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Development of an Integrated Web-Based Quality Control Dashboard for Automated Sorting Data Monitoring

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Abstract

This study supports the development of a web-based Quality Control (QC) dashboard designed to improve the monitoring of product sorting data in manufacturing process. The impetus comes from the fact that traditional methods of capturing data by hand are very likely to be incorrect, slow, and cause problems with managing data. Currently, sorting results are still written down on physical log sheets which often leads to delays in reporting, puts records at risk of being lost or destroyed, and makes it harder to analyze data in real time. The study uses the Agile Development method to fix these problems, with a focus on iterative design, getting input from stakeholders, and making improvements all the time. The proposed dashboard will include several basic features, such as the ability to enter sorting results digitally, interactive data visualization in both graphical and tabular formats, automatic quality control report generation, and user management through role-based access control. These features are expected to turn data into useful information, which will allow the QC team to quickly make decisions based on evidence that enhance product quality. Web programming utilizes modern web technologies such as Laravel framework for backend processing, JavaScript, HTML, CSS, and Bootstrap to make responsive the user interface. Utilization of open-source technologies is meant to ensure that the system may grow and be maintained while keeping installation costs low.

Keywords: Dashboard, Quality Control, Web Programming, Agile, Product.

1. Introduction

In recent decades, the rapid growth of information technology has transformed almost every economic sector worldwide, including the manufacturing industry. This digital revolution has brought about significant changes in various aspects, from data management and process automation to more efficient communication systems [1] [2]. Nevertheless, in many manufacturing companies, there are still processes prone to inefficiency, one of which is the Quality Control (QC) process. In the manufacturing industry, quality control is a crucial aspect to ensure that products meet the established standards [3]. However, conventional methods of manual data collection are often susceptible to errors, slow down the process, and make real-time data access difficult [4].

Manual recording of product sorting results, as is the case at PT. Garuda Metalindo, often leads to problems such as human error, delayed reports, and difficulties in real-time data analysis [5]. According to [5], implementing a web-based Quality Control system can significantly reduce this inefficiency and improve report accuracy within the manufacturing industry. Meanwhile, [6] [7] emphasizes that an information system must be able to integrate hardware, software, and databases to ensure data remains reliable and is protected from the risk of loss.

The importance of digitalization in Indonesia's manufacturing industry is also evident from available data. According to a report by McKinsey, the adoption of Industry 4.0 technology in Indonesia's manufacturing sector still lags behind other countries in Asia, with an adoption rate of 21% in 2023. This indicates a great potential for improvement and innovation through the implementation of technology [8]. Meanwhile, with the number of internet users in Indonesia continuously increasing, reaching over 180 million in 2024, the development of web-based solutions becomes highly relevant and has a wide potential for use [9].

To address these challenges, a system is needed to efficiently monitor, manage, and analyze sorting data. One effective solution is the development of a web-based dashboard. A dashboard, as a data visualization tool, can display information in various forms such as graphs and tables, which allows for better monitoring and faster decision-making [10] [11]. Previous research has shown that a web-based dashboard in a QC system can increase transparency and effectiveness in supervising production processes [12] [13] also asserts that an effective dashboard must be able to present critical information concisely and intuitively, enabling management to make quick decisions.

Based on the problems outlined, this research aims to develop a web-based Quality Control dashboard designed to monitor sorting data in real-time. According to [14], dashboard development not only functions as a data visualization medium but can also be utilized as a decision-making tool that considers aspects of personalization and ease of data access. This

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supports the role of the Quality Control dashboard in providing more comprehensive information for both managers and operators. This development is expected to improve the efficiency and accuracy of data recording, as well as provide informative visualization and automated reports. The method used in this research is Agile Development, which allows the system to be developed in stages and is flexible to changes. From this background, two main research problems can be derived how to improve the efficiency and accuracy of sorting data recording through digitalization?; How to develop a system that allows for more effective analysis of sorting data for digital reporting and decision-making needs?.

2. Research Method

This section outlines the approach, methodology, and steps used in the system's development. This research adopts the Agile Development methodology due to its iterative nature and focus on adapting to changing user requirements [15] [16] explains that software engineering methodologies, such as Agile, provide an iterative cycle that improves collaboration with stakeholders and accelerates system completion. Furthermore, [17] defines monitoring as a systematic evaluation process to ensure that activities are proceeding according to plan, which aligns with the Quality Control process. The system development process is divided into several stages: data collection, system analysis, and system design.

Data for this research was collected through three primary methods to gain a comprehensive understanding of the problems with the manual system at PT. Garuda Metalindo. First, the author conducted direct observations of the daily Quality Control (QC) report-recording process to identify problems and inefficiencies, which provided a deep understanding of the existing manual workflow, including the risks of human error and reporting delays. Second, questionnaires were distributed to QC Operators and QC Leaders directly involved in the sorting process, designed to collect structured data on the obstacles they faced, such as illegible handwriting, the risk of document loss, and difficulties in data analysis, with the results serving as the basis for designing new features. Third, a literature review was carried out by examining various books, journals, and scientific articles relevant to the research topic, which helped build a strong theoretical foundation, including theories related to information systems, dashboards, Quality Control, and software development methodologies [1].

This stage focuses on analyzing the existing system to identify problems, followed by designing the proposed new system. Currently, PT. Garuda Metalindo uses a manual system to record product sorting results, where data is written on physical worksheets. The analysis shows that this manual system poses several serious problems, including time inefficiency because the process of searching for and compiling data is time-consuming, as well as a high risk of human error due to illegible handwriting. In addition, data stored in physical form is vulnerable to damage or loss, creating a significant risk of data loss. Furthermore, the absence of a digital system limits the ability to conduct comprehensive data analysis, making it difficult to generate accurate reports and support effective decision-making.

The new system design is based on the weaknesses of the manual system and the functional requirements that have been analyzed. This design process uses Unified Modeling Language (UML) to visualize the system's architecture. UML, or Unified Modeling Language, is a standardized language used for specifying, visualizing, constructing, and documenting artifacts within a software system. These artifacts are pieces of information, such as models, descriptions, or software, that are created during the software development process. UML diagrams are utilized across several stages of application development by various roles, including analysts, programmers, and those involved in application or network infrastructure [18]. The diagrams used are on Figure 1.

Use Case Diagram

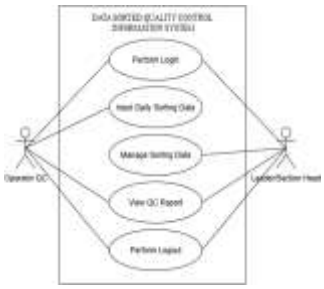

Figure 1. Usecase Diagram

Based on Figure 1, the Use Case Diagram shows that there are two users involved in the system usage. The first is the QC Operator, who can log in, input daily sorting data, view QC reports in the form of visual graphs, and log out. The second is the Leader/Supervisor, who has the ability to log in, manage sorting data, view QC reports in the form of visual graphs, and log out. Activity Diagram Login on Figure 2.

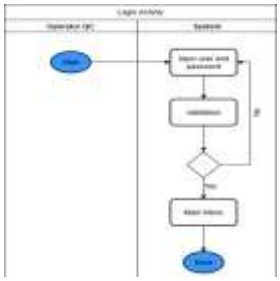

Figure 2. Activity Diagram Login

Activity Diagram on Figure 3.

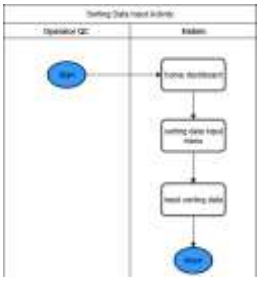

Figure 3. Activity Input Data

Activity Diagram Logout on Figure 4.

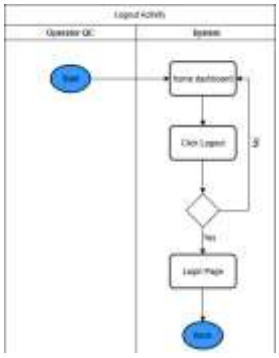

Figure 4. Activity Diagram Logout

Activity Digram, Models the workflow or business processes that occur within the system, such as login, data input, and logout processes. Sequence Diagram Login on Figure 5.

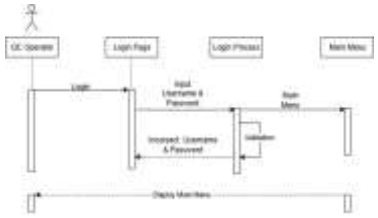

Figure 5. Sequence Diagram Login

Sequence Diagram Input Data on Figure 6.

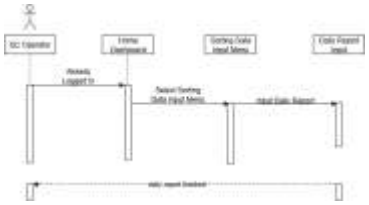

Figure 6. Sequence Diagram Input Data

Sequence Diagram Logout on Figure 7.

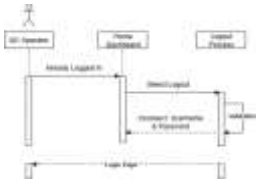

Figure 7. Sequence Diagram Logout

Sequence Diagram, Explains the sequence of messages between objects involved in a process, such as the authentication process during login or the data storage process. Next class diagram on Figure 8.

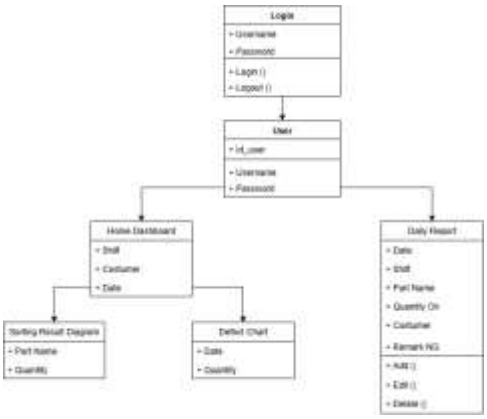

Figure 8. Class Diagram

Class Diagram, Describes the static structure of the system by showing the main classes (User, Sorting Data, QC Report), attributes, and the relationships between classes. Entity-Relationship Diagram (ERD) on Figure 9.

Figure 9. ERD

Entity-Relationship Diagram (ERD), Models the structure of the database that will be used to store data. This ERD includes the users, data_sortir, and ng_details tables to ensure proper data integrity and relationships. The system to be developed adopts a three-tier (Client-Server) architecture by utilizing several technologies. On the frontend, the system is built using HTML, CSS, and JavaScript, supported by the Bootstrap and Chart.js frameworks to provide responsive design and dynamic data visualization. On the backend, it uses the PHP programming language with the Laravel framework to handle application logic and ensure efficient system performance. Meanwhile, the database is managed using MySQL, which functions as the database management system responsible for storing and managing all required data. With this approach, it is expected that the resulting system will be able to address the research problems, namely improving efficiency and accuracy, and facilitating more effective data analysis.

3. Result and Discussion

This section presents the results of the system's design and development, including the user interface display, along with a comparative analysis of these results

against the research objectives and relevant theoretical foundations.

The web-based Quality Control Dashboard development has been successfully implemented in accordance with the design created using the Agile Development methodology. This system is designed to overcome the weaknesses of the manual system and enhance the efficiency of the Quality Control (QC) process at PT. Garuda Metalindo. The following are the implementation results visualized through the user interface on Figure 10.

Figure 10. User Interface Login

User Interface Login (Figure 10), The login page serves as a secure access gate to the system. This display separates user roles (Operator and Leader), ensuring each user can only access features according to their rights. This aligns with the Use Case Diagram analysis, which models the interaction between these two roles and the system.

Figure 11. Dashboard Operator

Figure 12. Dashboard Leader

The Dashboard User Interface for both Operators and Leaders (Figures 11 and 12) presents data in a real-time and visual format through two main visualizations. The first is the Sorting Result per Part Name Diagram, which uses a bar chart to display the comparison between the number of OK and NG products for each type of part sorted. This feature allows Operators and Leaders to quickly identify parts with a high defect rate. The second is the Daily NG Trend, which utilizes a line chart to illustrate fluctuations in the number of defective products over time, making it easier to detect anomalies or sudden spikes in quality issues that require further investigation.

Figure 13. Sorting Data Input User Interface

Sorting Data Input User Interface (Figure 13): This page completely replaces the manual paper forms. Operators can input data digitally, including details of defect types, which are automatically calculated by the system. This directly addresses the issues of human error and inefficiency that occurred in the manual recording process.

Figure 14. User Interface for Pareto Analysis

User Interface for Pareto Analysis (Figure 14), This feature is a vital analytical tool for the Leader. The Pareto diagram automatically identifies the most frequent defect types and their percentage contribution to the total problems. Aligned with the Pareto Principle, this feature helps management focus improvement efforts on the 20% of main causes that lead to 80% of the problems.

Figure 15. Data Management User Interface

Data Management User Interface (Figure 15), This system is equipped with a comprehensive management feature. The Manage Sorting Data function provides the Leader with full control to monitor, edit, and delete all sorting data inputted by every operator, ensuring data accuracy is always maintained.

Figure 16. User Interface Manage User

Manage User (Figure 16): This feature allows the Leader to manage user accounts, including adding, editing, and deleting users, which maintains the security and integrity of the system.

Figure 17. Manage Part User Interface

Manage Part User Interface (Figure 17). This page is designed as the central hub for managing master part data, allowing the Leader to maintain data consistency. This feature is crucial because the data inputted by the Operator can only be selected from the list established here. The page includes a table of part lists and buttons for performing data management operations (add, edit, and delete), which ensures the master data is always accurate and standardized.

This study used the Black-box Testing method to test the system's functionality according to user requirements. This method focuses on testing inputs and outputs without knowing the program's internal structure [19]. With this approach, each feature is tested based on how well the system's output matches the predetermined test scenarios. The table below contains the test scenarios for some of the key functionalities in the application on Table 1.

Table 1. Blackbox Testing

No	Testing Scenario	Input	Expected Results(output)	Testing Results
1.	Operator Login Testing	Valid username and password	The system has successfully logged into the Operator dashboard.	Success
2.	Leader Login Testing	Valid username and password	The system has successfully logged into the Leader dashboard.	Success
3.	Sorting Data Input Test	Fill in all sorting data fields correctly.	Data is stored in the database and appears in the sorting history table.	Success
4.	My Sorting History Test	Select a date and click Show	Displaying sorted data according to the selected date	Success
5.	Dashboard Filter Testing	Choose the shift, customer, month, and year that have data.	The data displayed corresponds to the selected filter.	Success
6.	Print Button Testing	Click the Print button on the page that has that feature.	The print dialog appears with the correct data display.	Success
7.	Testing the Export to Excel Button	Click the Export to Excel button	The Excel file containing the filtered data has been successfully downloaded.	Success
8.	Testing Edit Sorted Data	Making changes to the data in one of the table rows	The data in the database has been successfully updated and the table view has changed.	Success
9.	Sorting Data Deletion Test	Deleting one of the data in the table	Data has been successfully deleted from the database and table.	Success
10.	Pareto Analysis Testing	Select the month and year period	The Pareto diagram and the NG detail table appear according to the selected period.	Success
11.	Management Part Testing	Adding, editing, and deleting part data	The data part in the database has been successfully updated according to the actions.	Success
12.	User Management Testing	Adding, editing, and deleting user data	User data in the database has been successfully updated according to the action.	Success
13.	Operator Monitoring Testing	Choose the date and operator username	Display a summary of the activities and details of the operator's sorting results on that date.	Success
14.	Detailed Testing of Sort Results	Select month and year	Displaying graphs and tables of monthly sorting results	Success
15.	Monthly NG Trend Detail Testing	Select month and year	Displaying monthly NG trend graphs and pie charts	Success
16.	Logout Testing	Click the Logout button on the sidebar	The user is redirected back to the login page and the login session ends.	Success

Based on the implementation results and the Black Box Testing (Table 1), the developed system successfully addresses all research problems and fulfills the study objectives. Improved Efficiency and Accuracy: Testing shows that all data input features function correctly and store data accurately in the database. The digitization of the process successfully eliminates the risk of input errors due to illegible handwriting, which was a major problem with the manual system. The data recapitulation process, which previously took a long time, now happens automatically, significantly increasing operational efficiency.

Decision-Making Support: The data visualizations on the dashboard directly support data-driven decision-making. Unlike the manual system which only provides raw data, this dashboard presents data in an easy-to-understand graphical format, allowing Leaders and management to identify quality trends, predict potential issues, and take corrective actions more quickly. This is highly consistent with the theory of dashboards as an effective information visualization tool.

Alignment with Methodology and Theory: The implementation of this system also proves the success of the Agile Development methodology and the concept of a Web-Based Information System. The

developed features, such as data input, analysis, and user management, reflect the key components of an information system, all of which are realized in a web environment that can be accessed in real-time. The implementation of dashboards in the private sector has also been shown to yield positive results. A study at WWMusik Malang revealed that the use of a Business Intelligence Dashboard for monitoring KPIs received a high usability score, indicating that users felt supported in their operational decision-making processes [20]. This finding aligns with the results of this study, which emphasizes the importance of data integration and visualization in supporting the Quality Control process. Thus, the development of this dashboard is not merely a data recording tool but an integrated and effective information system for monitoring the Quality Control process, which substantially enhances the company's operational efficiency, accuracy, and transparency.

4. Conclusion

In conclusion there should be no reference. The conclusion contains the facts obtained. State the application possibilities, implications and speculations as appropriate. If necessary, give suggestions for further research. This research aims to develop a web-based Quality Control Dashboard to monitor sorting data at PT. Garuda Metalindo. Based on the implementation and analysis conducted, several key conclusions can be drawn that address the research objectives. The developed Quality Control Dashboard has successfully improved both efficiency and accuracy in the sorting data recording process. By digitizing the workflow, the system eliminates human errors caused by illegible handwriting and significantly accelerates the data recapitulation process, which previously had to be performed manually and required considerable time. In addition, the system provides effective and real-time data visualization through the dashboard, directly supporting data-driven decision-making for Leaders and management. With the use of graphs and diagrams, monitoring product quality trends and identifying potential issues can be carried out more quickly and accurately, allowing corrective actions to be implemented immediately. Furthermore, the development of this system successfully applies the Agile Development methodology and the concept of a Web-Based Information System. The implemented features, ranging from data input to analysis, demonstrate that the system serves as an integrated and effective solution for monitoring the Quality Control process. For future system development, several suggestions can be considered to make this application more optimal Automatic Notification Feature Development: Adding a real-time notification feature for leaders or managers if there is a significant spike in the number of NG (Not Good) products, so that corrective actions can be taken immediately. Integration with Other Systems: Integrating the system with existing production or inventory systems in the company for more comprehensive data automation, such as part data that is automatically updated from other systems. Predictive Analytics: Developing a predictive analytics feature using historical data to forecast potential quality issues in the future, which can help with prevention and strategic planning.

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