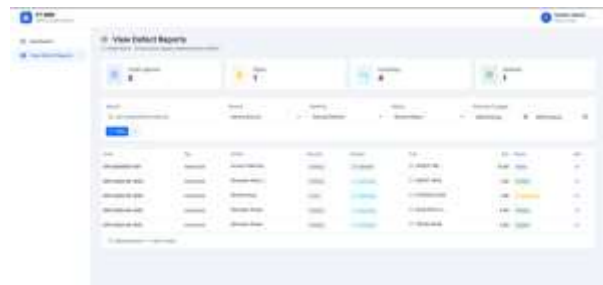


Figure 20. User interface View Defect Report

The View Defect Report page displays all material defect reports in read only mode for Section Heads. The top section displays a data summary (Total Reports, Open, Incoming, General), while the middle section features a search feature, filters, and a defect list table containing Code, Date, Defect Type, Severity, Source, Origin, Qty, and Status. This page makes it easy for Section Heads to monitor and evaluate defect reports quickly and in a structured manner. In this study, the system was tested using a black box testing method. The test results were conducted to ensure that every feature in the PT MBR Material Quality System functioned according to its function and user needs [20]. Testing was conducted by examining every page, form, button, and input and output processes in the system without viewing the program code used. The test results are presented in the following Black Box Testing table 1.

Table 1. Black Box Testing

No	Feature Tested	Expected Result	Test Result	Status
1	Login	System displays dashboard page according to role	Dashboard displayed according to role	Valid
2	Login	System displays error message	Error message displayed	Valid
3	Login	System displays validation message "Please fill in all fields"	Validation message displayed	Valid
4	Team Leader Dashboard	Dashboard summary & charts displayed	All elements displayed correctly	Valid
5	Incoming Material Management	Data can be managed, filtered, and exported successfully	Functions work properly	Valid
6	Defect Data Management	Defect reports can be managed, filtered, and exported successfully	Functions work properly	Valid
7	Supplier Data Management	Supplier data can be managed and filtered successfully	Functions work properly	Valid
8	Section Head Dashboard	Display summary of Total Reports, Open, Incoming, General, and defect list table	All elements displayed correctly	Valid
9	View Defect Report	Display all defect reports in read only mode	Defect table displayed correctly	Valid
10	View Defect Report	Display reports according to keyword	Search feature works properly	Valid
11	View Defect Report	Display reports according to filter	Filter works properly	Valid
12	Section Head Access Rights	System hides or denies access	No add/edit/delete buttons displayed	Valid
13	Logout	System redirects to login page	Logout successful	Valid

Based on the test results using the Black Box Testing method, all features in the PT MBR Material Quality System can function properly and according to user requirements. Testing was conducted on several key features such as incoming material management, defect data, supplier data, and user management by testing the input process, data processing, and output produced by the system. From the test results, all features in the system were declared to function properly as expected. Testing was conducted on two user roles, namely Team Leader and Division Leader with a total of 24 test scenarios. The test results showed that all scenarios (100%) were declared Valid because the system was able to produce outputs that matched the given inputs.

4. Conclusion

Based on the results of the study, it can be concluded that the web-based Material Quality Monitoring System at PT MBR has been successfully implemented and has improved the effectiveness and efficiency of the material quality monitoring process. This system also successfully addressed the issue of manual recording using Microsoft Excel, which previously resulted in quite lengthy data collection, defect recapitulation and report preparation. This system was developed using the Rapid Application Development (RAD) method, allowing the manufacturing process to be carried out quickly, in stages, and according to user needs. The system implementation includes several main features: incoming material data management, material defect recording, defect monitoring dashboard and supplier percentage monitoring based on material defect levels. The dashboard, in graphic and report formats, facilitates fast, easy and structured material quality monitoring. Furthermore, this system is equipped with security features in the form of login and user access rights, ensuring that data can only be accessed by authorized parties. Based on the test results using the black box test method, all the main features of the system function well according to user needs and produce valid results in each test scenario. Therefore, this web-based Material Quality Monitoring System is declared suitable for use as a support tool in the material quality monitoring process at PT MBR.

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