



Implementation of HACCP and GMP in the Coffee Processing Industry With a Website-Based Information System

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ABSTRACT

Digital transformation is essential in improving operational efficiency and food safety compliance in the food processing industry. Argopuro Walida still manages warehouse and production activities manually, resulting in data inaccuracies, limited traceability, and delayed reporting. This research aims to develop a web-based Warehouse Management and Production Information System integrated with Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Point (HACCP) standards using the Rapid Application Development (RAD) method. The system was developed through requirements planning, design workshop, development, and testing phases. It supports production recording, real-time stock monitoring, transaction management, and structured GMP-HACCP documentation with role-based access control. Black Box Testing confirmed that all functional modules operated properly. The results show that the system improves data accuracy, operational efficiency, real-time monitoring, and food safety documentation, supporting better warehouse and production management in coffee processing industries.

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1. Introduction

Digital transformation has become a strategic necessity in improving efficiency, transparency, and competitiveness in industrial sectors. Information systems play an essential role in supporting production monitoring, data management, and inter-division coordination within organizations [1]. In warehouse operations, the implementation of web-based Warehouse Management Systems (WMS) has significantly improved inventory control, traceability, and data processing accuracy [2], [3]. Web-based inventory systems also contribute to minimizing manual recording errors and enhancing reporting efficiency [4]. Traditional system development approaches such as the Waterfall model provide structured stages but tend to be less adaptive to requirement changes during development [5]. In contrast, modern industries require flexible systems capable of responding to dynamic operational needs.

In the food processing sector, digital transformation becomes more critical due to compliance requirements with food safety standards. The implementation of Good Manufacturing Practices (GMP) has been proven to enhance product quality consistency and hygiene control [6], [7]. Furthermore, the integration of Hazard Analysis Critical Control Point (HACCP) principles strengthens systematic monitoring and

documentation processes in food industries [8]. These standards demand structured documentation, sanitation recording, and critical control point monitoring, which are difficult to manage effectively through manual systems.

Argopuro Walida is a coffee processing industry located in Situbondo Regency, Indonesia, producing 120–150 tons of Arabica red cherry coffee annually. Despite its production capacity, warehouse and production management activities are still recorded manually, leading to data inconsistencies, delayed reporting, and limited real-time stock monitoring.

Previous studies demonstrate that Rapid Application Development (RAD) is effective in building flexible and time-efficient web-based systems. RAD has been successfully implemented in warehouse systems [9], management information systems [10], progressive web applications [11], online sales systems [12], inventory systems [13], coffee shop systems [14], and inventory applications [15]. These studies indicate that RAD reduces development time while ensuring alignment between system functionality and user requirements. Additionally, the application of GMP in coffee processing SMEs has been shown to improve production workflow and quality control consistency [16], while standardized coffee bean processing ensures traceability and quality assurance [17]. The integration of GMP, SSOP, and HACCP principles in small-scale industries further strengthens food safety compliance and documentation practices [18]. Based on these considerations, this research proposes the design and development of a web-based Warehouse Management System integrated with GMP and HACCP standards using the Rapid Application Development (RAD) method. The system aims to enhance operational efficiency, improve data accuracy, and support structured documentation for food safety compliance within a coffee processing industry.

2. Research Method

This research applies the Rapid Application Development (RAD) method to develop a web-based Warehouse Management System at Argopuro Walida. RAD was selected due to its iterative, user-centered, and adaptive characteristics, which enable rapid prototyping and continuous refinement based on stakeholder feedback [9], [10], [13], [15]. Compared to traditional Waterfall development [5], RAD provides shorter development cycles and greater flexibility. Agile-based approaches such as Extreme Programming (XP) also emphasize iterative development [22], while alternative models like Feature-Driven Development (FDD) focus on feature-oriented increments [21]. However, RAD is more suitable for this research due to its emphasis on rapid prototyping and structured requirement validation.

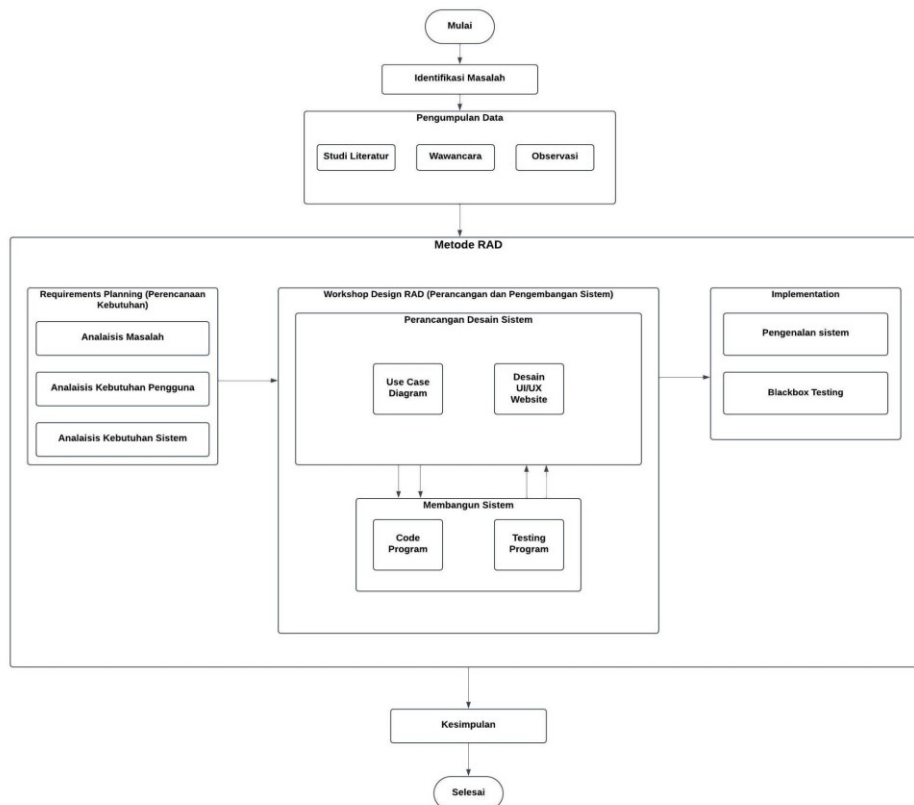


Figure 1. Research Methodology Flow

2.1 Requirements Planning

The requirements planning phase aims to identify system and user needs based on Argopuro Walida's operational conditions. Data collection was conducted through observations and interviews to analyze existing warehouse and production workflows. Manual recording of raw materials, processing stages, and finished goods poses a risk of data inaccuracy and limited traceability. In a warehouse environment, systematic monitoring and structured documentation are essential to maintain inventory reliability and operational control [2], [3]. In the food industry, the implementation of GMP and HACCP ensures hygiene standards, sanitation procedures, and quality assurance throughout the production process [6], [7].

Hazard Analysis and Critical Control Points (HACCP) is a systematic, preventative food safety management system that aims to identify, evaluate, and control significant hazards in food production. The Hazard Analysis and Critical Control Point approach focuses on controlling critical control points (CCPs), which are vulnerable points in the production process that can impact product safety. Good Manufacturing Practices (GMP) are fundamental guidelines for food production that cover requirements for sanitation, hygiene, quality control, and facility maintenance [18][19].

Table 2.1 HACCP Assessment Aspects

No	Stage	Potential Hazard	Critical Limit
1	Material Receipt	- Foreign Objects - Mold and Pests - Condition without defects that could reduce quality	- Free of foreign objects - Free of mold and pests - Good quality and no Defects
2	Production	- Foreign Objects - Mold and Pests - Condition without defects that could reduce quality	- Free of foreign objects - Free of mold and pests - Good quality and no Defects

Table 2.2 GMP Assessment Aspects

No	Stage	Assessment Points
1	Material Receipt	Free of foreign objects Free of mold and pests Good quality and no Defects
2	Production	Free of foreign objects Free of mold and pests Good quality and no Defects
3	Warehouse and production sanitation	Clean & Dry Floors Mold-free Walls Good drainage Clean and normal air ventilation Free of pests and animals
4	Sanitation of production equipment	Clean production equipment and machinery Free of residual production materials and foreign objects Production equipment and machinery are in good condition and not damaged Clean water is available
5	Toilet and sink sanitation	Clean, odor-free toilets Soap available Clean, running water that doesn't smell bad

		Hand dryers available Trash cans available
6	Environmental sanitation around the factory	The surrounding area is free of trash and clean No foul odors Free from standing water and mosquitoes Free from waste materials and foreign objects Pest control

Standardized coffee processing procedures also play a crucial role in maintaining consistent quality and traceability of coffee beans [17]. Therefore, the proposed system must support master data management, production record keeping, stock monitoring, sanitation documentation, critical control point tracking, and traceability reporting. Non-functional requirements are evaluated to ensure system performance, reliability, security, usability, and scalability in supporting operational activities.

2.2 Design Workshop

The design workshop phase was conducted collaboratively and iteratively to translate system requirements into structured models and interface prototypes. System modeling utilized Unified Modeling Language (UML) to describe system interactions and workflows. The user interface was developed using responsive web design principles supported by the Bootstrap framework to ensure cross-device compatibility and usability [19]. The backend architecture employed the Flask framework to manage routing, business logic, and system integration [20]. Flask-based development has demonstrated efficiency in building lightweight yet scalable web systems [21]. Through iterative prototyping and user feedback sessions, system design adjustments were made to align with operational needs and minimize usability gaps.

2.3 System Development

The system development phase translated approved designs into a functional web-based application. The frontend was developed using HTML, CSS, and JavaScript to provide an interactive user interface. The backend was implemented using Python with the Flask framework [20], while database management was structured to support real-time data storage and traceability. RAD implementation during this phase allowed incremental development and continuous refinement [9], [13], [15]. Each module—including authentication, inventory management, production monitoring, transaction processing, and GMP–HACCP documentation was developed and validated iteratively.

2.4 Testing And Implementation

System testing was conducted using the Black Box Testing method to evaluate functional correctness without examining internal code structures [23]. Black box testing has been effectively applied in warehouse systems and inventory applications to validate system functionality and reliability [23], [24]. Each functional module—including login authentication, stock management, production input, transaction recording, and food safety documentation—was tested against predefined scenarios. After successful validation, the system was implemented within the operational environment of Argopuro Walida to support digital warehouse and production management processes. RAD-based implementation in various information systems has demonstrated improved adaptability and reduced deployment errors [25], supporting the suitability of this method for operational industrial environments.

3. Result and Discussion

3.1 Requirements Planning

The Requirements Planning phase aims to identify user needs and define system objectives based on existing operational conditions at Argopuro Walida. This phase includes current system analysis, problem identification, user requirement analysis, and proposed system specification. Through direct observation and interviews with stakeholders, operational constraints and inefficiencies were identified to determine appropriate system solutions.

3.1.1 Problem Analysis

This stage presents the identification of operational problems and an analysis of the current business process workflow. Based on observations conducted at Argopuro Walida, several issues were identified that hinder operational efficiency and data accuracy. Warehouse and production records are still maintained manually using notebooks and spreadsheet applications. As a result, data are not systematically structured, difficult to trace, and prone to human error. Furthermore, the absence of a real-time monitoring system leads to delays in stock tracking and production status updates. Another critical issue is that food safety standards such as Hazard Analysis Critical Control Point (HACCP) and Good Manufacturing Practices (GMP) have not been optimally integrated into the operational workflow. Documentation related to sanitation, inspection, and quality control is not centralized, increasing the risk of inconsistent monitoring. Additionally, limited integration between warehouse, production, and sales divisions often results in miscommunication and data discrepancies. The company also lacks an automated notification system for low stock levels, product expiration, and sanitation inspections, reducing operational responsiveness.

3.1.2 User Requirements Analysis

User requirements analysis was conducted to identify the specific needs of each system actor. Based on interviews and operational observation, three primary users were identified:

1. **Admin** – Responsible for managing master data, system configuration, production records, stock management, transactions, and food safety documentation.
2. **Employee** – Responsible for recording daily operational activities, including production updates, stock adjustments, and sanitation reports.
3. **Owner** – Requires access to analytical reports, dashboards, financial summaries, stock monitoring, and HACCP–GMP documentation to support strategic decision-making.

Each user has distinct roles and access rights to ensure data security and operational control.

3.1.3 System Requirements Analysis

System requirements were analyzed to define both functional and non-functional specifications for the proposed Warehouse Management and Production Information System. System requirements are categorized into:

A. Functional Requirements

B. Table 3.1 Functional Requirements

No	Functional Requirement
1	The system must provide login and logout functionality for all user roles.
2	The system must provide user registration functionality (if required).
3	Admin can manage master data including products, coffee types, production processes, warehouses, users, and partners (Create, Read, Update, Delete – CRUD).
4	Admin and Employees can manage production processes and update production status (CRUD).
5	Admin and Employees can manage stock data including adding, updating, adjusting quantities, and storage locations (CRUD).
6	Admin can manage transactions such as orders and sales (CRUD).
7	Owner can view sales reports, stock reports, financial dashboards, and HACCP–GMP reports.
8	Owner can update profile information.
9	The system must store all operational data in a real-time database.
10	The system must provide reports in both dashboard visualization and tabular format.

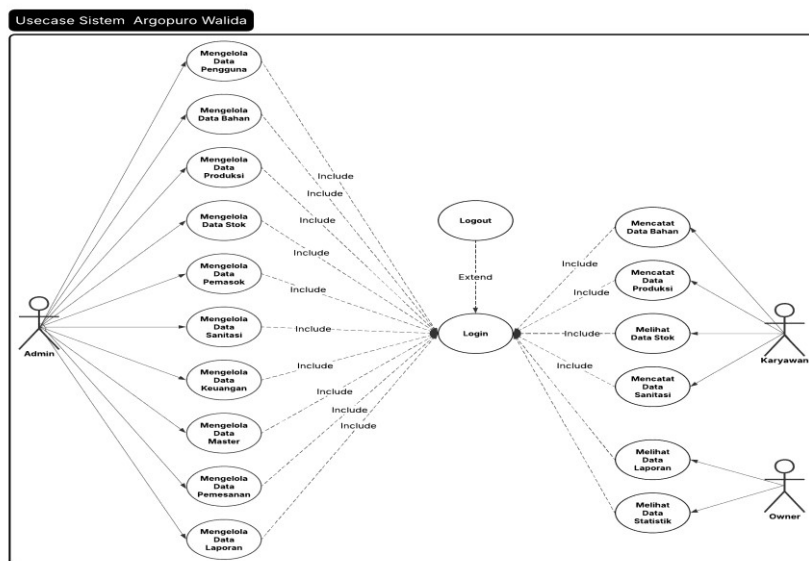
11	Admin can update final production results if input errors occur.
12	Admin can manage partner or customer data (CRUD).
13	Admin and Employees can record sanitation reports in accordance with GMP and HACCP standards.

C. Non-Functional Requirements

Table 3.2 Non-Functional Requirements Based on PIECES Framework

No	Kategori <i>PIECES Framework</i>	Kebutuhan Non-Fungsional
1	Performance	- The system must respond quickly to user requests. - The system must update data in real-time. - The system must be accessible via an internet network.
2	Information	- The system must generate sales reports, stock reports, and financial dashboards accurately. - The system must perform automatic daily data backup.
3	Economy	- The system must operate efficiently on modern web browsers without requiring expensive hardware.
4	Control	- The system must implement secure login authentication with encrypted username and password.
5	Efficiency	- The system must optimize data processing and minimize redundancy.
6	Service	- The system must provide a user-friendly interface. - The system must include user documentation or a user guide.

3.2 Design Workshop
3.2.1 Usecase Diagram



Gambar 2 Usecase Diagram

The use case diagram was developed to illustrate the interaction between users and the proposed warehouse and production record management information system at Argopuro Walida. The system involves three primary actors: Admin, Employee, and Owner. The Admin has the highest level of access and is responsible for managing overall operational data within the system. The Admin can manage user data, raw material data, production data, inventory data, supplier data, sanitation data, financial data, master data, order data, and report data. All administrative functions require authentication through the login process before access is granted. After completing system activities, the Admin can terminate the session using the logout feature. The Employee plays an operational role in recording daily warehouse and production activities. The Employee can record raw material data, record production data, view inventory data, and record sanitation data. Similar to the Admin, all Employee activities require successful authentication via the login process to ensure secure access control and proper data authorization. Meanwhile, the Owner has monitoring and evaluation privileges. The Owner is authorized to view report data and statistical data but does not have permission to modify or delete operational records. This restriction ensures data integrity while still supporting managerial decision-making based on real-time information. The diagram indicates that all primary use cases include the login process as a prerequisite, meaning that authentication is mandatory before accessing any system functionality. Additionally, the logout process extends the login activity as a mechanism to formally end the user session. Overall, the use case design demonstrates a role-based access control structure that supports data security, operational transparency, and clear separation of responsibilities among system users in managing warehouse and production records.

3.2.2 Activity Diagram

This section explains the main activity diagram, namely the production process from the initial input of green bean to the production stage

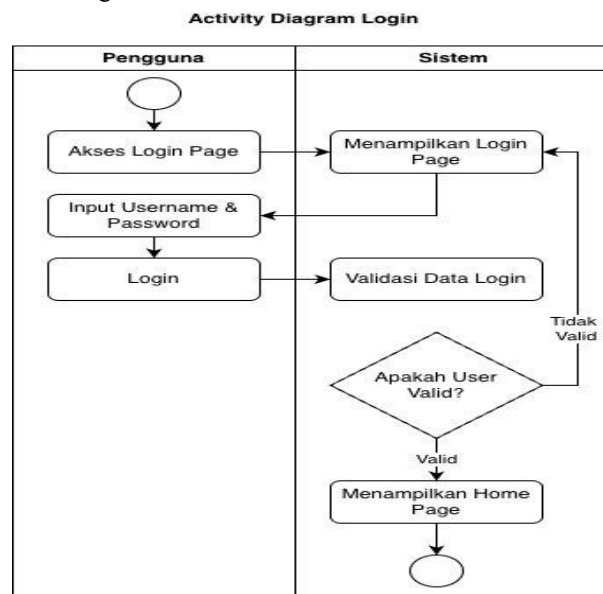


Figure 3. Login Activity Diagram

Figure 3 shows an activity diagram of the login process because every activity in the system must require login access first.

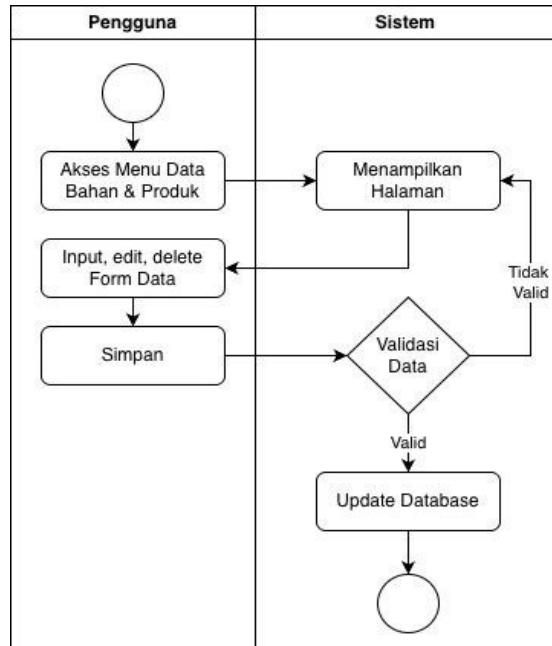


Figure 4. Material Management Activity Diagram

Figure 4 shows an activity diagram of the incoming materials management process and Figure 5 shows an activity diagram of production management which explains the production process in the system.

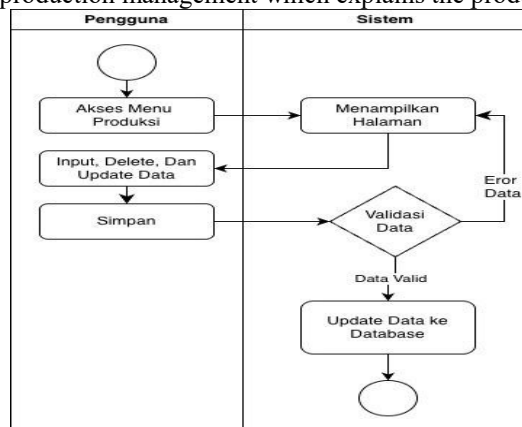


Figure 5. Production Management Activity Diagram

3.2.3 Sequence Diagram

Sequence diagrams illustrate the interactions between objects within and around the system, including users and views. The proposed sequence diagrams for this system include sequence diagrams for login, incoming materials management, and production.

This can be seen in the following figure:

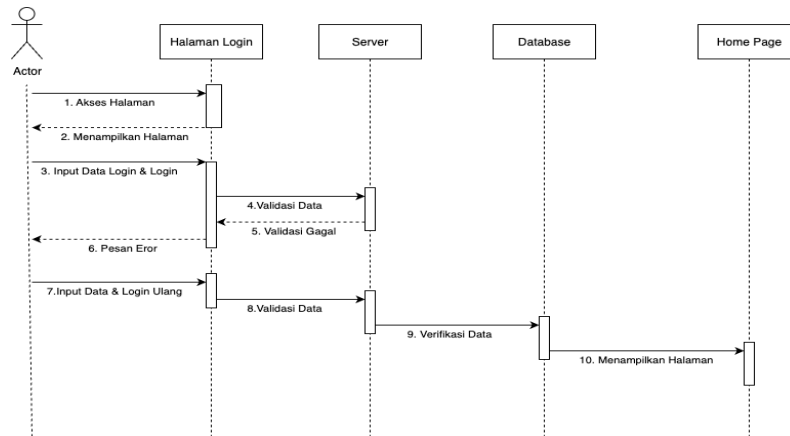


Figure 6. Login Sequence Diagram

Figure 6 shows the sequence of login processes for each user. By accessing the login page, users can log in and record incoming data, as shown in Figure 7 below:

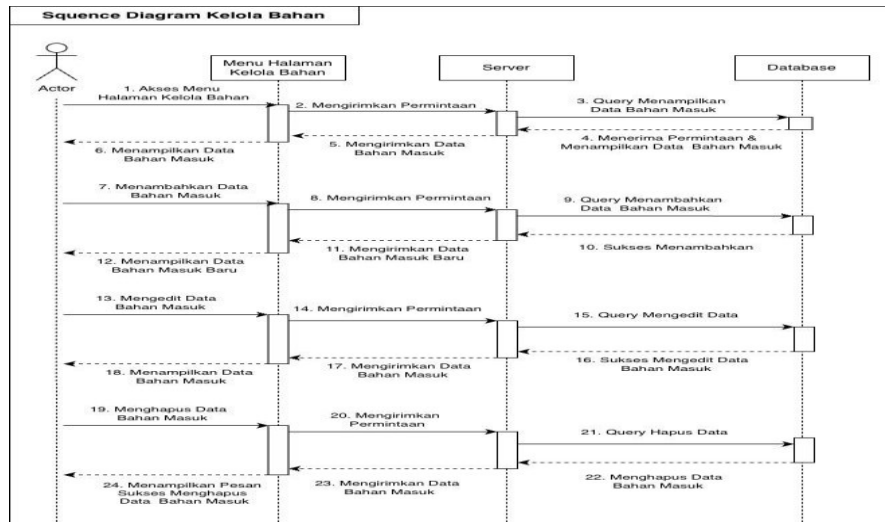


Figure 7 Sequence Diagram of Incoming Material Management

After recording the incoming materials, the production stage is entered. Users can carry out production recording activities as shown in Figure 8 below:

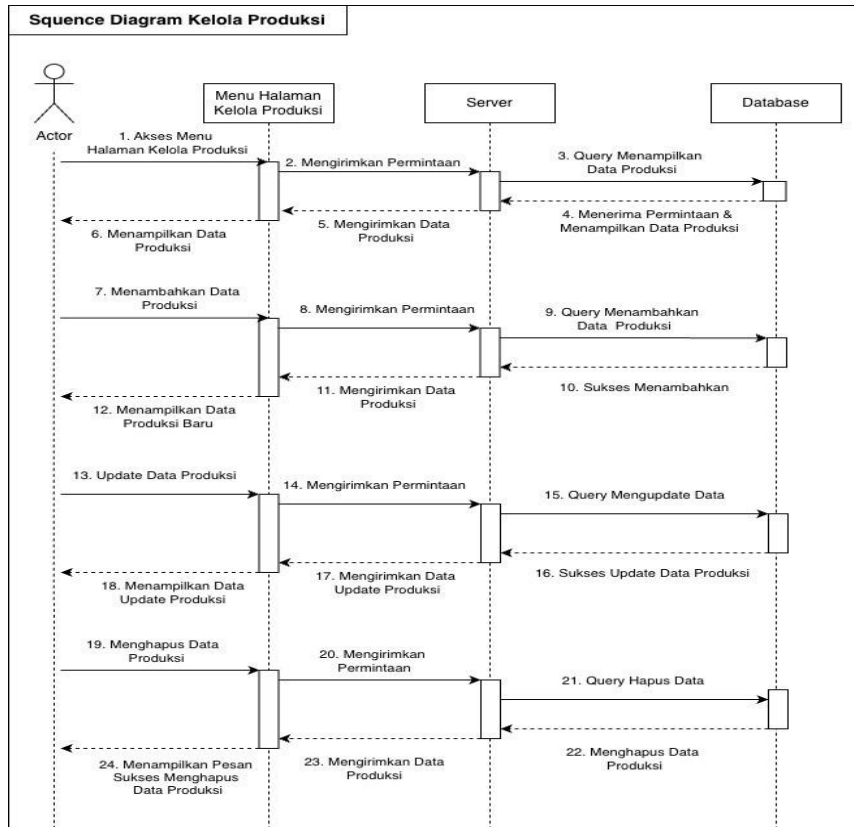


Figure 8. Production Management Sequence Diagram

3.2.4 User Interface Design

The first iteration of user interface design aimed to create an initial system layout that was responsive, intuitive, and easy to use for end users. The UI design was developed quickly based on the system's core functional requirements. This process involved creating realistic interfaces for key features such as login, incoming materials management, and production.

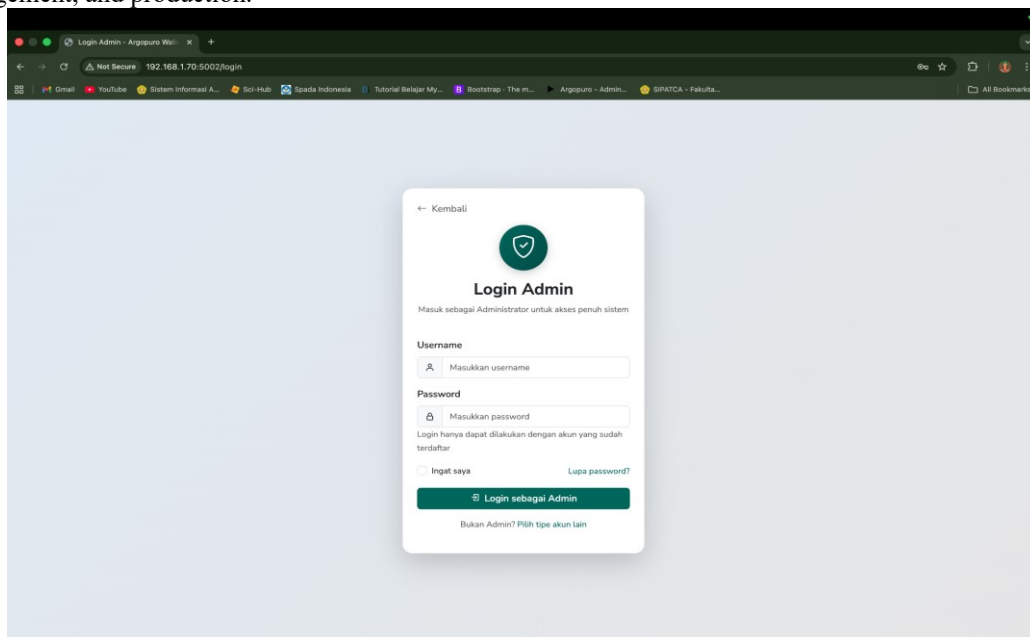


Figure 9 Login Page

The login page serves as a means of authentication for each user to access the system dashboard. Users are prompted to enter a username and password as mandatory data, and a "Remember me" option is available to save the login session.

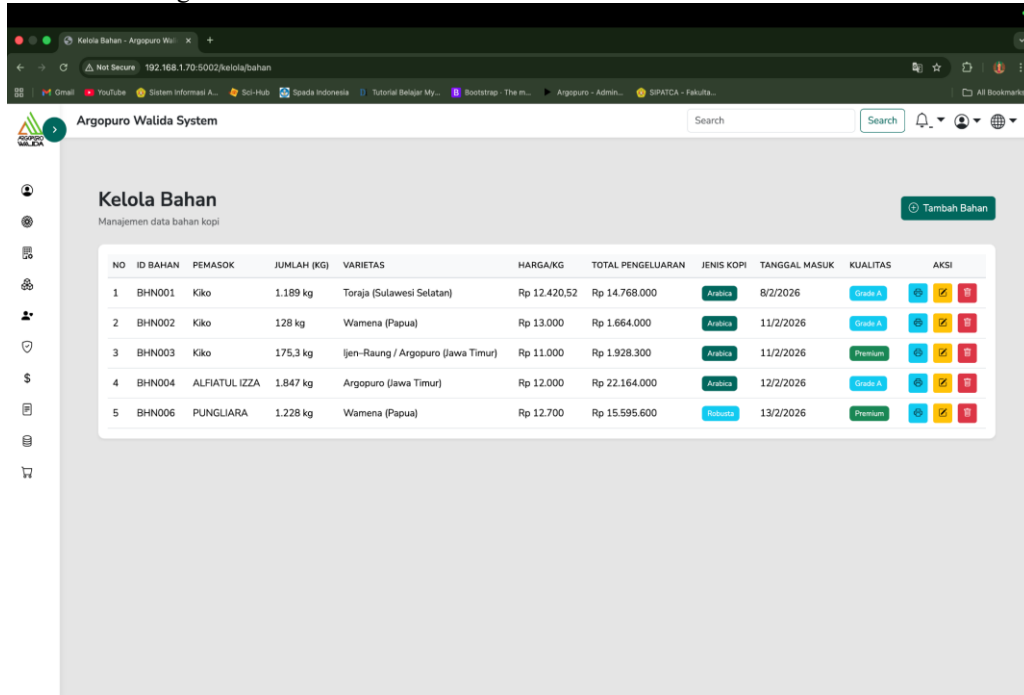


Figure 10 Manage Materials Page

The materials management page is used to manage incoming coffee raw material data, with full access for both admins and employees. This page displays a materials table containing supplier information, quantity, variety, coffee type, price, quality, date of receipt, and remaining materials. Admins can add, edit, and delete material data through a form integrated with supplier and master data, while the system automatically calculates total expenditure and remaining materials based on production usage.

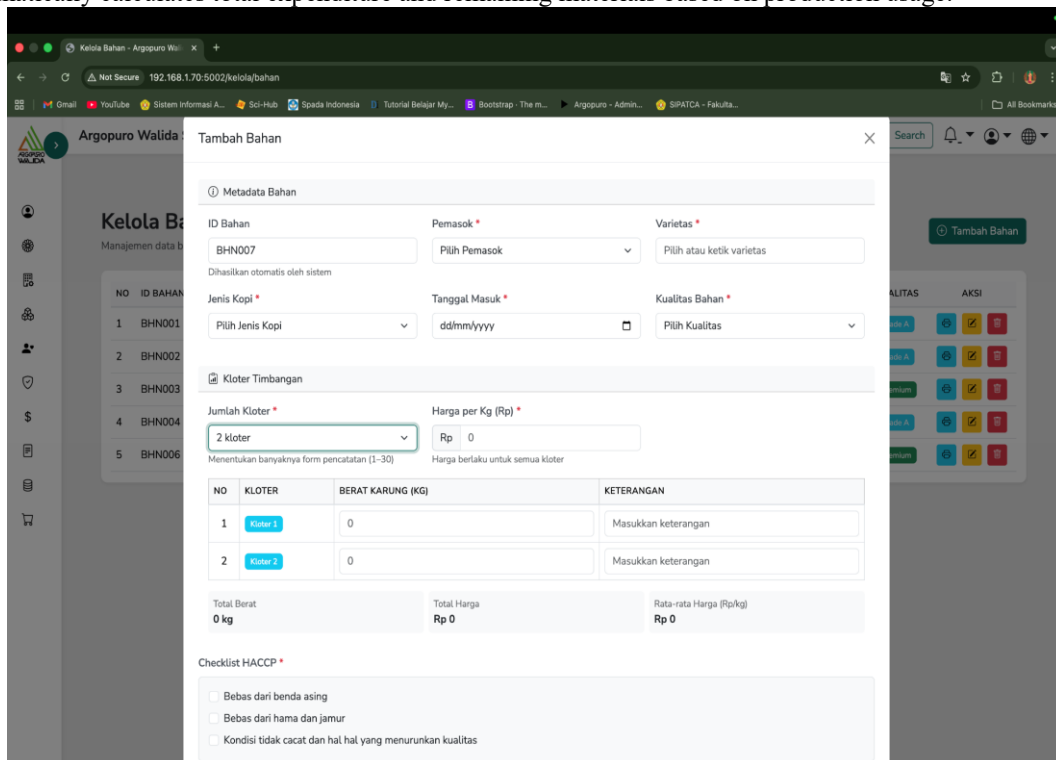


Figure 11 Add Materials Page

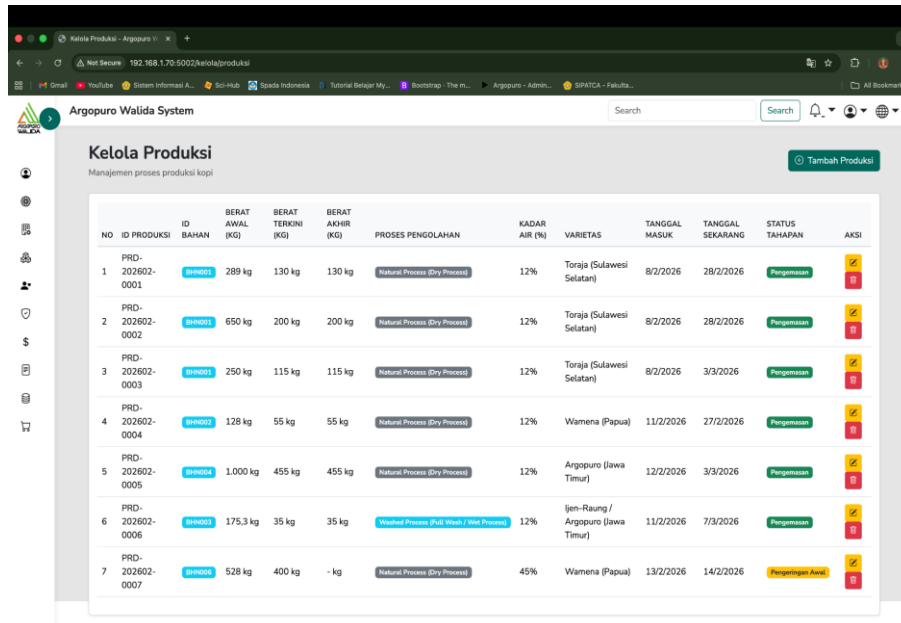


Figure 12 Production Management Page

The production management page is used to manage production process data with user access, namely admin and employee. This page displays a production table containing information on materials used, initial and final weights, production stage status, implementation dates, and process notes. Users can add, modify, and delete production data, as well as update production stages from initial sorting to packaging. The system is integrated with raw material data to validate material usage and automatically calculate remaining materials, so that the production recording process can be carried out in a controlled and accurate manner.

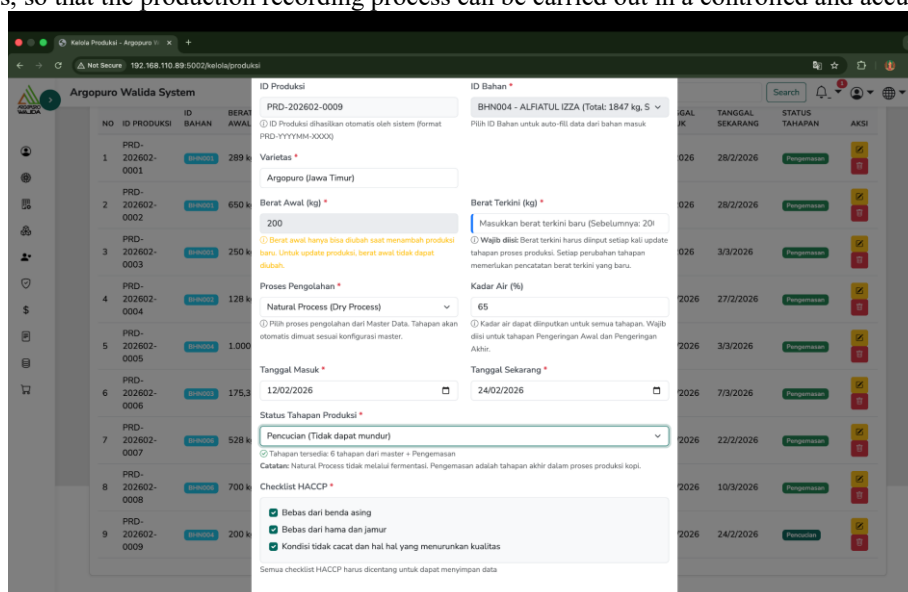


Figure 13 Add Production Page

3.2.5 Blackbox Testing

The following table shows the results of testing the login feature. This test involved eight test scenarios.

No	Case Id	Modul	Skenario	Expected Output	Actual Output	Status
1	A01	Login	Open the	Successfully logged in to	The system successfully verifies the username and	Valid

			login page → fill in your email and password → click Login	the Dashboard according to your role	password, then displays the dashboard page according to the user role.	
2	A02	Login	Input wrong username and login	Displays a message that cannot log in	The system displays an error message that the username or password does not match.	Valid
3	A03	Login	Input username benar, password salah dan login	Displays a message that cannot log in	The system rejects authentication and displays a login error message.	Valid
4	A04	Login	Do not enter username or password and login	The system displays a mandatory message	The system displays validation that the username and password fields must be filled in.	Valid
5	A05	Login	Login as admin	The system displays the admin page	The system directs the user to the Admin dashboard	Valid
6	A06	Login	Login sebagai owner	The system displays the owner page	The system directs the user to the Owner dashboard.	Valid
7	A07	Login	Login sebagai karyawan	The system displays the employee page.	Sistem mengarahkan pengguna ke dashboard Karyawan	Valid
8	A08	Login	Login tidak sesuai peran	Displays a message that cannot log in	The system rejects the login and displays a role error message.	Valid

Table 3.3 Blackbox testing of the Login Feature

The following table shows the test results for the material management feature. This test involved 12 test scenarios.

No	Case Id	Modul	Skenario	Expected Output	Actual Output	Status
1	C01	Kelola Bahan	Open the materials menu → click add → save	Production data saved successfully	Material data is successfully saved and displayed in the table.	Valid
2	C02	Kelola Bahan	Click save without filling in the data	The system rejects and displays an error message.	The system displays an error message because the field is empty.	Valid
3	C03	Kelola	Input data	The system	The system displays a	Valid

		Bahan	for incoming materials, quantity = 0	rejects input	validation message that the amount must be > 0.	
4	C04	Kelola Bahan	Negative price content	The system rejects input	The system displays an invalid price validation message.	Valid
5	C05	Kelola Bahan	ID will be automatically generated	The system will display the ID	The system displays the ID automatically	Valid
6	C06	Kelola Bahan	The automatic system adds up the total weight and purchase of materials and price	Total incoming and purchased materials are calculated automatically.	The automatic system adds up the total weight and purchase of materials.	Valid
7	C07	Kelola Bahan	Not selecting a supplier	The system refused to save	The system displays a validation message that the supplier must be selected.	Valid
8	C08	Kelola Bahan	Open the menu bahan	List of displayed material data	The system displays the list of materials data.	Valid
9	C09	Kelola Bahan	Click edit → change data → save	Changes saved	Material data changes were successfully saved	Valid
10	C10	Kelola Bahan	Change quantity / price	Total automatically updated	The system updates the total expenses automatically.	Valid
11	C11	Kelola Bahan	Click delete → confirm	Material data deleted	Material data successfully deleted	Valid
12	C12	Kelola Bahan	Input HACCP check box	The system can add data and save it by checking the box.	The system successfully saved by checking the box.	Valid

Table 3.4 Material Management and Add Material Testing

The following table shows the results of testing the production management feature. This testing involved 15 test scenarios.

Table 3.5 Production Management Page Testing

No	Case Id	Modul	Skenario	Expected Output	Actual Output	Status
1	D01	Kelola	Open the	Production	Production data	Valid

		Produksi	production menu → click add → save	data saved successfully	successfully saved and displayed	
2	D02	Kelola Produksi	Click save without filling in the data	The system rejects and displays an error message.	The system displays a mandatory field error message.	Valid
3	D03	Kelola Produksi	Production ID will be automatically generated	The system will display the production ID.	The system displays the production ID.	Valid
4	D04	Kelola Produksi	Select material ID	Loaded material data	Automatic material data filling system	Valid
5	D05	Kelola Produksi	Initial weight content > material stock	The system rejects input	The system displays an insufficient stock message.	Valid
6	D06	Kelola Produksi	Water content > 100	The system rejects input	The system displays a validation message.	Valid
7	D07	Kelola Produksi	Select stage status	Data saved	Production data successfully saved and displayed	Valid
8	D08	Kelola Produksi	Select the processing process	Data saved	Production data successfully saved and displayed	Valid
9	D09	Kelola Produksi	Click edit → update data → save	Changes saved	Production data successfully saved and displayed	Valid
10	D10	Kelola Produksi	Try changing the starting weight	The system rejects changes	The system rejects the initial weight change	Valid
11	D11	Kelola Produksi	No weight content at this time	The system refused to save	The system displays a mandatory field error message.	Valid
12	D12	Kelola Produksi	Final weight > initial weight	The system refused to save	The system displays a validation error message.	Valid
13	D13	Kelola Produksi	Clear the HACCP check box	The system refused to save	The system displays a mandatory field error	Valid

					message.	
14	D14	Kelola Produksi	Open the production menu	Production list appears	The system displays all production data	Valid
15	D15	Kelola Produksi	Click delete	Data deleted	Production data successfully deleted	Valid

4. Conclusion

The main problem in Argopuro Walida is the warehouse and production management process which is still done manually, so that the recording of stock, production, and distribution is not integrated and has the potential to cause data errors. In addition, documentation for the implementation of HACCP and GMP standards has not been optimally digitized. As a solution, this study designed and built a website-based warehouse and production management system using the Rapid Application Development (RAD) method. This system supports recording of raw materials, monitoring production and documentation of HACCP and GMP standards in a more structured and integrated manner. The implementation of HACCP and GMP is carried out on every recording of incoming materials and production processes to ensure that the resulting product complies with food safety standards. The system is able to improve recording efficiency, reduce data errors, and support the implementation of HACCP and GMP in Argopuro Walida.

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