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WEB-BASED TRAY MONITORING APPLICATION USING CODEIGNITER (CI) FRAMEWORK: CASE STUDY OF PT SIIX EMS INDONESIA

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Abstract

PT SIIX EMS Indonesia currently manages tray monitoring manually, which leads to issues such as data inaccuracies, delays in information retrieval, and difficulties in tracking tray availability across production lines. This study aims to design and develop a web-based tray monitoring system to improve data management efficiency and support real-time monitoring. The research method includes data collection through observation and literature review, while system development follows the Waterfall model. The application is implemented using the CodeIgniter framework with PHP and MySQL.The results show that the developed system successfully integrates data for new trays, recycled trays, and scrap trays into a centralized platform. Based on Black Box Testing, 100% of test scenarios were executed successfully without functional errors, indicating that all system features operate as expected. The implementation of the system reduces manual recording processes and improves data accessibility, which is expected to enhance operational efficiency and minimize data inconsistencies.In conclusion, the web-based tray monitoring system effectively addresses the limitations of manual processes by providing accurate, real-time, and integrated data management. The system is considered ready for implementation and has the potential to improve decision-making processes within the company. Future development is recommended to include performance evaluation and user satisfaction analysis to further enhance system effectiveness.

Keywords: *Monitoring Tray, Information System, CodeIgniter, Waterfall, Web*

1. INTRODUCTION

PT SIIX EMS Indonesia is a manufacturing company engaged in the production and assembly of electronic components. In its operations, the company uses various types of trays for temporary storage and distribution of components between production lines. Trays play a crucial role in maintaining orderly production flows, ensuring component safety, and facilitating more efficient material distribution [1]. Good tray management is a key factor in ensuring a smooth production process, particularly in the logistics and production departments, which are responsible for providing and returning trays throughout the production process.

However, in practice, the tray monitoring and data collection process at PT SIIX EMS Indonesia is still carried out manually using conventional record keeping. This manual system presents various challenges, such as recording errors, data loss, and difficulty tracking the number and condition of trays scattered across various production areas. Furthermore, manual record keeping also leads to delays in information delivery and a lack of data transparency between relevant departments. This situation reduces the company's operational efficiency, particularly in the logistics and production departments, which must ensure timely tray availability. A mismatch between the number of trays available and production needs can hinder the production process and increase the risk of delays in product delivery to customers. These issues indicate that the current tray monitoring system is not yet capable of optimally supporting the company's operational needs [2].

The increasingly rapid development of information technology has encouraged the use of web-based systems as an alternative solution to address various operational challenges. Web-based systems offer several advantages, such as ease of access, flexibility of use, and the ability to centrally integrate data. Through the implementation of a web-based tray monitoring system, the process of recording and tracking trays can be carried out in real time, allowing for quick and accurate information on the number, location, and condition of trays. Furthermore, this system is capable of generating automatic reports that can assist management in making decisions based on available data. Therefore, this study proposes the development of a web-based tray monitoring application to improve the efficiency of tray management at PT SIIX EMS Indonesia.

In developing the web-based tray monitoring application, this study utilized the CodeIgniter (CI) framework. The CodeIgniter framework was chosen because it implements a Model-View-Controller (MVC) architecture, which allows for a structured separation of program logic, interface display, and data management. This separation allows for a more organized system development process and simplifies future application maintenance and development[3]. Furthermore, CodeIgniter is relatively lightweight and has fast execution times, improving the performance of web-based applications [4]. Ease of configuration and comprehensive documentation are also advantages of CodeIgniter in supporting application development within a limited timeframe [5].

Compared to other frameworks such as Laravel, CodeIgniter is considered simpler in the initial configuration process and does not require high server specifications. This makes CodeIgniter more efficient for use in medium-scale system development with limited development time [6]. Furthermore, compared to the Yii framework and native PHP-based development, CodeIgniter offers good flexibility and ease of system maintenance [7]. Extensive community support and comprehensive documentation were also supporting factors in selecting CodeIgniter as the framework used in this study.

Although several previous studies have developed web-based monitoring systems for inventory and production equipment management, most of these studies focused primarily on general inventory control without specifically addressing tray monitoring in manufacturing environments[8]. Some studies implemented web-based systems using frameworks such as Laravel or native PHP; however, they often emphasized system functionality without focusing on real-time tray tracking and inter-departmental data integration[9]. In addition, previous research rarely discussed tray management as a critical element in maintaining production flow efficiency, particularly in electronics manufacturing companies where component handling requires high precision and organization[10].

Furthermore, previous studies generally applied Agile or prototype development methods, which require continuous iteration and adjustment during development. While these approaches are flexible, they may not be suitable for research with clearly defined system requirements and limited development time[11]. Therefore, there is still a need for research that develops a structured web-based tray monitoring system using the Waterfall method, combined with a lightweight and efficient framework such as CodeIgniter, to address tray management problems more effectively.

The system development method used in this research is the Waterfall method. The Waterfall method was chosen based on its characteristics, which include systematic and structured development stages, starting with needs analysis, system design, implementation, and system testing [12]. This approach was deemed appropriate for the research needs because the tray monitoring system to be developed had clear requirements from the outset. Therefore, using the Waterfall method can help make the system development process more focused and facilitate documentation at each development stage. Furthermore, compared to Agile methods, which are iterative and require repeated changes, the Waterfall method is more suitable for academic research with limited time because each stage is carried out sequentially and in a planned manner [13].

Through the development of this web-based tray monitoring application, the company is expected to obtain a system capable of presenting tray data more accurately, quickly, and easily accessible to relevant departments. This integrated system is expected to reduce recording errors, accelerate the tray tracking process at each production stage, and minimize the potential for data loss or inconsistencies[14]. Furthermore, this system is expected to improve operational effectiveness and efficiency in logistics and production, as well as support more informed decision-making due to the real-time and well-documented information displayed.

For companies, this system can help increase productivity and streamline production processes. Meanwhile, for researchers and academics, the results of this study are expected to serve as a reference and example of the application of web-based technology to solve operational problems in the industrial world, particularly in inventory management and production equipment monitoring.

2. RESEARCH METHODOLOGY

The research method in this study consists of two main parts: data collection and software development. Data collection was conducted through direct observation to obtain a picture of actual conditions in the field, and through literature review to obtain theoretical references relevant to the research[15]. Meanwhile, software development was carried out using the Waterfall model, which is implemented in stages and sequentially, starting from requirements analysis, system design, implementation, testing, and maintenance[16]. This approach is used to ensure the system development process can proceed systematically, directed, and structured.

2.1 Data Collection Method

Data collection techniques in this research were conducted through observation and literature review. Direct observation was conducted to obtain information regarding conditions and needs in the field, while literature review was used to gather theoretical references from books, journals, and other relevant scientific sources. The combination of these two techniques aims to obtain accurate data and support the analysis and system development process in the research.

1) Observation

The observation method was conducted to gain a direct understanding of the work processes at PT SIIX EMS Indonesia, specifically regarding the flow of tray use and data collection on the production line. This observation included observing tray use, returning leftover trays, and manually recording existing tray stock, as well as any obstacles that arose during the monitoring process. Through observation, researchers were able to identify real-world problems in the field and determine the need for a relevant system to be proposed in the research[17].

2) Literature Review

The literature review was used to collect references, journals, books, and previous research related to information systems, asset monitoring, and web-based application development. The literature reviewed serves as a theoretical basis and support in compiling the system design, as well as ensuring that the proposed method is in line with the latest research standards and technological developments[18].

2.2 System Development Method

Software development in this study used the Waterfall method, which was carried out in stages and systematically. The process begins with a needs analysis to identify system specifications, followed by design as the basis for system development, followed by implementation to translate the design into an application, and testing to ensure the system operates according to requirements. The final stage is maintenance to maintain performance and make improvements when necessary, ensuring optimal and sustainable system function.

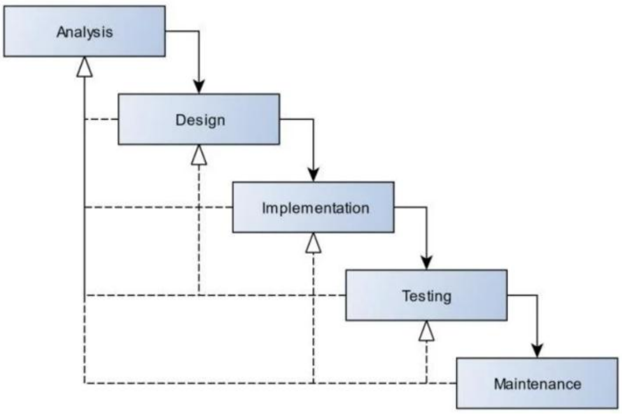

Figure 1. Waterfall Method
[19]

2.3 Analysis Requirement

Based on observations and documentation, the tray monitoring process at PT SIIX EMS Indonesia is still carried out manually using conventional record keeping, resulting in data not yet being integrated into a single system. This situation creates various problems, such as potential recording errors, inconsistent data, reporting delays, and difficulties in tracking the number and condition of trays in real time. Furthermore, data retrieval is time-consuming due to manual review of records, reducing operator efficiency and making it difficult for management to obtain accurate information for decision-making. Therefore, a web-based information system capable of managing tray data in an integrated manner is required. Functional requirements include user login based on access rights, tray data management, data retrieval, and report presentation. Non-functional requirements include ease of use, data security, and system accessibility via a web browser.

2.4 System Architecture Design

The system architecture of the web-based tray monitoring application is designed using a client–server model combined with the Model–View–Controller (MVC) architecture provided by the CodeIgniter framework. In this system, users consisting of Admin, Operator, and Leader access the application through a web browser on the client side. Each user has different roles and permissions, where the Admin manages user data, the Operator handles tray data input and updates, and the Leader focuses on monitoring and viewing reports. All interactions from the client are sent as HTTP requests to the web server.

The web server acts as the core of the system, where the application logic is processed using the CodeIgniter framework. Within this layer, the Controller handles incoming requests from users and determines the appropriate process flow. The Controller communicates with the Model, which is responsible for managing data operations such as retrieving, inserting, updating, and deleting data in the database. After processing, the results are passed to the View, which generates the user interface displayed in the browser. This separation of concerns ensures that the system is well-structured, maintainable, and scalable.

On the backend, the database server uses MySQL to store and manage all system data, including user data, new tray data, recycled tray data, and scrap tray data. The communication between the web server and the database server occurs through structured queries, allowing real-time data processing and retrieval. Overall, this architecture enables efficient data integration, improves accuracy in tray monitoring, supports real-time information access, and enhances decision-making processes within the organization.

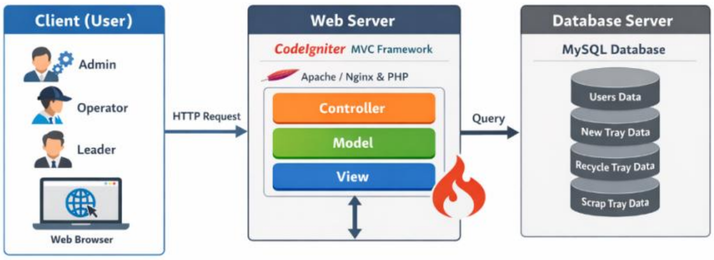

Figure 2. System Architecture Design
[Source: Author, 2026]

2.5 Design

The system design in this study was carried out using the Unified Modeling Language (UML) to provide an overview of the structure and workflow of the tray monitoring application to be developed. The diagrams used include Use Case Diagrams to describe the interaction between the user and the system, Activity Diagrams to show the process flow of the tray monitoring system, and Class Diagrams to describe the data structure and relationships between classes in the system. The use of UML aims to simplify the system development process, provide a clear understanding of system requirements, and ensure that the application being built is in accordance with user needs[20].

2.5.1 Use Case Diagram

This use case diagram illustrates the relationship between the three main actors—Admin, Leader, and Operator—with the tray monitoring system. Admins have access to log in to the system and manage user data. Operators input data, including adding, editing, and deleting data. Leaders use the system to view tray information and obtain summary reports generated by the system. This diagram provides a comprehensive overview of the functions each user can perform according to their roles and responsibilities in the tray monitoring process. Furthermore, this use case serves as a basis for determining the functional requirements of the system to be developed. This modeling allows for a clearer understanding of every interaction between actors and the system, thereby minimizing errors during the system design and implementation stages. This diagram also helps developers ensure that all required user functions are accommodated in accordance with the objectives of the tray monitoring system.

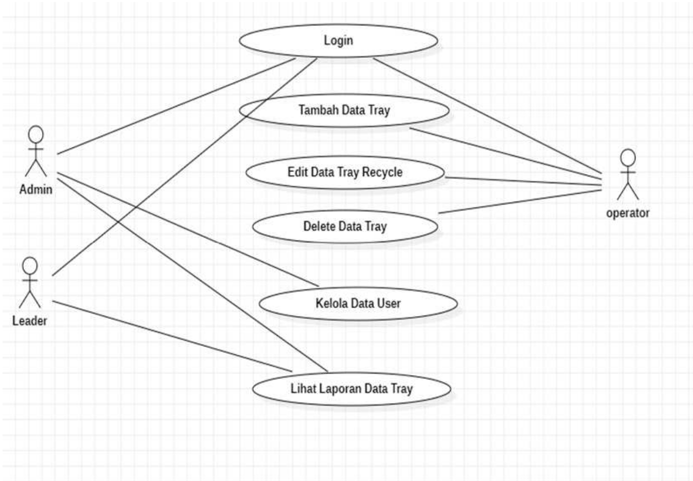

Figure 3. Use Case Diagram
[Source: Author, 2026]

2.5.2 Activity Diagram

An Activity Diagram is a type of behavioral diagram used to illustrate the flow of activities or processes within a system. It describes the sequence of actions, decision points, and parallel processes from the beginning to the end of a workflow. Activity diagrams help in understanding system functionality, identifying process logic, and visualizing how different components interact. This diagram is commonly used in system analysis and design to model business processes and user interactions clearly and systematically.

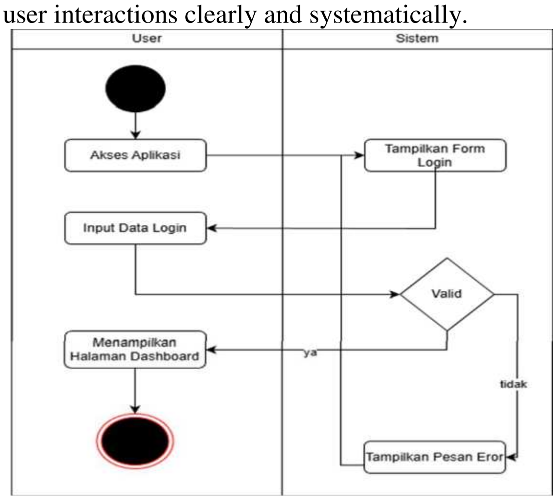

Figure 4. Activity Diagram Login
[Source: Author, 2026]

This login activity diagram illustrates the user authentication process, starting from when the user accesses the application until the system validates the login data. The user enters their username and password, and the system then checks for accuracy. If the entered data is valid, the system displays a dashboard page based on the user's access rights. Conversely, if the login data is invalid, the system displays an error message and prompts the user to re-login.

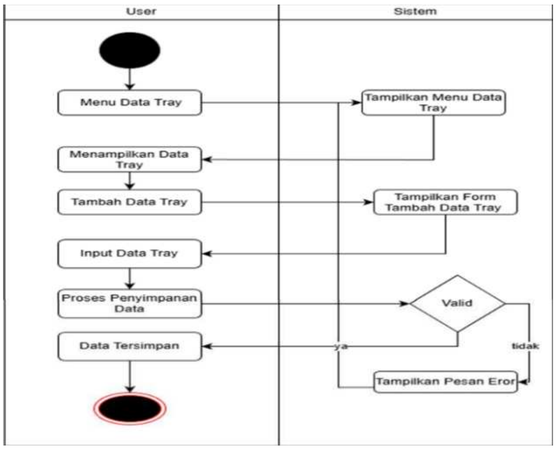

Figure 5. Activity Diagram Add New Data Tray
[Source: Author, 2026]

In this process, the user first accesses the data tray menu, which displays a list of available data trays. Next, the user selects the "Add Data Tray" option, and the system displays a data addition form. The inputted data is then processed by the system to check for completeness and accuracy before being saved to the database. This process ensures that the stored data tray complies with regulations and can be used in subsequent monitoring processes.

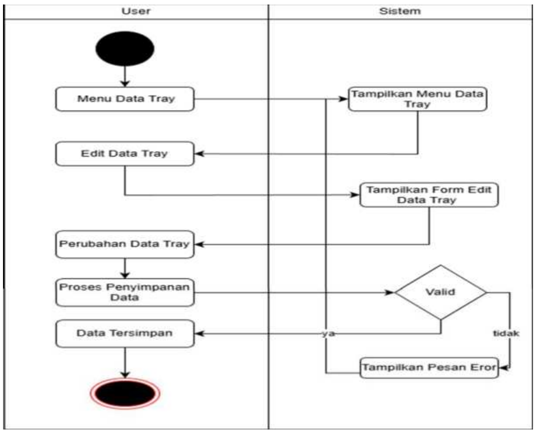

Figure 6. Activity Diagram Edit Data Tray

This data editing process aims to maintain the accuracy and currency of the tray data stored in the system. By validating each data change, the system can ensure that the stored data complies with applicable regulations. Furthermore, this mechanism assists users in making accurate data corrections so that the displayed tray information can be used as a basis for decision-making in the tray monitoring process.

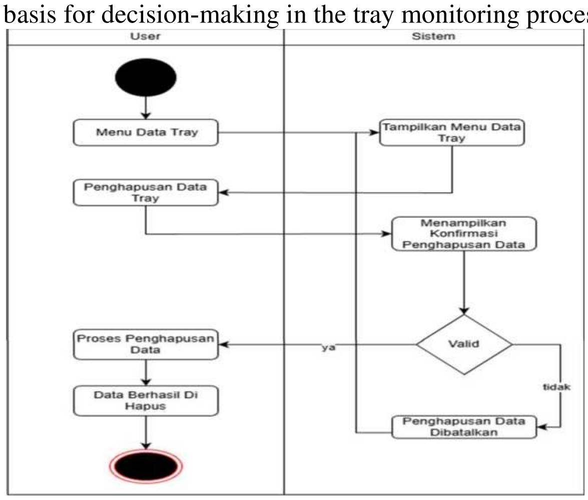

Figure 7. Activity Diagram Delete Data Tray
[Source: Author, 2026]

The purpose of deleting tray data is to manage unused data so that it doesn't accumulate within the system. Deletion confirmation serves as a security mechanism to prevent accidental data deletion. This way, the system can maintain data integrity and ensure that each deletion process is carried out based on user consent and in accordance with established procedures. Furthermore, the delete tray data feature supports more effective and structured data management, particularly for tray data that is no longer relevant or has been recorded incorrectly. With a clear and controlled deletion process, the system can minimize the risk of data inconsistencies and maintain the quality of stored information.

2.5.3 Class Diagram

A class diagram is one of the diagrams in Unified Modeling Language (UML) used to describe the static structure of a system. This diagram illustrates the classes within a system, the attributes owned by each class, the methods or operations that can be performed, and the relationships between classes such as association, inheritance, and dependency. Class diagrams help developers understand system structure and data relationships more clearly, making the software design and development process more structured and systematic[21].

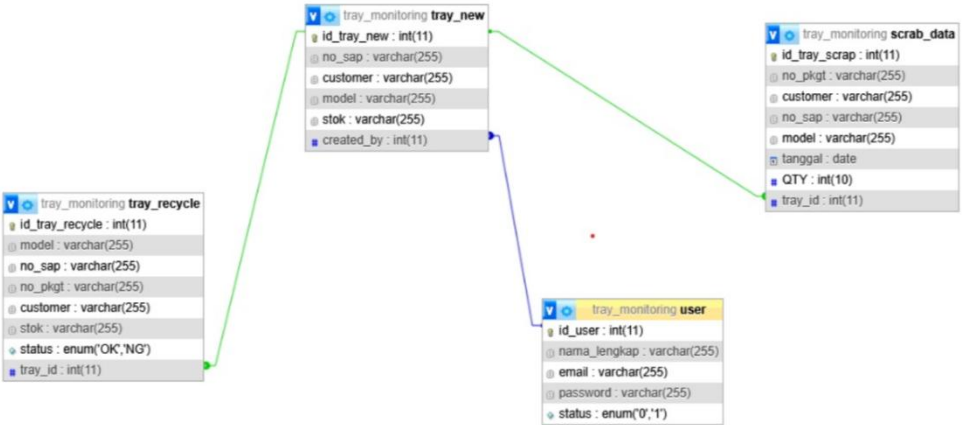

Figure 8. Class Diagram
[Source: Author, 2026]

Based on the class diagram shown in the figure, the tray monitoring system consists of four main classes: tray_new, tray_recycle, scrab_data, and user. The tray_new class functions as the main data table that stores new tray information such as *no_sap*, *customer*, *model*, *stok*, and *created_by*. The tray_recycle class is connected to tray_new through the *tray_id* attribute, indicating that recycle tray data originates from the new tray data. Furthermore, the scrab_data class also has a relationship with tray_new through *tray_id*, which is used to record scrap tray data, including date and quantity (QTY). In addition, the user class is related to tray_new through the *created_by* attribute, indicating the user who created the tray data. These relationships show that the tray monitoring system integrates new tray data, recycle tray data, scrap tray data, and system users in a structured manner.

2.5.4 Database Design

The database in this system is designed as a structured data storage component that supports the operation of a web-based tray monitoring application. It functions to store, manage, and organize all data related to users and tray activities, including new trays, recycled trays, and scrap trays. By using a relational database management system (MySQL), the system ensures data consistency, integrity, and efficient retrieval through well-defined relationships between tables. This database design enables real-time data processing, minimizes errors caused by manual recording, and supports accurate reporting and decision-making. Overall, the database plays a crucial role in integrating all system components and ensuring that information is accessible, reliable, and well-organized.

Table 1. Table user
[Source: Author, 2026]

Field Name	Data Type	Length	Key	Description
id_user	INT	11	PK	Primary key (auto increment)
username	VARCHAR	50		User login name
password	VARCHAR	255		Encrypted password
role	ENUM	-		User role (admin, operator, leader)
created_at	DATETIME	-		Record creation time
updated_at	DATETIME	-		Last update time

The users table stores all user account data that can access the system. Each user has a unique identifier (id_user) and login credentials consisting of a username and password. The password is stored in encrypted form to ensure system security. The role field defines the level of access for each user, such as admin, operator, or leader, which determines their permissions within the system. The created_at and updated_at fields are used to track when the user data was created and last modified, supporting better data management and auditing.

Table 2. Table tray_new
[Source: Author, 2026]

Field Name	Data Type	Length	Key	Description
id_tray	INT	11	PK	Primary key
no_sap	VARCHAR	50		SAP part number
customer	VARCHAR	100		Customer name
model	VARCHAR	100		Product model
stock	INT	11		Number of trays available
created_by	INT	11	FK	Reference to user
created_at	DATETIME	-		Record creation time
updated_at	DATETIME	-		Last update time

The tray_new table serves as the main data entity in the system, storing information about newly available trays. It includes details such as the SAP part number, customer name, product model, and the quantity of trays in stock. The created_by field establishes a relationship with the users table, indicating which user entered the data. This table plays a central role in the system because it connects to other tables such as recycle and scrap trays. The timestamps help maintain data accuracy and track changes over time.

Table 3. Table tray_recycle
[Source: Author, 2026]

Field Name	Data Type	Length	Key	Description
id_recycle	INT	11	PK	Primary key
tray_id	INT	11	FK	Reference to tray_new
qty	INT	11		Quantity of recycled trays
condition	VARCHAR	50		Tray condition
created_at	DATETIME	-		Record creation time
updated_at	DATETIME	-		Last update time

The tray_recycle table stores data related to recycled trays that are still usable after being returned from production. Each record is linked to the tray_new table through the tray_id field, indicating the origin of the tray. The qty field records the number of recycled trays, while the condition field describes their physical condition. This table helps the system track reusable trays efficiently and supports better inventory management by distinguishing between new and recycled items.

Table 4 Table tray_scrab
[Source: Author, 2026]

Field Name	Data Type	Length	Key	Description
id_scrap	INT	11	PK	Primary key
tray_id	INT	11	FK	Reference to tray_new
qty	INT	11		Quantity of scrap trays
scrap_date	DATE	-		Date of scrap record
created_at	DATETIME	-		Record creation time
updated_at	DATETIME	-		Last update time

2.6 Implementation

The implementation phase is the process of developing the system based on the previously completed design. In this stage, the tray monitoring application is developed using the CodeIgniter framework with PHP as the programming language and MySQL as the database management system for data storage. In addition, the system interface is built using HTML, CSS, and JavaScript to ensure that the application can be easily accessed through a web browser[3]. During this phase, the main features of the system are developed, including tray data management, tray monitoring, tray reporting, and user management according to system requirements. The implementation phase translates system design into a functional application that can be used by users effectively and efficiently.

2.7 Testing

After the system has been developed, the next stage is system testing to ensure that the application functions properly and meets user requirements. Testing is conducted using the Black Box Testing method by examining each feature of the system, such as login processes, tray data management, tray monitoring, and report generation. This testing approach focuses on validating system functionality without examining the internal code structure. The purpose of testing is to identify errors or bugs so that improvements can be made before the system is fully implemented in the company. System testing is an essential stage to ensure system reliability, functionality, and user satisfaction[22].

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2.8 Maintence

Maintenance is the final stage of the Waterfall method, carried out after the system has been implemented and used by users. At this stage, monitoring of the tray monitoring application performance is conducted to ensure the system operates according to company requirements. System maintenance includes fixing errors or bugs discovered during system usage, updating the system when requirements change, and improving features to support optimal system performance[23]. In addition, maintenance also involves database management, periodic data backup, and system adjustments to technological developments or changes in business processes. Through proper maintenance, the tray monitoring application is expected to be used sustainably and continue supporting operational efficiency at PT SIIX EMS Indonesia.

3. RESULT AND DISCUSSION

3.1 Resukt

The results of this study show that the tray monitoring system was successfully developed as a web-based application using the CodeIgniter framework. The system involves three main actors: admin, operator, and leader, each with different roles and access rights. The admin is responsible for managing user data, system configuration, and overall data control. The operator functions to input and manage tray data, including new trays, recycle trays, and scrap trays. Meanwhile, the leader has access to monitor tray data and view reports to support decision-making processes. The web-based system allows users to access the application through a browser, enabling real-time monitoring, easier data management, and improved efficiency in tray tracking and reporting processes.

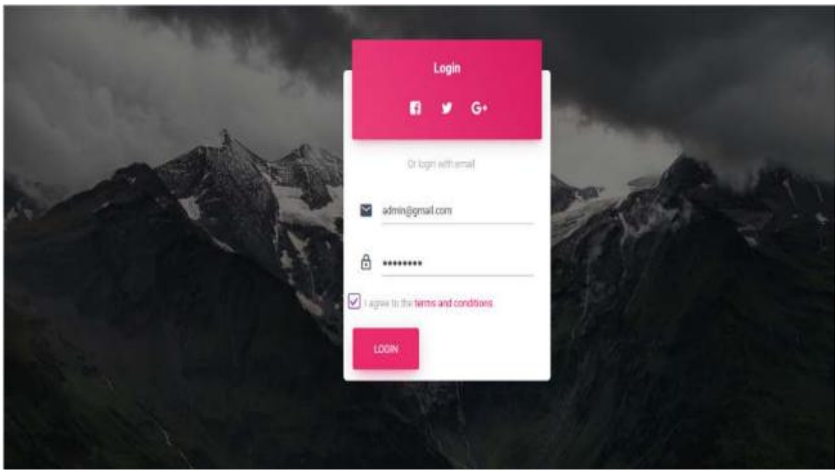

Figure 9. Login Page
[Source: Author, 2026]

The login page is the initial display used by users to access the tray monitoring system by entering their registered username and password. The interface is designed to simplify the user authentication process. If the entered data is valid, the system will redirect the user to the dashboard page according to their access rights. If it is invalid, the system will display an error notification. The login page also serves as a security mechanism to restrict access to authorized users, ensuring data security and preventing unauthorized access.

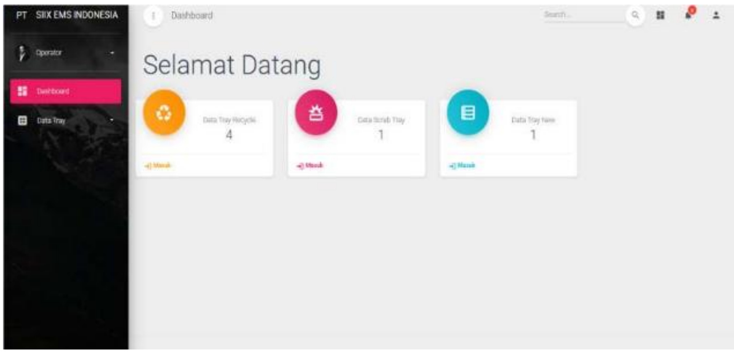

Figure 10. Dashboard Page
[Source: Author, 2026]

The dashboard is the main page displayed after a user successfully logs in to the system. This page displays a summary of tray monitoring data, such as the number of recycle bins, scrap bins, and new bins recorded in the system. The dashboard also features a navigation menu on the left side to facilitate user access to the tray data management features. The simple and informative interface helps users quickly assess data status and simplifies the process of monitoring and managing trays without having to open each menu separately.

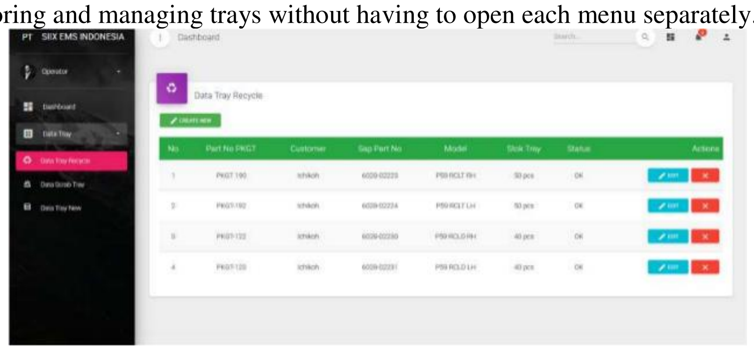

Figure 11. Data Tray Recycle Page
[Source: Author, 2026]

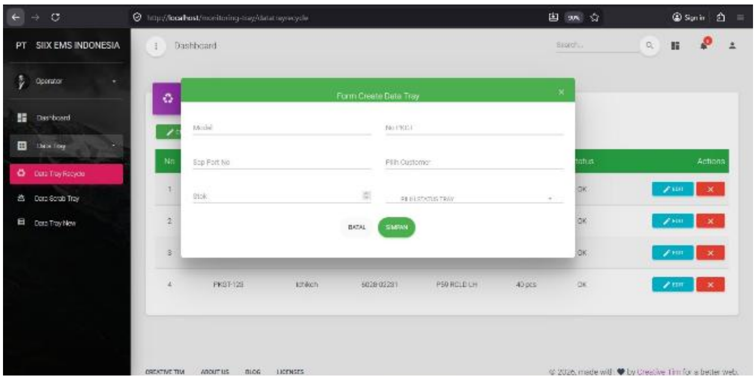

Figure12. Add New Data Tray Recycle Page
[Source: Author, 2026]

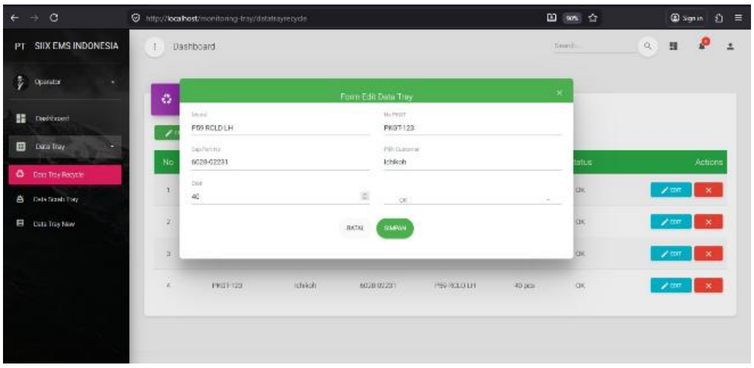

Figure 13. Edit Data Tray Recycle Page
[Source: Author, 2026]

The Tray Recycle Data page is used to display and manage tray recycle data in the system. The information displayed includes the PKGT Part No., customer name, SAP Part Number, product model, stock quantity, and tray condition status in tabular form. This page also provides data management features such as add, edit, and delete to facilitate information updates. With this feature, users can monitor the number and condition of trays in a more organized manner, thereby minimizing recording errors and increasing the effectiveness of tray recycle data management.

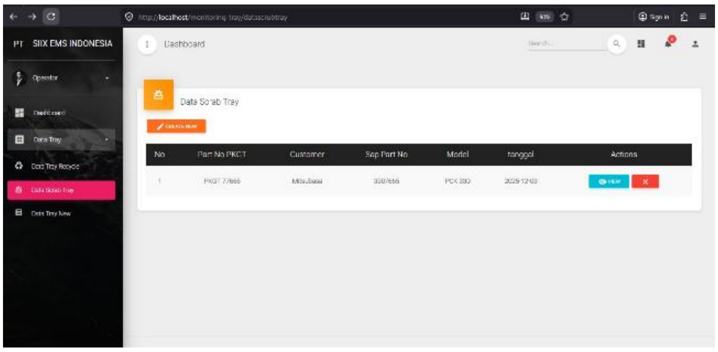

Figure 14. Data Scrab Tray Page
[Source: Author, 2026]

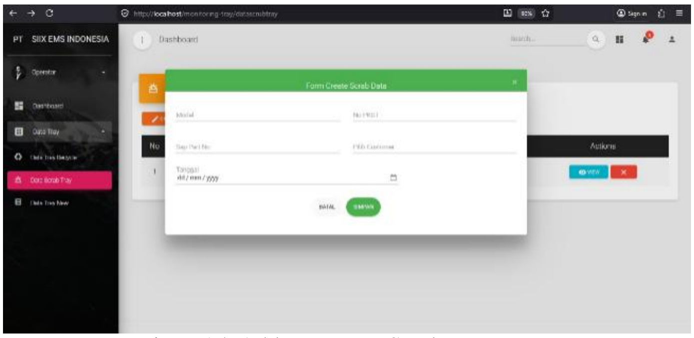

Figure15. Add New Data Scrab Tray Page
[Source: Author, 2026]

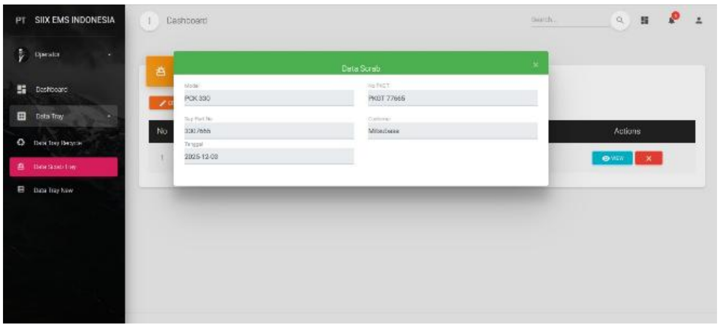

Figure16. Edit Data Scrab Tray Page
[Source: Author, 2026]

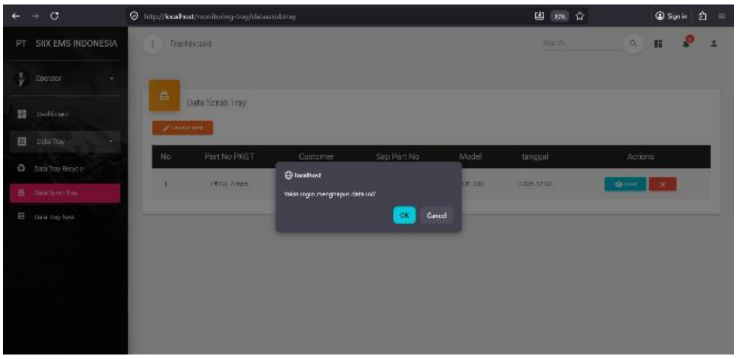

Figure 17. Delete Data Scrab Tray Page
[Source: Author, 2026]

The Scrap Tray Data page is used to display and manage data on trays that are no longer usable. Information displayed includes the PKGT Part No., customer name, SAP Part Number, product model, and recording date in tabular form. This page is equipped with features to add data, view details, delete data, and download Excel files for easier documentation. This page allows users to record and monitor scrap trays in a structured manner, simplifying data management and reporting within the tray monitoring system.

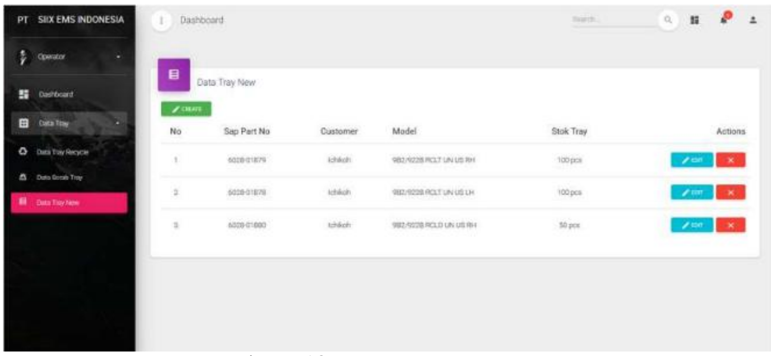

Figure 18. Data Tray New page
[Source: Author, 2026]

The New Tray Data page displays and manages new tray data in the system, including information on the number, SAP Part Number, customer, product model, and stock quantity, presented in a tabular format for easy monitoring. This page also features Create, Edit, and Delete features for adding, updating, and deleting data, helping users maintain accurate information and simplifying tray stock management effectively and efficiently.

3.2 Testing

System testing of the tray monitoring application was conducted using the Black Box Testing method to ensure that all system features functioned properly according to user requirements. Black Box Testing focuses on evaluating system functionality by examining inputs and outputs without analyzing the internal program code. This approach is widely used to validate software functionality, usability, and system reliability from the user's perspective[24].

Table 5. Black Box Testing
[Source: Author, 2026]

No	Scenario	Test Steps	Expected Result	Testing Result
1	System Login	Enter valid username and password, then click login	System displays dashboard page	Successful
2	Access Dashboard	User successfully logs in to the system	System displays dashboard page	Successful
3	Access Tray Recycle Page	Click the Tray Recycle menu	Tray Recycle page is displayed	Successful
4	Add Tray Recycle Data	Click Create New, fill in the data, then click save	Tray recycle data is successfully added	Successful
5	Edit Tray Recycle Data	Click Edit on selected data, modify data, then save	Tray recycle data is successfully updated	Successful
6	Delete Tray Recycle Data	Click Delete on selected data	Tray recycle data is successfully deleted	Successful
7	Access Scrap Tray Page	Click the Scrap Tray menu	Scrap Tray page is displayed	Successful
8	Add Scrap Tray Data	Click Create New, fill in the data, then save	Scrap tray data is successfully added	Successful
9	Edit Scrap Tray Data	Click Edit on selected data, modify data, then save	Scrap tray data is successfully updated	Successful
10	Delete Scrap Tray Data	Click Delete on selected data	Scrap tray data is successfully deleted	Successful
11	Access Tray New Page	Click the Tray New menu	Tray New page is displayed	Successful

Based on the testing results shown in Table 5, all scenarios were executed successfully without any functional errors. The login feature successfully authenticated users and directed them to the dashboard page, indicating that the authentication mechanism worked properly. The dashboard page was displayed correctly after login, allowing users to access system menus according to their roles. Furthermore, testing on the Tray Recycle data management feature showed that users were able to access the page, add new data, edit existing data, and delete data successfully. This indicates that the CRUD (Create, Read, Update, Delete) operations in the Tray Recycle module functioned correctly and met system requirements.

Similarly, testing on the Scrap Tray feature demonstrated that users could access the page, input scrap tray data, update data, and delete records successfully. This confirms that the scrap tray monitoring feature operates as expected and supports data management effectively. In addition, testing of the Tray New menu confirmed that the system successfully displayed tray data, indicating proper integration between tray modules. The successful execution of all test scenarios shows that the system is stable and capable of supporting tray monitoring activities efficiently.

These findings are consistent with recent studies on web-based information systems developed within the last five years, which emphasize that system testing plays a crucial role in ensuring software reliability and alignment with user requirements. For instance, studies by Supriatiningsih (2023) and Tristianto & Hermanto (2025) demonstrate that systems developed using the Waterfall method and tested through functional approaches, such as Black Box Testing, are generally able to operate reliably and meet user needs[8], [9]. Similarly, Yanti &Kurniawan (2026) highlight that web-based inventory systems contribute to improved data management efficiency and reduced manual errors[10].

The successful testing results in this study indicate that the developed tray monitoring system is technically ready for implementation in an operational environment. The system is capable of improving efficiency in tray data management, minimizing manual recording errors, and supporting real-time monitoring. These outcomes are in line with previous research findings that digital inventory systems enhance operational effectiveness through centralized and structured data processing.

However, a critical comparison reveals that most previous studies not only focus on functional testing but also incorporate additional evaluation metrics such as system usability, performance testing, and user satisfaction analysis. In contrast, this study primarily emphasizes functional validation through Black Box Testing. While this approach successfully verifies that the system operates correctly, it does not fully capture the overall system impact from the user's perspective or organizational performance.

Therefore, although the system has demonstrated strong functional reliability and stability, further evaluation is necessary to provide a more comprehensive assessment. Future research should include quantitative measurements such as efficiency improvement, error reduction rates, and user satisfaction levels to better evaluate the effectiveness of the system in real-world implementation.

Overall, the results confirm that the tray monitoring application has fulfilled its functional requirements and operates reliably. The absence of critical errors indicates that the system design and implementation processes were carried out effectively. Nevertheless, compared to recent studies, this research would be strengthened by incorporating broader evaluation methods to assess system performance and user acceptance more comprehensively.

4. CONCLUSION

This study successfully achieved its objective of designing and developing a web-based tray monitoring system using the CodeIgniter framework. The system is able to transform manual recording processes into a more structured, centralized, and digital system, thereby improving data accuracy, facilitating faster data retrieval, and supporting real-time monitoring. The results of system testing indicate that all features function properly, confirming that the application meets user requirements and is suitable for implementation in an operational environment.

However, this study has several limitations. The system evaluation is primarily limited to functional testing using the Black Box method, without incorporating additional assessments such as system performance, usability, or user satisfaction. Furthermore, the study does not include quantitative measurements to evaluate the actual impact of the system on operational efficiency or error reduction. These limitations indicate that the overall effectiveness of the system has not been fully explored.

Therefore, future research is recommended to conduct more comprehensive evaluations by including performance testing, usability analysis, and user acceptance studies. In addition, further development could involve integrating the system with other enterprise systems, enhancing scalability, and implementing mobile-based access to improve flexibility and usability. With these improvements, the system is expected to provide greater value and support more effective decision-making in industrial operations.

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