

Design and Development of Raw Material Inventory System Using MRP for Es Barbar

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ABSTRACT

Raw material inventory management is a major challenge for Es Barbar SME, often facing imbalances such as shortages or excess materials, which hinder operational smoothness. This study aims to design and develop a web-based information system using the Material Requirement Planning (MRP) method to improve raw material management efficiency. With the System Development Life Cycle (SDLC) approach using the waterfall model, the system was designed through stages of communication, planning, modeling, construction, and implementation. The results show that the application of the MRP method successfully reduced stock shortages by 95% and excess stock by 85%, as well as improved the accuracy of raw material planning based on the Master Production Schedule (MPS) and Bill of Materials (BOM). This system facilitates precise raw material requirement planning, supports decision-making, and reduces waste. Therefore, this system has a positive impact on the operational efficiency of Es Barbar SME, improving the quality of raw material inventory management and ultimately contributing to the sustainability and development of the SME.

Keyword: Information System, Material Requirement Planning, SMEs, Raw Material Management, SDLC.

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1. INTRODUCTION

The rapid evolution of the modern business landscape requires enterprises to continuously adapt to technological advancements and shifting market demands. Businesses today are engaged in both the production of goods with specific functions and the provision of specialized services. These enterprises range from large-scale corporations with extensive workforces to small and medium-sized enterprises (SMEs). To maintain a competitive edge in the global market, SMEs must embrace digitalization and integrate technological innovations into their operations [1]. SMEs play a crucial role in national economic development by fostering employment opportunities and driving economic expansion [2]. In Indonesia, the SME sector significantly contributes to job creation and GDP growth, making it a fundamental pillar of the economy [3]. One such emerging SME is Es Barbar, which specializes in tea-based beverages with a diverse selection of flavors.

Established in 2020 in Sidoarjo, Es Barbar has experienced notable growth, attracting a broad customer base. This success is attributed to stringent quality control over raw materials and the consistent maintenance of flavor profiles. Additionally, leveraging social media for marketing has enhanced brand visibility and expanded customer reach, leading to increased sales performance [4]. Despite its growth, Es Barbar faces persistent challenges in raw material inventory management. A primary concern involves maintaining an efficient supply chain to prevent shortages or excess inventory, which could disrupt business operations. Inaccurate forecasting of raw material requirements often results in inventory imbalances, leading to inefficiencies in production and financial losses. Addressing these challenges necessitates the implementation of an advanced inventory management system [5].

Tabel. 1 Raw Material Components Before the MRP Process

No	Component	Initial Stock	Status
1	Teh Racik (Kg)	34	less
2	Gula (Kg)	75	more
3	Air (Galon)	45	more
4	Es Batu (Kg)	560	less
5	Susu Kental Manis (Sachet)	720	less
6	Thai Tea Powder (Sachet)	300	less
7	Manggo Tea Powder (Sachet)	150	less
8	Matcha Tea Powder (Sachet)	180	less
9	Milo (Sachet)	210	less
10	Madurasa (Sachet)	250	less
11	Yakult (Botol)	250	more
12	Oreo (Sachet)	250	more
13	Jeruk Nipis (Kg)	24	less

Ineffective forecasting of raw material needs can cause inefficient inventory management, resulting in either excessive stockpiling or shortages both of which carry financial implications [6]. Various inventory management approaches, including Economic Order Quantity (EOQ), Just in Time (JIT), and Material Requirement Planning (MRP), are widely used to optimize stock management [7]. Among these, MRP stands out as the most appropriate method for Es Barbar SME, as it utilizes real-time data on material requirements, available stock levels, and production capacity to ensure precise inventory planning. Additionally, MRP provides a structured framework for production planning by integrating key operational variables [8].

Material Requirement Planning (MRP) is a strategic inventory management methodology designed to ensure the availability of essential raw materials and components throughout the manufacturing process. This system enhances inventory control by forecasting demand trends, regulating procurement cycles, and maintaining optimal stock levels for dependent-demand components [9]. Implementing MRP in SMEs enhances operational efficiency, optimizes inventory levels, and reduces production costs. Through MRP, SMEs can improve stock control, mitigating risks associated with shortages and overstocking that may hinder production activities. This method provides a structured and cost-effective approach to inventory management, strengthening overall business performance and sustainability [10].

Moreover, MRP supports data-driven decision-making in procurement and production planning. The integration of accurate demand forecasting and inventory data enables SME

managers to determine optimal raw material order schedules and production quantities. Consequently, the MRP system enhances managerial responsiveness to market fluctuations, fostering an agile and systematic decision-making process [11]. This study aims to develop and implement a web-based inventory management system that incorporates the MRP methodology to improve efficiency at Es Barbar SME. The proposed system is expected to optimize raw material procurement and production planning, enabling the enterprise to respond swiftly and effectively to market demands [12].

The research follows the System Development Life Cycle (SDLC) waterfall model, which includes the stages of communication, planning, modelling, construction, and implementation [13]. This structured development approach ensures a systematic and efficient implementation process, leading to accurate and reliable outcomes. Empirical research has demonstrated that MRP-based systems significantly improve inventory management efficiency by reducing the risks of stock imbalances [14]. Therefore, incorporating MRP into this inventory management system is anticipated to enhance operational efficiency at Es Barbar SME, supporting sustainable business growth and ensuring seamless operational continuity.

2. METHODS

The research adopts a quantitative approach to analyze and measure the efficiency of Material Requirement Planning (MRP) in managing raw material inventory at UMKM Es Barbar. This approach evaluates the system's impact on reducing shortages and surpluses while improving production planning accuracy. The study follows a System Development Life Cycle (SDLC) waterfall model, consisting of problem identification, system design, development, implementation, and testing, to achieve the research objectives systematically [15]. Data collection consists of primary and secondary sources. Primary data includes direct observations of existing inventory management practices and interviews with the SME owner and staff to identify operational challenges and system requirements [16]. Secondary data consists of historical inventory records, sales data, and production schedules, supporting a quantitative analysis of inventory performance before and after the MRP system implementation. To assess the system's effectiveness, data analysis techniques include descriptive statistics to examine inventory levels and trends, along with a comparative analysis to evaluate the system's impact on key performance indicators, such as stockout rates, inventory holding costs, and order fulfillment times [17].

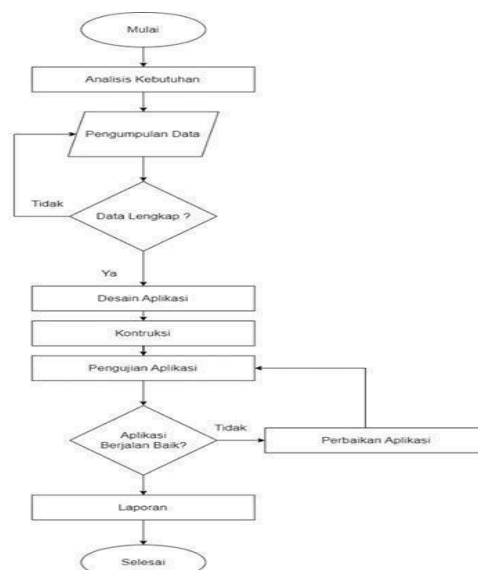


Figure 1. Research Flow

2.1 Research Location and Time

This research was conducted at one of the Es Barbar SME branches located in Dungus Village, Sukodono Subdistrict, Sidoarjo Regency, East Java. The research activities were carried out from March to September 2024.

2.2 Requirements Analysis

The requirements analysis phase plays a crucial role in defining the needs and expectations for developing a web-based inventory management system using the Material Requirement Planning (MRP) method for Es Barbar SME. This phase ensures that the system is designed to effectively optimize raw material inventory management and support operational efficiency.

1. Functional Requirements

- a. Inventory Management: The system should track raw material stock levels, detect shortages or excess stock, and update inventory automatically.
- b. Procurement Planning: The system should generate forecasts based on Master Production Schedule (MPS) and Bill of Materials (BOM) to ensure precise raw material ordering.
- c. MRP-Based Calculation: The system should implement MRP formulas to determine material needs, optimize stock availability, and reduce waste.
- d. Real-Time Tracking & Notifications: The system should provide real-time updates on inventory levels and alert users about critical stock conditions.

2. Non-Functional Requirements

- a. Web-Based Accessibility: The system must be accessible via web browsers to enable users to manage inventory from different locations.
- b. Security & Data Protection: The system must include secure authentication, data encryption, and role-based access to protect sensitive inventory data.
- c. User-Friendly Interface: The system should have an intuitive and easy-to-navigate interface to enhance user experience.
- d. System Performance & Scalability: The system must handle large volumes of data efficiently and scale as business operations grow.

2.3 Data Collection

1. Observation

The author conducted direct observations by visiting one of the outlets owned by Es Barbar SME to understand the ongoing business processes.

2. Interview

The author conducted an interview with Mrs. Hidayatus Sholichah, the owner of Es Barbar SME, on Sunday, February 4, 2024, at her residence located in Sidoarjo.

3. Analysis

The author reviewed theories, research methodologies, programming, as well as information system analysis and design to gather information relevant to the final project.

2.4 Data Processing

1. Netting

Calculating the net requirements for each period within the planning horizon. The net requirements are determined as the difference between the gross requirements and the initial inventory available.

2. Lotting

Calculating the optimal order size for a material based on the net requirements obtained from the netting process. This process focuses on determining the amount of material that needs to be ordered or provided efficiently.

3. Explosion

Calculating the raw material requirements at lower levels within the product structure based on the Bill of Materials (BOM). This process aims to compute the gross requirements for each component needed to produce finished goods or final products.

2.5 System Design

1. Usecase Diagram

Illustrates the interaction between users (actors) and the system, showing the main functions that users can perform within the system.

2. Activity Diagram

Represents the workflow or process within the system, including the sequence of activities, decisions, and data flow that occur during execution.

3. Sequence Diagram

Depicts the interaction between objects in the system in sequential order over time, showing the messages sent and received between objects.

2.6 Construction

At this stage, the system is developed by implementing the program code using PHP and Laravel, based on the designed model. This process ensures that all functions and features operate as required. Once coding is complete, the system is tested using black box testing, focusing on validating inputs and outputs without examining the internal structure. This testing aims to detect errors or deficiencies before the system is further implemented.

3. RESULTS AND DISCUSSION

The Material Requirement Planning system developed for Es Barbar SME is a web-based application. This application is designed to facilitate the management of raw material requirements in the SME. The system users consist of the owner and the seller, each having different access rights according to their roles. Below are the results and discussion regarding the implementation of the Material Requirement Planning website at Es Barbar SME.

3.1 MRP calculations

The implementation stage ensures the correct application of MRP formulas within the system. This process verifies that raw material calculations align with input data, including product demand, initial stock, and order quantities. The expected outcome is to provide accurate material requirement information to efficiently support the production process.

1. Gross Requirement (GR) Formula:

$$\text{Production Quantity} \times \text{Amount of Material per Serving} \quad (1)$$

2. Net Requirement (NR) Formula:

$$GR - OHI (\text{On Hand Inventory}) \quad (2)$$

3. Purchase Order Requirement (POREL) Formula:

$$POREL = NR \quad (3)$$

3.2 Application design

The Material Requirement Planning (MRP) system developed for Es Barbar SME is a web-based application. This application is designed to facilitate the management of raw material requirements in the SME. The system users consist of the owner and the seller, each having different access rights according to their roles. Below are the results and discussion regarding the implementation of the Material Requirement Planning website at Es Barbar SME.

1. Login

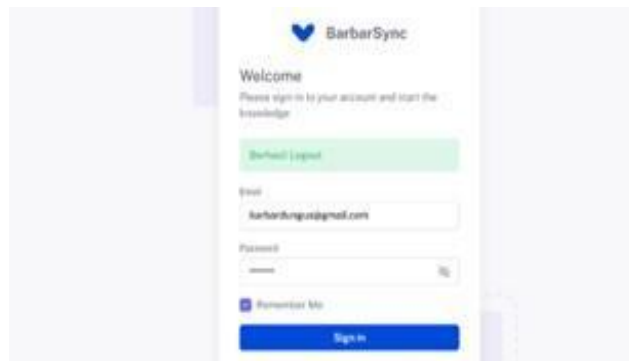


Figure 2. Login Page

This page displays the login screen used by users to access the Barbarsync website. On this page, users are required to enter their email and password before they can log into the system.

2. Manage User

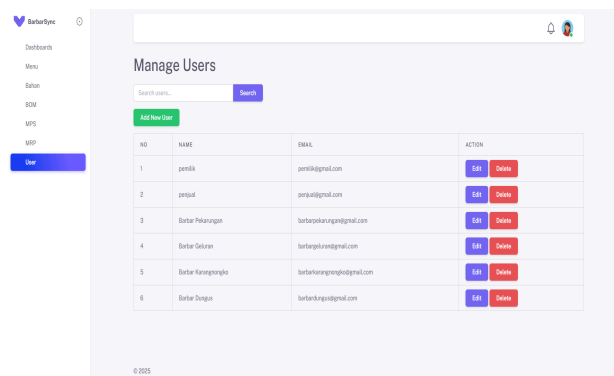


Figure 3. Manage User Page

This page displays the manage user section used by the admin to manage user data in the system. On this page, the admin can perform various actions such as adding, deleting, and updating user information.

3. Add User

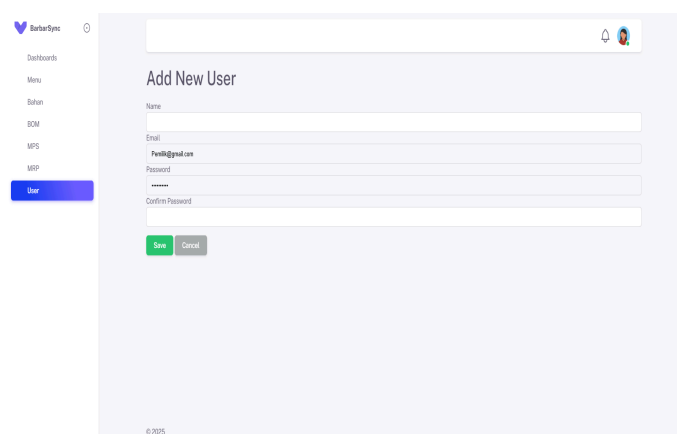


Figure 4. Add User Page

This page displays the add user section used by the admin to add new user data into the system. On this page, the admin can fill in the name, email, password, and confirm password fields.

4. Update User

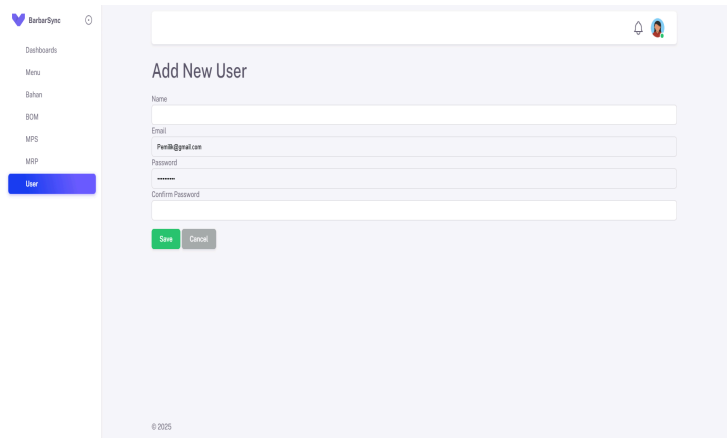


Figure 5. Update User Page

This page displays the update user section used by the admin to modify the data of registered users in the system. On this page, the admin can fill in the name, email, and password fields.

5. Dashboard

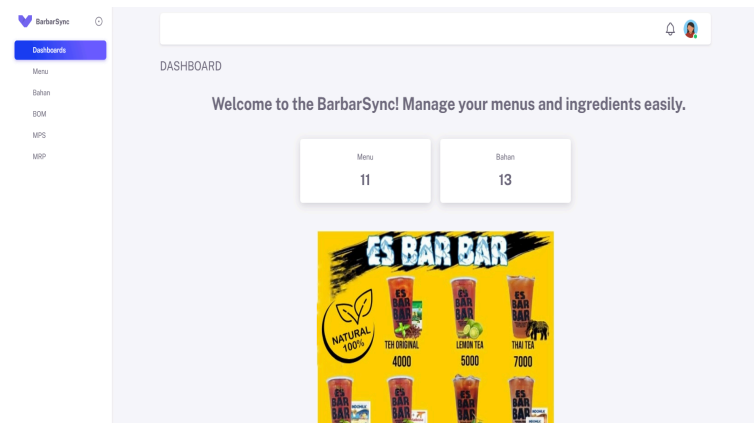


Figure 6. Dashboard Page

This page displays the dashboard section used by the admin and users to view a summary of the data in the system. This page also contains notifications that serve as reminders when stock is low or out of stock.

6. Menu

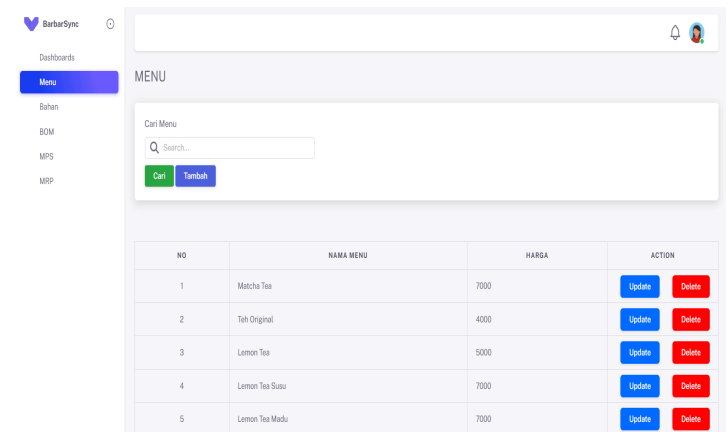


Figure 7. Menu Page

This page displays the menu section used by users to manage menu data in the system. On this page, users can perform various actions such as adding, deleting, searching, and updating menu items.

7. Add Menu

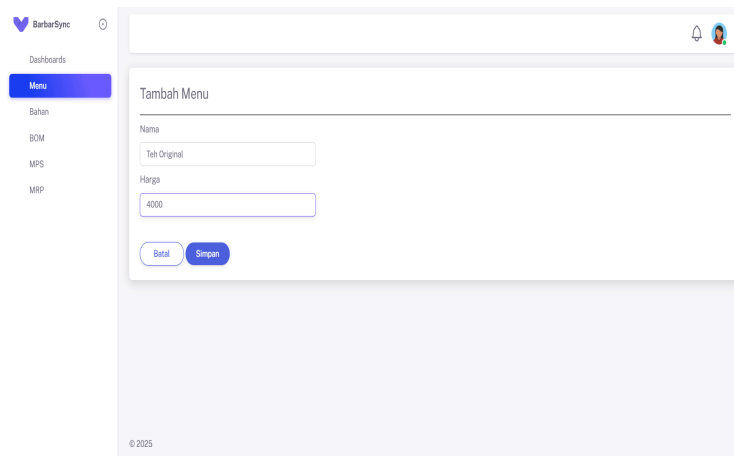


Figure 8. Add Menu Page

This page displays the add menu section used by users to add new menu items to the system. On this page, click the 'add' button and input the requested information.

8. Update Menu

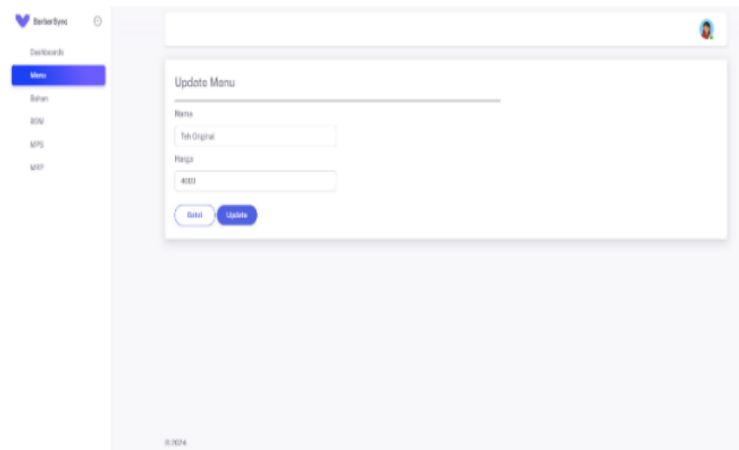


Figure 9. Update Menu Page

This page displays the update menu section used by users to update menu data in the system. On this page, click the 'update' button and input the requested information.

9. Materials

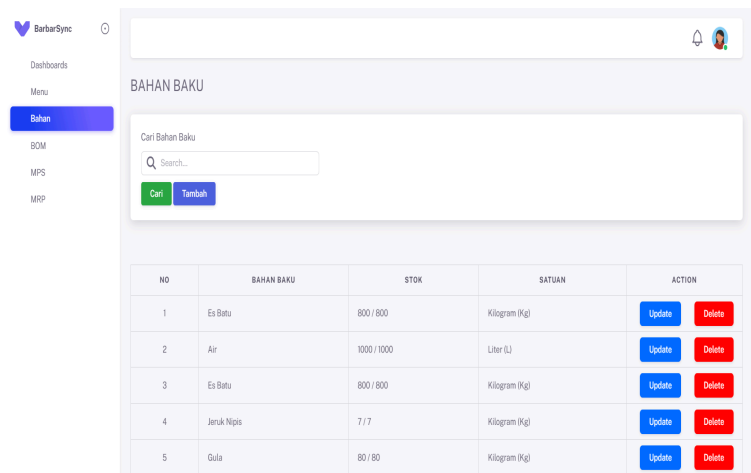


Figure 10. Materials Page

This page displays the raw materials section used by users to manage raw material data in the system. On this page, users can perform various actions such as adding, deleting, searching, and updating raw materials.

10. Add Materials

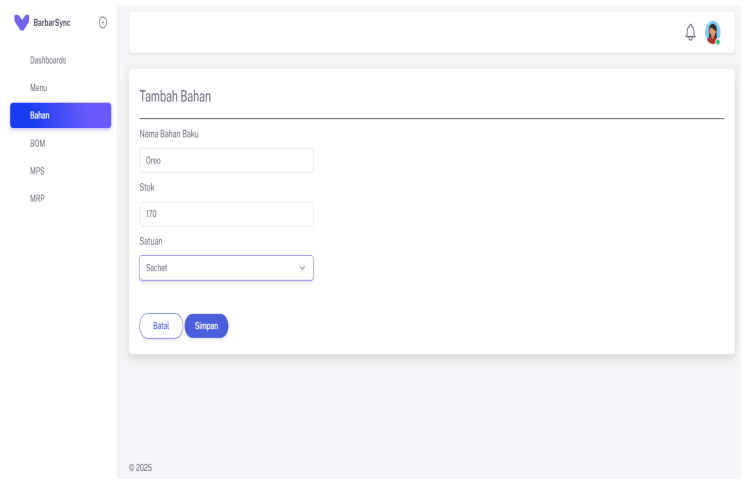


Figure 11. Add Materials Page

This page displays the add raw materials section used by users to add new raw material data into the system. On this page, click the 'add' button and input the requested information.

11. Update Materials

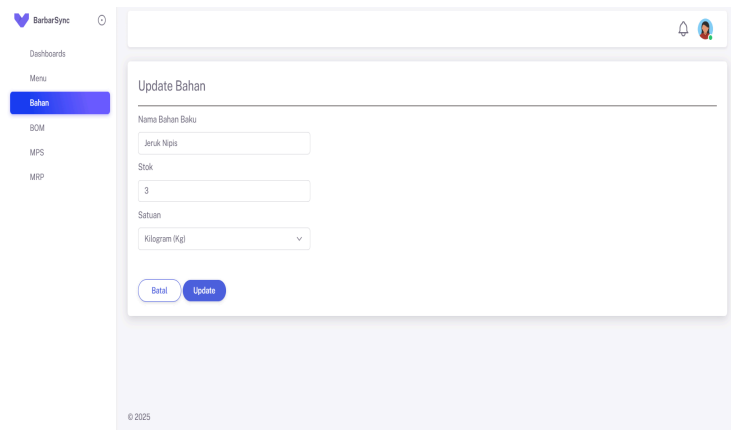


Figure 12. Update Materials Page

This page displays the update raw materials section used by users to update raw material data in the system. On this page, click the 'update' button and input the requested information.

12. Bill of Material (BOM)

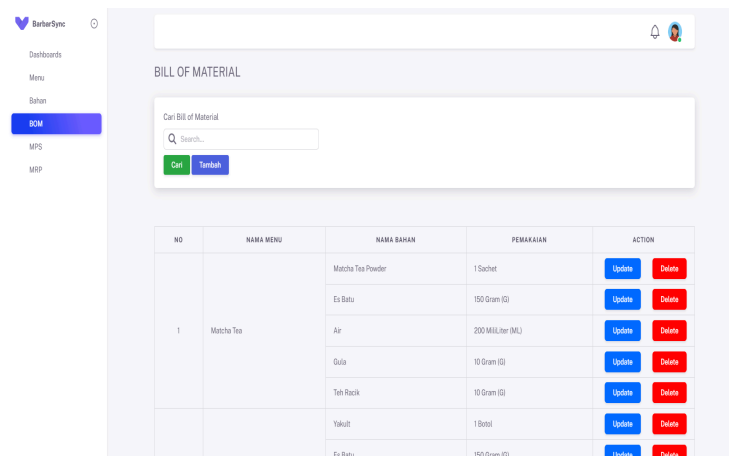


Figure 13. Bill of Material Page

This page displays the raw materials section used by users to manage raw material data in the system. On this page, users can perform various actions such as adding, deleting, searching, and updating raw materials.

13. Add Bill of Material (BOM)

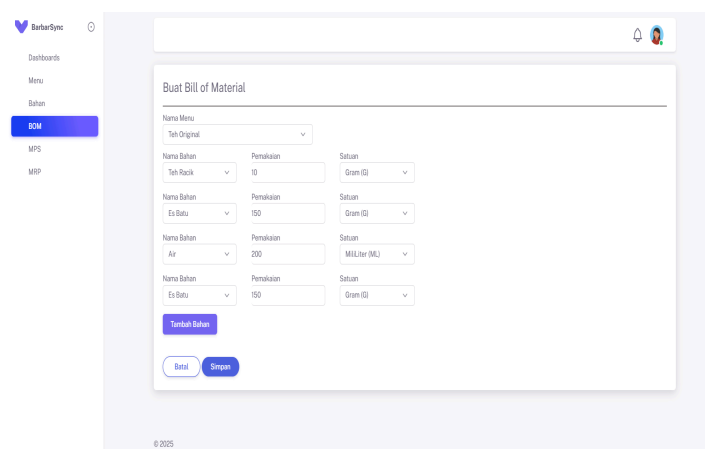


Figure 14. Add Bill of Material Page

This page displays the add BOM section used by users to add new BOM data into the system. On this page, click the 'add' button and input the requested information.

14. Update Bill of Material (BOM)

BarbarSync

Update Bill of Material

Nama Menu
Teh Original

Nama Bahan Baku
Teh Raki

Satuan
Gram (g)

Pembelian
10

Batal Update

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Figure 15. Update Bill of Material Page

This page displays the update BOM section used by users to update BOM data in the system. On this page, click the 'update' button and input the requested information.

15. Master Production Schedule (MPS)

BarbarSync

MASTER PRODUCTION SCHEDULE

Cari Master Production Schedule

Search...

Cari Tambah

NO	NAMA MENU	PORSI	TANGGAL	ACTION
1	Teh Original	1440 Porsi	2024-09-01	Delete
2	Lemon Tea	360 Porsi	2024-09-01	Delete
3	Lemon Tea Susu	260 Porsi	2024-09-01	Delete
4	Lemon Tea Madu	270 Porsi	2024-09-01	Delete
5	Milk Tea	260 Porsi	2024-09-01	Delete
6	Milk Tea Oreo	230 Porsi	2024-09-01	Delete
7	Thai Tea	350 Porsi	2024-09-01	Delete

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Figure 16. Master Production Schedule Page

This page displays the MPS section used by users to manage MPS data in the system. On this page, users can perform various actions such as adding, deleting, and searching for MPS entries.

16. Add Master Production Schedule (MPS)

BarbarSync

Buat Master Production Schedule

Nama Menu
Teh Original

Porsi
1440

Tanggal
01/09/2024

Batal Simpan

© 2025

Figure 17. Add Master Production Schedule Page

This page displays the add MPS section used by users to add new MPS data into the system. On this page, click the 'add' button and input the requested information.

17. Material Requirement Planning (MRP)

Figure 18. Material Requirement Planning Page

This page displays the MRP section used by users to estimate raw material requirements through the system using the MRP calculation. On this page, enter the material name along with the start and end dates, then click the ‘calculate’ button. The system will automatically compute the estimated material requirements using the MRP method. If you wish to save the results, you can print them by clicking the ‘print’ button, and the result will be generated in a PDF file

Figure 19. Material Requirement Planning Print Page
Tabel. 2 Raw Material Components After the MRP Process

No	Component	Initial Stock	Status
1	Teh Racik (Kg)	40	enough
2	Gula (Kg)	63	enough
3	Air (Galon)	42	enough
4	Es Batu (Kg)	600	enough
5	Susu Kental Manis (Sachet)	750	enough
6	Thai Tea Powder (Sachet)	350	enough
7	Manggo Tea Powder (Sachet)	170	enough
8	Matcha Tea Powder (Sachet)	200	enough
9	Milo (Sachet)	230	enough

10	Madurasa (Sachet)	270	enough
11	Yakult (Botol)	230	enough
12	Oreo (Sachet)	230	enough
13	Jeruk Nipis (Kg)	28	enough

After implementing the MRP system, Es Barbar SME experienced significant positive impacts, including a 95% reduction in raw material stockouts, ensuring uninterrupted production, and an 85% reduction in excess stock, preventing potential losses from damage or quality degradation. The system also improved the accuracy of raw material planning based on the Master Production Schedule (MPS) and Bill of Materials (BOM), enabling better decision-making in raw material procurement. These improvements provided a solid foundation for more efficient inventory management and strategic decision-making at Es Barbar SME

3.3 System testing

Testing was conducted to ensure that each function in the system operates correctly and meets the desired outcomes. This testing used the black-box testing method, where the focus is on the functionality of the application without considering the internal structure or code implementation. The testing is performed by providing appropriate inputs and checking whether the output generated matches the expected results or specifications.

(1) Login Page Testing

Tabel. 3 Login Page Testing

No	Testing Procedure	Expected Result	Status
1	Enter a valid email and password, then click the Sign in button.	The system redirects the user to the Dashboard page.	Correct

(2) Menu Page Testing

Tabel. 4 Menu Page Testing

No	Testing Procedure	Expected Result	Status
1	Click the Add button, enter new menu data, then click Save.	The new menu item is added to the table and appears in the menu list.	Correct
2	Click the Update button on a menu item, modify data, then click Save.	The updated menu item appears in the data table.	Correct
3	Click the Delete button on a menu item.	The system deletes the menu item from the list.	Correct
4	Click the Search button after filling in the input text.	The system displays the menu based on the entered name.	Correct

(3) Material Page Testing

Tabel. 5 Material Page Testing

No	Testing Procedure	Expected Result	Status
1	Click the Add button, enter new material data, then click Save.	The new material is added to the table and appears in the material list.	Correct
2	Click the Update button on a material, modify data, then click Save.	The updated material appears in the data table.	Correct

No	Testing Procedure	Expected Result	Status
3	Click the Delete button on a material.	The system deletes the material from the list.	Correct
4	Click the Search button after filling in the input text.	The system displays the material based on the entered name.	Correct

(4) Bill of Material Page Testing

Tabel. 6 Bill of Material Page Testing

No	Testing Procedure	Expected Result	Status
1	Click the Add button, enter new BOM data, then click Save.	The new BOM is added to the table and appears in the BOM list.	Correct
2	Click the Update button on a BOM, modify data, then click Save.	The updated BOM appears in the data table.	Correct
3	Click the Delete button on a BOM.	The system deletes the BOM from the list.	Correct
4	Click the Search button after filling in the input text.	The system displays the BOM based on the entered menu name.	Correct

(5) Master Production Schedule Page Testing

Tabel. 7 Master Production Schedule Page Testing

No	Testing Procedure	Expected Result	Status
1	Click the Add button, enter new MPS data, then click Save.	The new MPS is added to the table and appears in the MPS list.	Correct
2	Click the Delete button on an MPS.	The system deletes the MPS from the list.	Correct
3	Click the Search button after filling in the input text.	The system displays the MPS based on the entered menu name.	Correct

(6) Material Requirement Planning Page Testing

Tabel. 8 Material Requirement Planning Page Testing

No	Testing Procedure	Expected Result	Status
1	Enter the production schedule data, then click the Calculate button.	The system generates raw material requirements based on the MRP method.	Correct
2	Click the Download button for the MRP calculation result.	The system downloads the file in the appropriate format (PDF or Excel).	Correct

CONCLUSION

The implementation of the Material Requirement Planning (MRP) method significantly improved raw material inventory management at Es Barbar SME, reducing stock shortages by 95% and excess stock by 85%. The web-based inventory management system enhanced procurement accuracy by integrating Master Production Schedule (MPS) and Bill of Materials (BOM), optimizing storage costs, minimizing waste, and ensuring a smooth production process.

The system development followed the System Development Life Cycle (SDLC) waterfall model, ensuring a structured and efficient process from communication, planning, modeling, construction, to implementation. The system also improved decision-making through real-time inventory tracking and demand forecasting, preventing supply chain disruptions and increasing operational efficiency.

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