VIETNAM NATIONAL UNIVERSITY HO CHI MINH CITY
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MIDTERM PROJECT

WAREHOUSE AND SHELF MANAGEMENT AT SUPERMARKET

Course
SYSTEMS ANALYSIS AND DESIGN

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GROUP 3

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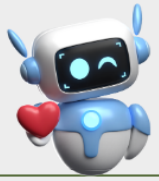
Once again, we express our heartfelt gratitude to all those of you who have supported us throughout the course. We are immensely appreciative of the knowledge and skills we have acquired, and we look forward to applying them in future endeavors.



GROUP 3

HCM CITY, DECEMBER 2024

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CHAP 1. PROJECT INTRODUCTION

1.1 Project Description & Objective

1.1.1 Purpose

The purpose of the project "Warehouse and Shelf management at supermarket " is to improve the efficiency of warehouse management and operations in supermarkets through the application of automation technology and smart robot solutions. This system was designed by the team not only to minimize dependence on manual processes, minimize errors in goods management, but also to ensure that the storage and circulation of goods takes place quickly, accurately and effectively.

1.1.2 Scope of project

Organization Scope

The solution is applied across the entire supermarket system, ensuring consistent inventory management and optimized operations. Customizations are allowed to meet the needs of individual supermarkets while maintaining core processes and features.

Functional Scope

- Shelf and warehouse inventory management with robot coordination:
- Monitor inventory, restock shelves, and trigger procurement processes when needed.
- Coordinate robots for arranging items, handling misplaced products, and updating new products.
- Track and report activities: Record warehouse events in real time, report the status of goods and shelves.

Integration Scope

- ERP System: Manage financial data, inventory, and operational processes, including cost tracking, automated ordering, location management, and product information synchronization.
- Robot System: Handle restocking, misplaced items, and expired products.
- POS System: Update sales information and determine inventory levels.

- Reporting System: Export data on inventory, operations, and performance.

Out of Scope

- Transportation Management: Focus is limited to the scope of a single warehouse for each supermarket.
- Customer Interaction and Wholesale: Staff will handle customer interaction functions, while robots and the system will not participate.
- Robot Algorithms: Task management only; navigation algorithm development is excluded.
- Perishable Goods: Provides basic tracking and management mechanisms only.

1.1.3 Objective

The ***"Warehouse and Shelf Management at Supermarkets"*** project is being developed to address current challenges in inventory management and warehouse operations at supermarkets. In the context of increasing demands for operational efficiency and resource optimization, this system will help reduce reliance on manual labor. The main goal of the project is to build a system with intelligent robots to automate critical processes in inventory management, ranging from controlling goods in the warehouse to managing products on supermarket shelves. Specifically, the system will be developed based on the following objectives:

- Ensure that products are always arranged in the correct positions on shelves.
- Ensure that shelves are always fully stocked, preventing stock outs or shortages.
- Ensure that products on shelves are of the highest quality, avoiding issues such as expired items, damage, or abnormalities.
- Control the quality of goods before they are stored in the warehouse.
- Closely monitor inventory levels to ensure timely and efficient supply of goods.
- Automatically detect anomalies, such as expired products or shelf shortages, and send alerts to robots for immediate handling.

By automating and optimizing these processes, the project aims to enhance operational capabilities, improve work efficiency, and elevate service quality at supermarkets,

particularly by achieving the highest level of optimization in warehouse management operations.

1.2 Deliverables

The project will provide an internal (private) website for supermarket staff, supporting comprehensive management of activities related to shelves and warehouses. The website will integrate key functions such as: monitoring the status of products on shelves through the Smart Shelf system, real-time inventory management, and automatically assigning tasks based on information from sensors or requests from departments. In addition, the website also provides an interface to track the operating status of robots, helping to optimize operational performance and ensure processes take place seamlessly and efficiently.

1.3 Business Requirement

No.	Function Requirement Group	Detail	Next action
1	The process of out - of shelves.	The system receives problems from another system, then notifies the interface and simultaneously activates the restocking process → Ensuring shelves are always replenished promptly.	• Define in detail the alert process and thresholds, specifying how many products remain on the shelf before a restocking notification is sent. • Identify suitable types of sensors/monitoring devices, specifically using Smart Shelves and Arranging Robots.
		Automate the process of requesting stock	• Determine the type of robot to be used for restocking items

		replenishment from the warehouse when empty shelves are detected → Ensure an uninterrupted supply chain.	from the warehouse → Warehouse Robot. • Define the method/path/logic for the robot to automatically deliver items to the Picking Area.
2	Product Receiving Process (When Goods Arrive)	The system automatically triggers the warehouse receiving process (when goods arrive).	• Identify the robot/department responsible for performing the warehouse receiving task. • Identify the document generated (specifically the GR).
3	Procurement Process	The system will automatically check the inventory and trigger the purchasing process.	• Identify the logic that triggers the purchasing process, integrating with the existing ERP system. • Identify the departments/robots that will participate in this process. • Identify the documents generated (specifically PR, PO)."
4	Shelf Management	The smart shelf automatically detects issues when there are changes in weight →	• Define the criteria for detecting issues on the Smart Shelf (e.g., weight change threshold for in-out, based on product ID).

		Provides timely alerts for abnormal situations.	• Analyze potential situations: • The shelf is empty (out of stock). • Errors in product replenishment. • Customers place products in the wrong position.
5	Process for Managing Wrong Position Products	The system automatically triggers the process for handling wrong position products.	• Identify the current location and the correct position of the product. • Determine the type/method/path/logic through which the robot can automatically move the product to the correct position → Arranging Robot.
6	Product Discontinuation Management Process	The system receives information about discontinued products and substitute products → Automatically triggers the inventory check process and handles the discontinued products.	• Determine the department responsible for managing discontinued products (specifically the Sales Department). • Identify substitute products based on information received from the Sales Department.
7	Expiration Date Management	The system automatically checks the	• Determine which types of products will be managed

		expiration date and sends an alert when it identifies products nearing expiration. It automatically activates the process to handle products nearing expiration.	(including both packaged goods and fresh items). • Determine the type of robot to be used for restocking items from the warehouse → Warehouse Robot. • Determine the method/path/logic for the robot to autonomously deliver items to the designated area for processing and the picking area to fill in new stock.
8	Task Assignment Process	When the system receives a problem from departments or from the Smart Shelf, it will automatically create a task, assign it to the Robots, and send the problem to the relevant department (if applicable). → Automation.	• Build task prioritization logic (which task should be prioritized first). • Build a robot queue for each robot.

Table 1.1 Business Requirements

1.4 Solution and Function

To address the remaining issues, the supermarket has implemented a system that applies multiple technological solutions to facilitate management. The Warehouse and Shelf management at supermarket system consists of the following functions:

- **Arranging Robot:** responsible for arranging goods on shelves (filling goods) according to designated locations, arranging products in the wrong locations. Besides, it also removes discontinued products and expired products, replaces them with new products.

- **Warehouse Robot:** is designed to handle the main tasks related to warehouse management. It performs checking the location of goods in the warehouse, moving products from the warehouse to the Picking Area. This robot is also responsible for checking the status of goods when the shipment is received, ensuring that the product is of the right quality and notifying relevant departments when the goods have abnormal problems, entering the goods into the warehouse, and attaching product codes after checking the products.

- **Smart Shelf:** is a smart shelf system, capable of automatically managing the status of goods on the shelf. It relies on the weight factor on the shelf to recognize the goods being put in or taken out of the shelf. This system is integrated with data and sensor technology and AI Camera to monitor the quantity and information of products, helping to promptly detect the status of shelves running out of stock or products being placed in the wrong position, Smart Shelf will send notifications to related departments.

- **System Automation:** This system plays a role in coordinating and monitoring operating processes in the entire system. It integrates data from different departments such as Arranging Robot, Warehouse Robot and Smart Shelf to ensure that the processes run smoothly and efficiently. This system records notifications from Smart Shelf or requests from related departments (Sales Department, Purchasing Department). From there, the system will analyze, assign tasks to Robots, and coordinate the work.

- **Website:** Website is embedded from System and Robot data. Provides an overview of the system with important information to support managers in controlling the database, monitoring the operation process and receiving notifications when problems occur as well as when decisions need to be made.

- **Sales Department:** Takes on the role of handling requests related to discontinued products. Specifically, the department receives requests to update information about

discontinued products from the Sales Manager, then selects appropriate replacement products and makes a detailed list including discontinued products and corresponding replacement products. Related information or issues will be sent to the Automation System for processing, ensuring the operation process is fast and efficient.

- **Purchasing Department:** Takes on tasks related to processing purchase requests (Purchase Requisition) and return requests. The Purchasing Department reviews and decides to accept or reject the request when receiving a purchase request. If the request is accepted, the department will create a purchase order (PO), save the order information in the database, and then send the PO to the supplier. In case of rejection of the purchase request, this department will save the reason for rejection in the system and send a notification to the supplier if necessary. In addition, the department is also responsible for handling return requests, including sending return notifications to the supplier.

- **Quality Management Department:** performs functions related to checking the quality of goods. If a product is found to be defective, the department will transfer the product to the return area and send a notification to the Purchasing Department. For qualified products, the department will assign a product code to each item. Update the database with new information, as well as create and save Goods Receipt into the system. Ensure that only qualified products are circulated. Additionally, promptly handle problems with defective goods, maintaining the quality standards of the goods.

1.5 Roles & Permissions

LINK: Roles&Permissions

Function	Page	Field Data	CRUD	Smart Shelf	Warehouse Robot	Arranging Robot	Purchasing Department	Sales Department	Quality Management Department
Handle Out-of-Stock Shelf	*Page: Task Management*		Create						
			Read					✓	
			Update						
			Delete						
	Page: Robot Queue Detail		Create						
			Read		✓	✓		✓	
			Update		✓	✓			
			Delete						
	Page: Product		Create						
			Read	✓	✓	✓		✓	
			Update		✓			✓	
			Delete					✓	
	Page: Goods Issue	Goods issue	Create		✓				
			Read		✓			✓	
			Update		✓				
			Delete						
		Product	Create						
			Read		✓				
			Update		✓				
			Delete						
	Page: Shelf Detail Information		Create					✓	
			Read	✓				✓	
			Update	✓				✓	
			Delete					✓	

Figure 1.1 Roles & Permissions 1

Function	Page	Field Data	CRUD	Smart Shelf	Warehouse Robot	Arranging Robot	Purchasing Department	Sales Department	Quality Management Department
Handle Discontinued Product	*Page: Task Management*		Create						
			Read					✓	
			Update						
			Delete						
	Page: Robot Queue Detail		Create						
			Read		✓	✓		✓	
			Update		✓	✓			
			Delete						
	Page: Product +Product Detail + Edit Status popup		Create						
			Read	✓	✓	✓		✓	
			Update		✓			✓	
			Delete					✓	
	Page: Goods Issue	Goods issue	Create		✓				
			Read		✓			✓	
			Update		✓				
			Delete						
		Product	Create						
			Read		✓				
			Update		✓				
			Delete						
	Page: Shelf Detail Information		Create					✓	
			Read	✓				✓	
			Update	✓				✓	
			Delete					✓	

Figure 1.2 Roles & Permissions 2

Function	Page	Field Data	CRUD	Smart Shelf	Warehouse Robot	Arranging Robot	Purchasing Department	Sales Department	Quality Management Department
Handle Misplaced Product	*Page: Task Management*		Create						
			Read					✓	
			Update						
			Delete						
	Page: Robot Queue Detail		Create						
			Read		✓	✓		✓	
			Update		✓	✓			
			Delete						
	Page: Product		Create						
			Read	✓	✓	✓		✓	
			Update		✓	✓		✓	
			Delete						
	Page: Shelf Detail Information		Create					✓	
			Read	✓				✓	
			Update	✓				✓	
			Delete					✓	

Figure 1.3 Roles & Permissions 3

Function	Page	Field Data	CRUD	Smart Shelf	Warehouse Robot	Arranging Robot	Purchasing Department	Sales Department	Quality Management Department
Handle Exprired	*Page: Task Management*		Create						
			Read					✓	
			Update						
			Delete						
	Page: Robot Queue Detail		Create						
			Read		✓	✓		✓	
			Update		✓	✓			
			Delete						
	Page: Product		Create						
			Read	✓	✓	✓		✓	
			Update		✓	✓		✓	
			Delete					✓	
	Page: Goods Issue	Goods issue	Create		✓				
			Read		✓			✓	
			Update		✓				
			Delete						
		Product	Create						
			Read		✓				
			Update		✓				
			Delete						
	Page: Shelf Detail Information		Create					✓	
			Read	✓				✓	
			Update	✓				✓	
			Delete					✓	

Figure 1.4 Roles & Permissions 4

Function	Page	Field Data	CRUD	Smart Shelf	Warehouse Robot	Arranging Robot	Purchasing Department	Sales Department	Quality Management Department
Receive goods into the warehouse	*Page: Task Management*		Create						
			Read				✓		✓
			Update						✓
			Delete						
	Page: Robot Queue Detail		Create						
			Read		✓		✓		✓
			Update		✓				
			Delete						
	Page: Purchase Order		Create						
			Read		✓		✓	✓	✓
			Update				✓		
			Delete				✓		
	Page: Goods Receipt	Goods receipt	Create		✓				✓
			Read		✓		✓		✓
			Update		✓				✓
			Delete						✓
		Product	Create						
			Read		✓				✓
			Update		✓				✓
			Delete						
	Page: Request Return/Create Request Return	Request Return	Create				✓		
			Read				✓		
			Update				✓		
			Delete				✓		
		PO	Create						
			Read				✓		
			Update				✓		
			Delete						

Figure 1.5 Roles & Permissions 5

Function	Page	Field Data	CRUD	Smart Shelf	Warehouse Robot	Arranging Robot	Purchasing Department	Sales Department	Quality Management Department
Manage stockout in warehouse	*Page: Purchase Order*		Create				✓		
			Read		✓		✓		✓
			Update				✓		
			Delete				✓		
	Page: Purchase Requisition		Create						
			Read				✓		
			Update				✓		
			Delete				✓		
	Page: Create PO	PO	Create				✓		
			Read				✓		
			Update				✓		
			Delete				✓		
		Product	Create						
			Read				✓		
			Update				✓		
			Delete						
		Vendor	Create				✓		
			Read				✓		
			Update				✓		
			Delete				✓		

Figure 1.6 Roles & Permissions 6

Function	Page	Field Data	CRUD	Smart Shelf	Warehouse Robot	Arranging Robot	Purchasing Department	Sales Department	Quality Management Department
Assign task	*Page: Task Management*		Create						
			Read				✓	✓	✓
			Update						✓
			Delete						
	Page: Robot Queue Detail		Create						
			Read		✓	✓	✓	✓	✓
			Update		✓	✓			✓
			Delete						

Figure 1.7 Roles & Permissions 7

CHAP 2. PROJECT ANALYSIS

2.1 BPMN

Diagram: **LINK**

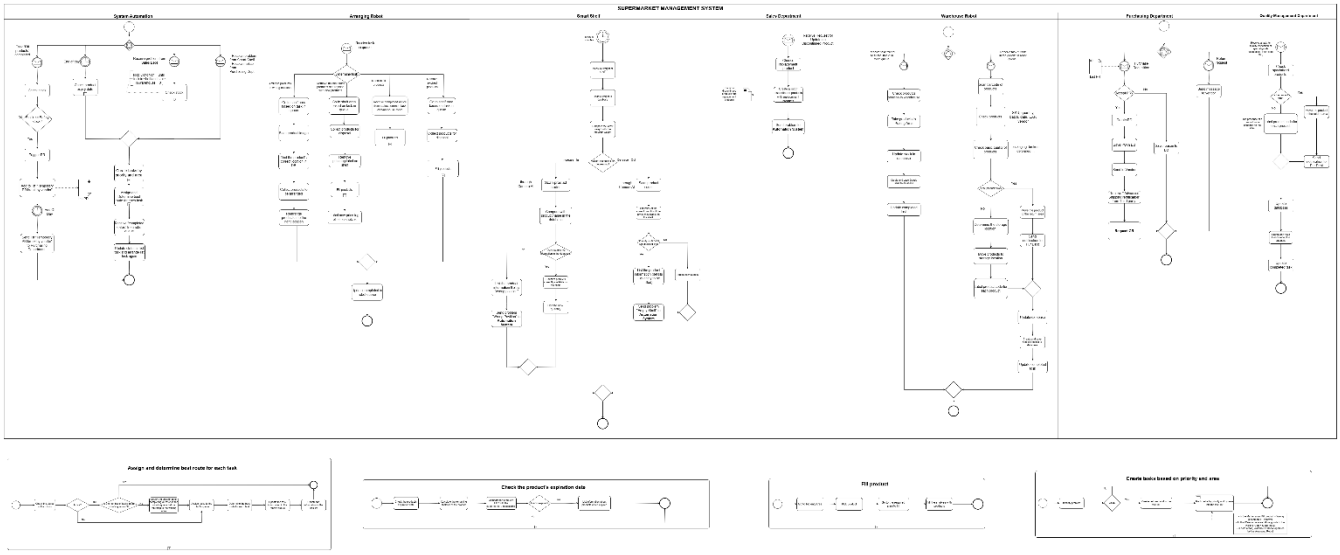

Figure 2.1 BPMN

Description

The management system is divided into two main processes: **Supermarket Management** and **Warehouse Management**.

- **Supermarket Management:** Smart shelves continuously monitor products, detecting issues such as misplaced items or empty shelves. When a problem is identified, the smart shelves send information to the system, which automatically assigns tasks to various robots based on system logic. **Arranging robots** handle errors such as rearranging misplaced products or resolving identified issues. If a shelf runs out of stock, the system sends a replenishment request to the **Warehouse robot**. Additionally, the **sales department** can provide a list of discontinued products, and the system will manage the removal of these items from the shelves and execute subsequent management steps.
- **Warehouse Management:** The warehouse management process integrates alerts from **smart shelves** and robot automation. When a **smart shelf** detects a stock

shortage, the system sends a replenishment request to the **Warehouse robot**. The robot retrieves stock from the warehouse and transfers it to the picking area for **Arranging robots** to handle. Simultaneously, the system continuously monitors inventory levels. If stock falls below the minimum threshold, the robot generates a purchase requisition (PR) and sends it to the **purchasing department**. After the PR is approved, a purchase order (PO) is created for restocking. Upon the delivery of goods, the **Warehouse robot**, in coordination with the **quality management department**, scans and inspects the product's condition, after which the system updates the database.

***(*) Note:** If customers want to purchase in bulk or wholesale quantities (exceeding the specified product limit per shelf), they will need to contact the market staff for assistance. Robots will not participate in this process, so it will not be represented in the BPMN diagram.*

2.2 DFD

Diagram: [LINK]

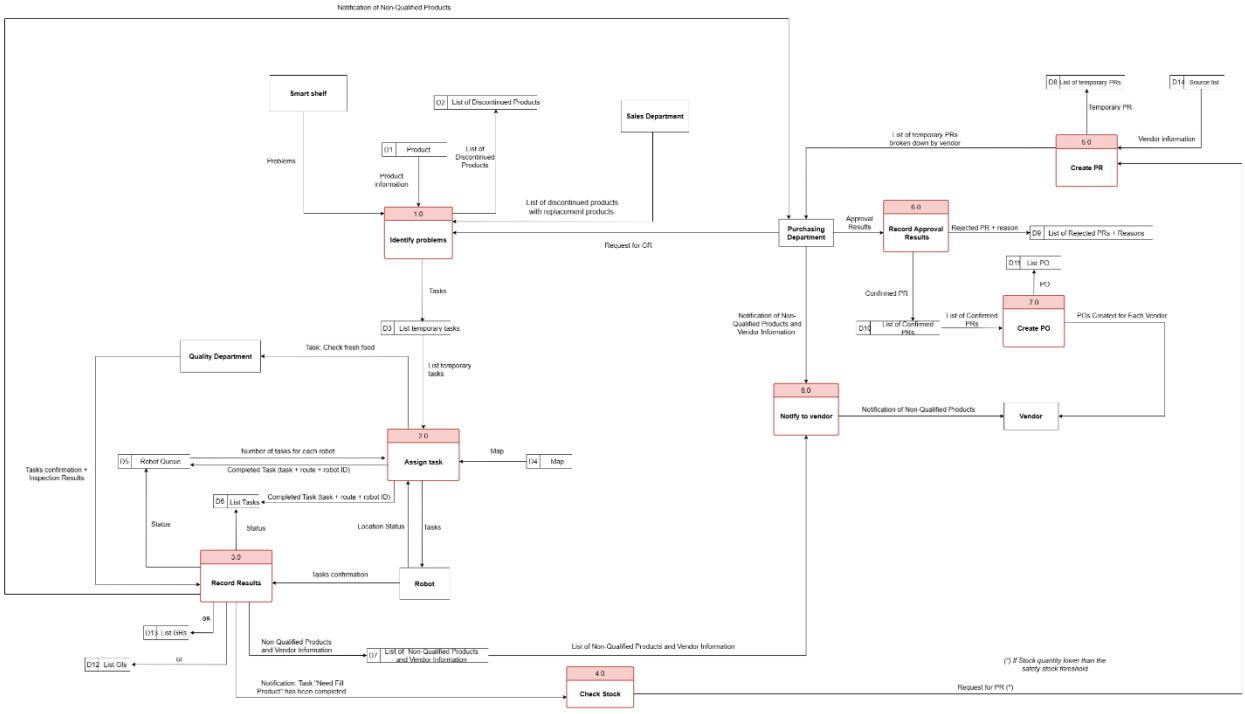

Figure 2.2 DFD Level 0

Description

1. **Smart shelf** detects and sends **Problems** to the system, **Sales Department** sends **List of discontinued products with replacement products, Purchasing Department** sends **Request for GR** to the system. Then the system will go through the **Identify Problem** process based on **Product information** taken from the **Product** data store to create **Tasks** saved into the **List Temporary Tasks** data store and **List of Discontinued Products** saved into the **List of Discontinued Products** data store.
2. The system will perform the **Assign Task** process based on **List temporary tasks** taken from the **List Temporary Tasks** data store, **Map** taken from the **Map** data store, **Number of tasks for each robot** taken from the **Robot Queue** data store, position after completing all tasks in the Robot Queue before returning to the waiting area in **Location Status** provided by **Robot**, thereby creating a **Completed Task (Task, Route, Robot ID)** saved into the **List Tasks** data store and the **Robot Queue** data store. The system assigns **Tasks** to **Robot** and **Task: Check fresh food** to **Quality Department.**
3. The system will perform the **Record Results** process based on **Tasks Confirmation** from **Robot,** save **Status** into the **Robot Queue** data store and the **List Tasks** data store. Besides, based on the **Record Results** process, the system also receives **Tasks Confirmation** and **Inspection Results** from **Quality Department,** saves **Status** into the **List Tasks** data store, saves **GR** into the **List GRs** data store, saves **GI** into the **List GIs** data store if any. If there are products that do not meet quality standards, they will be saved into the **List of Non-Qualified Products and Vendor Information** data store and send **Notification of Non-Qualified Products** to **Purchasing Department**.
4. The system automatically performs the **Check Stock** process after receiving **Notification: Task "Need Fill Product" has been completed,** the system will create a **Request for PR** if the stock quantity is lower than the safety stock threshold.

5. The **Create PR** process is carried out based on **Request for PR** received and **Vendor information** from the **Source list** data store. The system then saves **Temporary PR** into the **List of temporary PRs** data store and sends **List of temporary PRs broken down by vendor** to **Purchasing Department.**
6. The **Record Approval Results** process is executed when the system receives the **Approval Results** from the **Purchasing Department.** If the result is a rejection, the system will save the **Rejected PR and rejected reason** in the **List of Rejected PRs and Reasons** data store. If the result is an approval, the system will save the **Confirmed PR** in the **List of Confirmed PRs** data store.
7. The **Create PO** process is executed upon receiving the **List of Confirmed PRs** from the **List of Confirmed PRs** data store, saves the **POs** to the **List PO** data store, and the system sends **POs Created for Each Vendor** to the **Vendor**.
8. If the system receives a **Notification of Non-Qualified Products and Vendor Information** from the **Purchasing Department** and the **List of Non-Qualified Products and Vendor Information** data from the **List of Non-Qualified Products and Vendor Information** data store, the system will trigger the **Notify to Vendor** process and send a **Notification of Non-Qualified Products** to the **Vendor.**

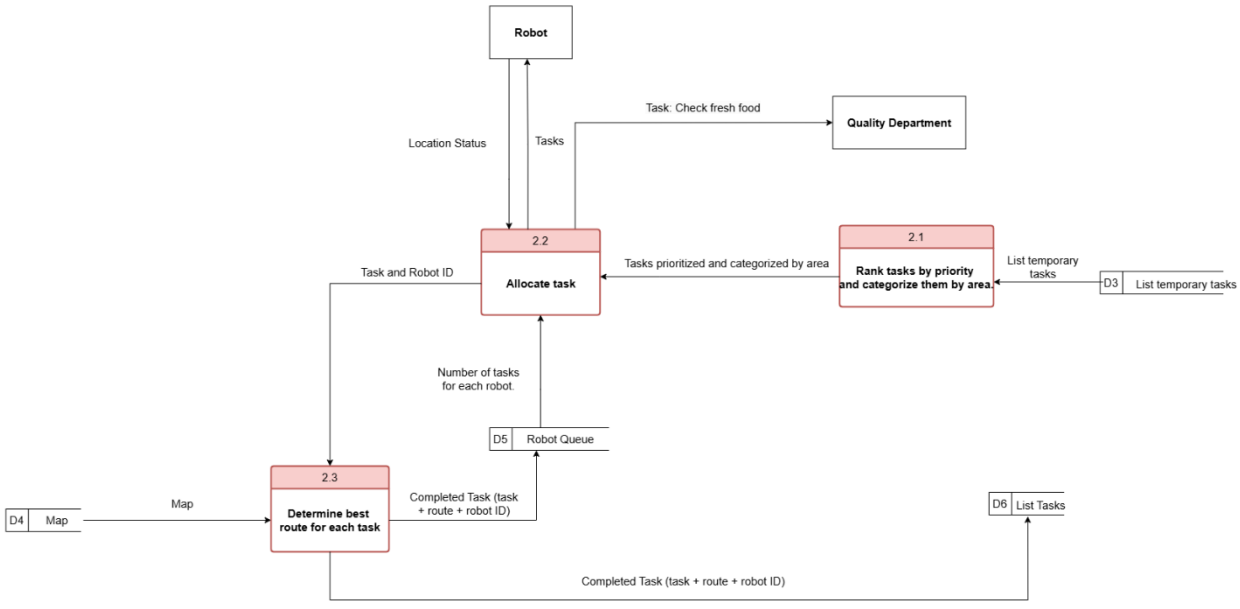

Figure 2.3 DFD Level 1 of the Assign Task process.

Description

1. The **Rank tasks by priority and categorize them by area** process will be carried out based on **List temporary tasks** from the **List Temporary Tasks** data store, thereby creating **Tasks prioritized and categorized by area**
2. Based on **Tasks prioritized and categorized by area,** position after completing all tasks in the Robot Queue before returning to the waiting area in **Location Status** provided by **Robot** and **Number of tasks for each robot** taken from the **Robot Queue** data store, the system will perform the **Allocate Task** process. The system will then assign **Tasks** to **Robot** and **Task: Check fresh food** to **Quality Department.**
3. Based on **Map** from the **Map** data store and **Task and Robot ID**, the system will **Determine best route for each task,** thereby creating a **Completed Task** (**Task, Route, Robot ID)** saved into the **List Tasks** data store and the **Robot Queue** data store.

2.3 Use Case

Diagram: **LINK**

2.3.1 Sale Department

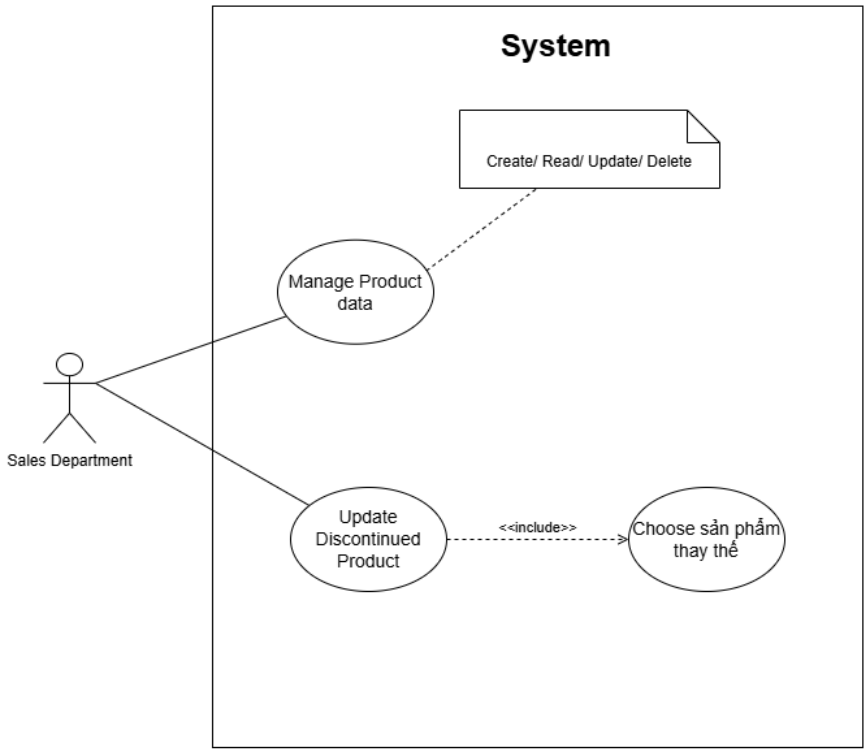

Figure 2.4 Use Case of Sales Department

USE CASE SPECIFICATION

Use Case Name	Manage Product Data
Description	The Sales Department manages information related to products.
Actor	Sales Department
Priority	Must Have
Trigger	The Sales Department wants to view or edit product data.
Pre-Condition(s):	• The Sales Department must be logged into the system. • The user's account must be authorized to perform product data management operations.

	• The system must have a database with existing product data records.
Post-Condition(s):	• Any changes made to product data (if applicable) are successfully saved in the database. • The product data is updated, retrieved, or deleted correctly, reflecting the user's input.
Basic Flow	1. The Sales Staff logs into the system. 2. The user navigates to the Warehouse Management → Product 3. The user selects the desired action (Create, Read, Update, or Delete). •For Create, the user enters new product information and submits the form. •For Read, the user views the product list or details of a specific product. •For Update, the user edits the information of an existing product and saves changes. •For Delete, the user confirms the deletion of a product. 4. The system processes the request and updates the database accordingly. 5. The system provides feedback on the success or failure of the operation.
Alternative Flow	2a. User selects specific search filters (e.g. category, price range) to find desired products.

	2a1. System processes filter and displays refined product list matching criteria. *Use case continues to step 3* 3a1. User uploads CSV or Excel file containing product data. 3a2. System validates uploaded file, processes data and performs corresponding operations (Create, Update or Delete) in bulk. *Use case continues to step 4*
Exception Flow	3c. If there is a system error or database failure during any operation: • 3c.1. The system displays an error message and logs the incident. • 3c.2. The user selects the option to retry the operation. Use Case continues at the previous step. 3d. If the user does not have sufficient permissions: • 3d.1. The system denies access and displays an "Unauthorized Access" message. • 3d.2. The user contacts the system administrator to request appropriate permissions. Use Case stops until permissions are updated.
Business Rules	BR1.1-1: The system must validate that the following fields are not empty when creating a product: Product Name, Category, Price, and Stock Quantity. BR1.2-1: The system must ensure that the product price is greater than zero. Negative or zero prices are not allowed. BR1.3-1: The system must implement record locking to prevent conflicts during simultaneous updates to the same product. (button “Edit” is unable)

Non-Functional Requirement	NFR1.1-1: The system must ensure that product data operations complete within 2 seconds.

Table 2.1 Use Case Specification Mangage Product data, Sales Department

Use Case Name	Update Discontinued Product
Description	The Sales Department wants to update information about a discontinued product.
Actor	Sales Department
Priority	Must Have
Trigger	The Sales Department wants to update the status or details of a discontinued product.
Pre-Condition(s):	• The Sales Department must be logged into the system. • The user's account must be authorized to perform product data management operations. • The system must have a database with existing product data records.
Post-Condition(s):	• The discontinued product information is updated successfully in the system. • The replacement product is selected and updated.
Basic Flow	1. The user selects the option to update a discontinued product. 2. The user selects a replacement product to update.

	3. The system displays the product details (e.g., name, price, description, stock). 4. The user makes necessary updates to the product details. 5. The user saves the updates. 6. The system processes the updates and provides feedback on success.
Alternative Flow	1a. User selects specific search filters (e.g. category, price range) to find desired products. *Use case continues to step 2*
Exception Flow	5b. If the user does not have sufficient permissions: • 5b.1. The system denies access and displays an "Unauthorized Access" message. • 5b.2. The user contacts the system administrator to request appropriate permissions. Use Case stops until permissions are updated.
Business Rules	BR-DP-1: Button “Update” in Edit Product Status pop up is enabled when the Replacement Product is picked.
Non-Functional Requirement	NFR1.2-1: The system must ensure that product updates are processed efficiently, with a response time of less than 2 seconds for displaying updated product information.

Table 2.2 Use Case Specification Update Discontinued Product, Sales Department

2.3.2 Smart Shelf

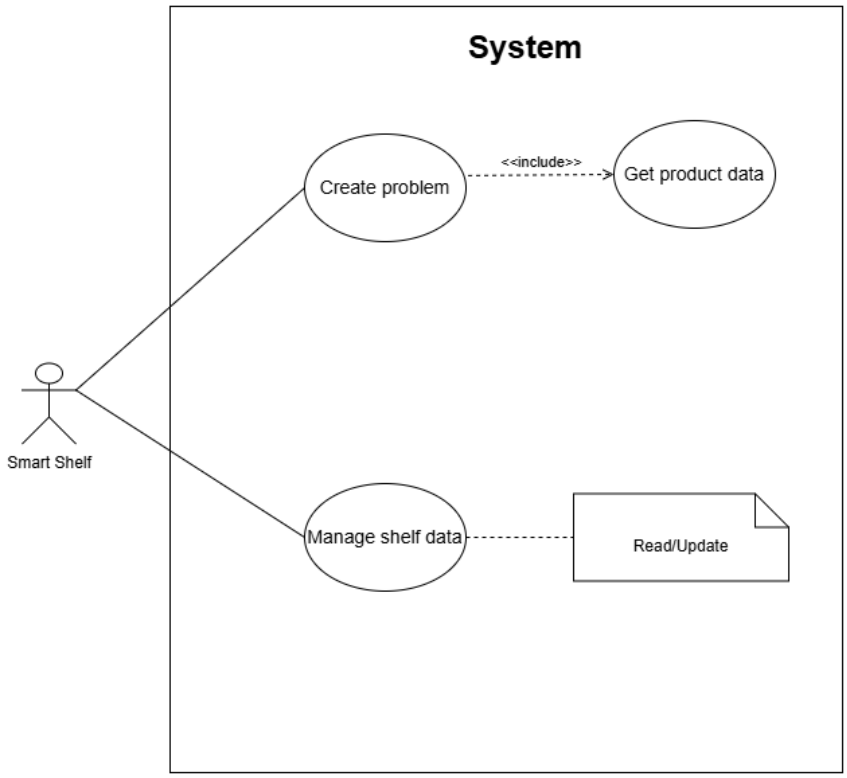

Figure 2.5 Use Case of Smart Shelf

USE CASE SPECIFICATION

Use Case Name	Create problem
Description	Smart Shelf creates a problem when it detects an issue.
Actor	Smart Shelf
Priority	Must Have
Trigger	When the Smart Shelf detects an issue
Post-Condition(s):	• A new problem is created and stored in the system.
Basic Flow	1. Smart Shelf detects an issue or problem.

	2. Smart Shelf uses the data from Get Product Data to create a new problem in the database. 3. The system confirms the successful creation of the problem and notifies relevant parties (if applicable).
Business Rules	BR-SS-1: Trigger every 5 minutes → perform action.

Table 2.3 Use Case Specification Create Problem, Smart Shelf

Use Case Name	Manage shelf data
Description	Smart Shelf autonomously manages its own data
Actor	Smart Shelf
Priority	Must Have
Trigger	The Smart Shelf detects a change or event that requires an update to its data, such as a change in stock levels, shelf condition
Pre-Condition(s):	• The Smart Shelf is installed, operational, and connected to the system. • The Smart Shelf has access to real-time data feeds (e.g., sensor data, inventory systems) to update shelf information.
Post-Condition(s):	The Smart Shelf updates its own data, including stock levels, condition, and product details
Basic Flow	1.The Smart Shelf starts monitoring its own data (e.g., stock levels). 2.The Smart Shelf detects a change, such as a product being added or removed, or a product's stock level changing.

	3. The Smart Shelf updates its internal records to reflect the new data (e.g., updating the product quantity, status). 4. The Smart Shelf sends the updated data to the central system to update the database.

Table 2.4 Use Case Specification Manage Shelf data, Smart Shelf

2.3.3 Warehouse Robot

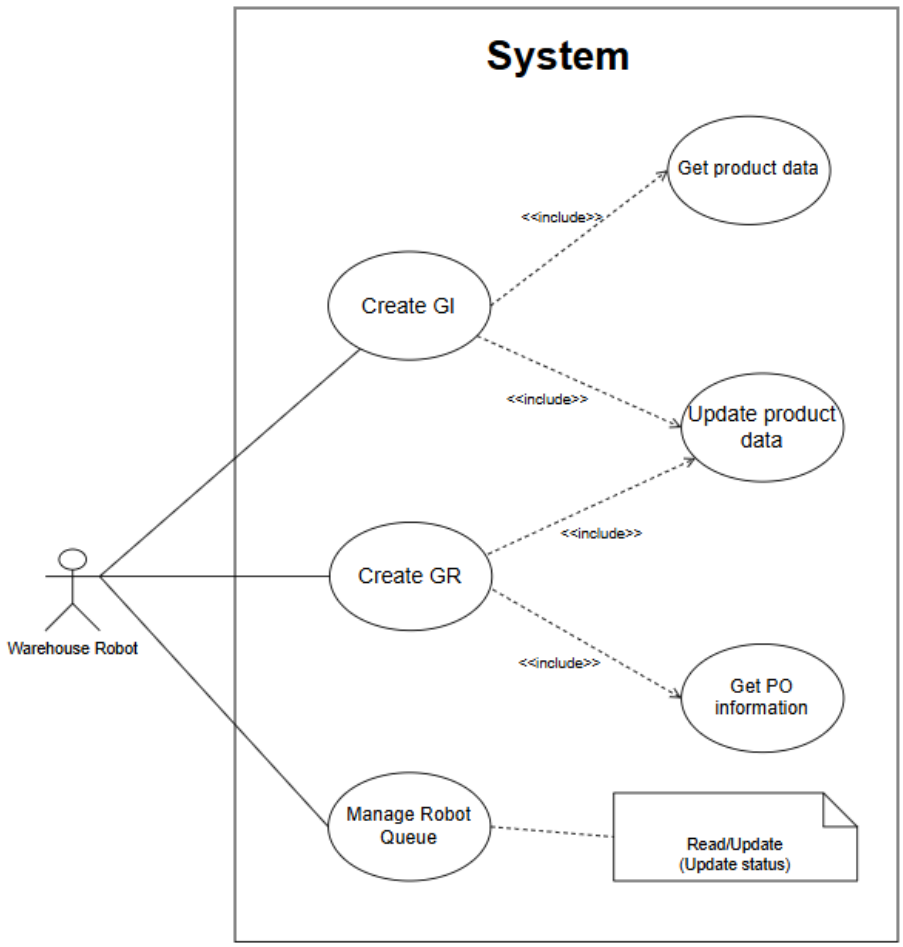

Figure 2.6 Use Case of Warehouse Robot

USE CASE SPECIFICATION

Use Case Name	Manage Robot Queue
Description	Manage the queue of tasks and update the status of processing tasks.
Actor(s)	Warehouse Robot
Priority	Must Have
Trigger	A new task needs to be added, or an existing task's status is updated.
Pre-Condition(s)	• The warehouse robot system is operational. • The system has an active queue for managing tasks.
Post-Condition(s)	• The task queue is updated with new tasks. • The status of completed or in-progress tasks is updated in the system log.
Basic Flow	1. The system adds a new task to the queue. 2. The system appends the new task to the existing queue. 3. The warehouse robot processes tasks in the queue sequentially. 4. When a task is completed, the warehouse robot updates its status to "Completed" and logs the operation. 5. The warehouse robot moves to the next task in the queue.
Non-Functional Requirement	NFR-MRQ-1: The system must support a queue of up to 3 concurrent tasks without performance issues.

Table 2.5 Use Case Specification Manage Robot Queue, Warehouse Robot

Use Case Name	Create GI

Description	Warehouse Robot creates Goods Issue when completing the task "Fill goods"
Actor(s)	Warehouse Robot
Priority	Must Have
Trigger	Warehouse Robot is assigned the task "Fill goods" by the system.
Pre-Condition(s)	Warehouse Robot receives accurate information about the product to be filled (product code, quantity, location in the warehouse).
Post-Condition(s)	• The product is filled correctly, in the required quantity and brought to the waiting area. • Goods Issue is created. • Update inventory quantity after completing the task.
Basic Flow	1. Warehouse Robot is assigned the task "Fill goods" from the system. 2. The system provides detailed information about the product to be filled in (product code, quantity, location in the warehouse). 3. Warehouse Robot creates GI and updates inventory quantity after completing the task. 4. Warehouse Robot records the completed task into the Robot Queue.

Table 2.6 Use Case Specification Create GI, Warehouse Robot

Use Case Name	Create GR

Description	Warehouse Robot creates Goods Receipt when completing the task "Receiving goods"
Actor(s)	Warehouse Robot
Priority	Must Have
Trigger	Warehouse Robot is assigned the task "Importing goods" by the system.
Pre-Condition(s)	Warehouse Robot receives accurate information about PO (Purchase Order) of warehoused goods.
Post-Condition(s)	• Save a list of products that do not meet quality standards and why. (if any) • Goods Receipt is created. • Update inventory quantity after completing the task.
Basic Flow	1. Warehouse Robot receives the task "Importing goods" from the system. 2. The system provides detailed information about imported shipments (PO code, quantity, vendor, storage location...). 3. Warehouse Robot creates GR and updates inventory quantity after completing the task. 4. Warehouse Robot records the completed task into the Robot Queue.

Table 2.7 Use Case Specification Create GR, Warehouse Robot

2.3.4 Quality Management Department

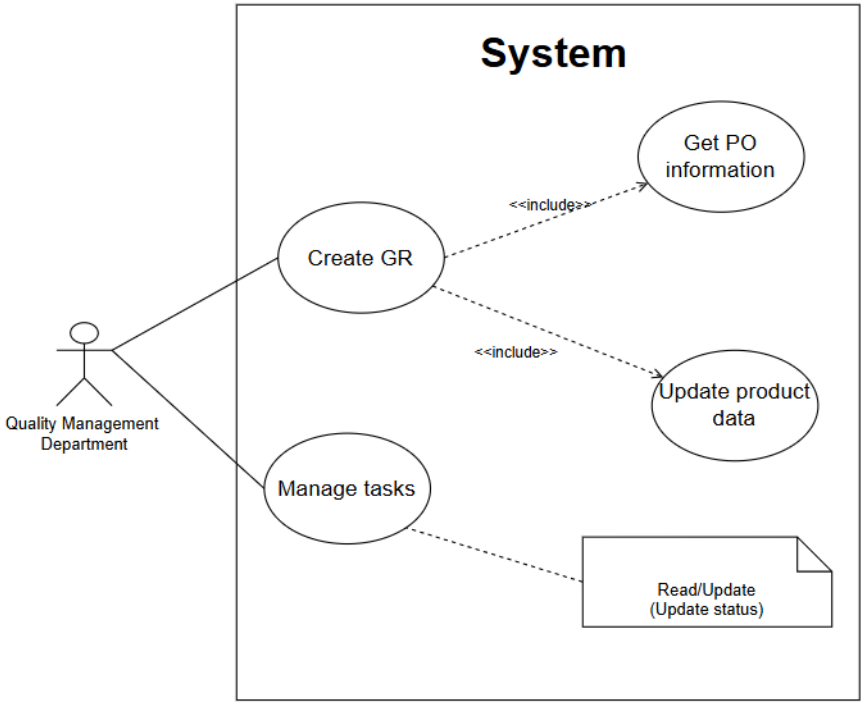

Figure 2.7 Use Case of Quality Management Department

USE CASE SPECIFICATION

Use Case Name	Manage tasks
Description	The Quality Management Department performs the review and updates the status of assigned tasks in the system.
Actor(s)	Quality Management Department
Priority	Must Have
Trigger	The system updates the task list.
Pre-Condition	• The Quality Management Department must be logged into the system.

	• The user's account must be authorized to read and update tasks status.
Post-Condition	The status of the tasks in the task list is updated accurately.
Basic Flow	1. The system assigns new tasks to the task list. 2. The Quality Management Department checks the task list. 3. After completing the task, the Quality Management Department updates the task status to “Completed.”
Non-Functional Requirement	NFR-MRQ-1: The time to update the task status must not exceed 5 minutes after task completion or encountering an issue.

Table 2.8 Use Case Specification Manage task, Quality Management Department

Use Case Name	Create GR
Description	Quality Management Department creates Goods Receipt when completing the task "Importing goods"
Actor	Quality Management Department
Priority	Must Have
Trigger	The Quality Management Department is assigned the task "Goods Receipt" by the system
Pre-Condition	The Quality Management Department receives accurate PO (Purchase Order) information for the incoming goods.
Post-Condition	• A list of non-compliant products and reasons is recorded (if applicable). • Goods Receipt is created.

	• Inventory quantity is updated upon completing the "Goods Receipt" task.
Basic Flow	1. The Quality Management Department receives the task "Goods Receipt" from the system. 2. The system provides detailed information about the incoming goods (PO number, quantity, vendor, storage location, etc.). 3. The Quality Management Department creates a Goods Receipt and updates the inventory count upon task completion. 4. The Quality Management Department records the completed task in the system.
Business Rules	BR-GR-1: Button "Create" in Create GR Page is enabled when “PO ID, Vendor, Items” Area are filled

Table 2.9 Use Case Specification Create GR, Quality Management Department

2.3.5 Purchasing Department

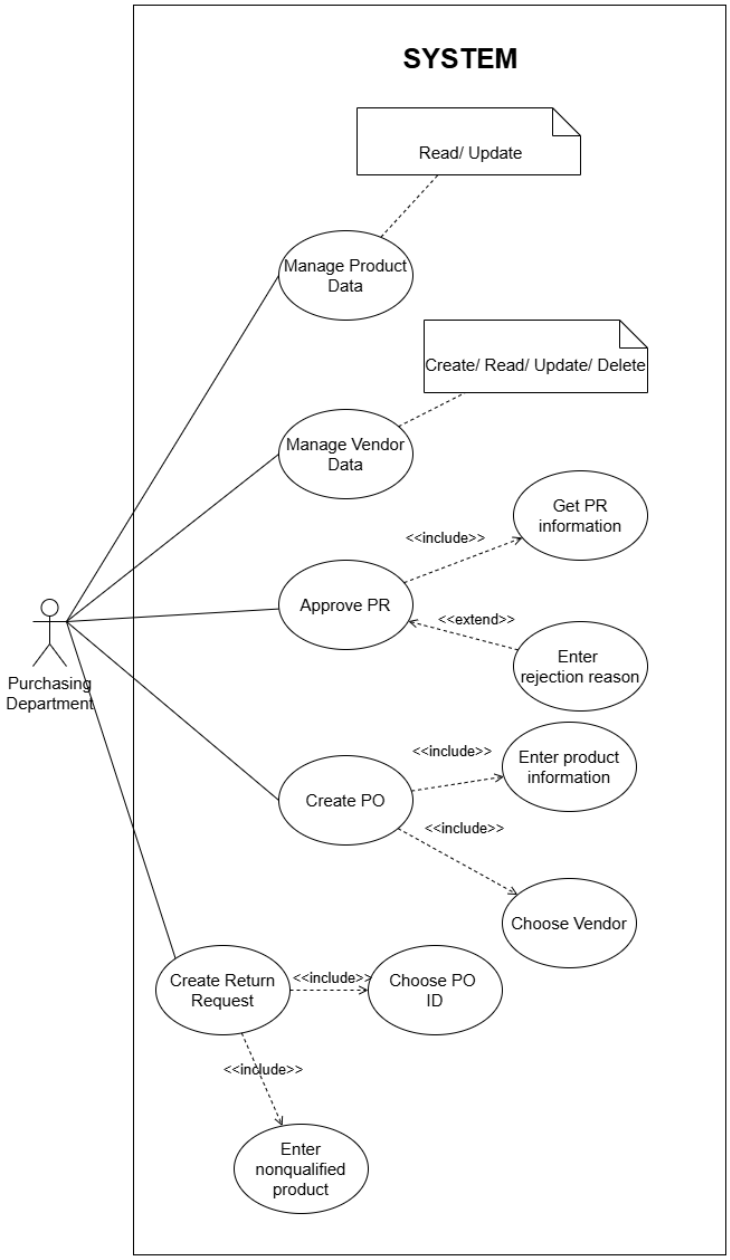

Figure 2.8 Use Case of Purchasing Department

USE CASE SPECIFICATION

Use Case Name	Manage Product Data

Description	The Purchasing Department manages information related to products.
Actor	Purchasing Department
Priority	Must Have
Trigger	The Purchasing Department wants to view or edit product data.
Pre-Condition(s):	• The user must be logged into the system. • The user's account must be authorized to perform product data management operations. • The system must have a database with existing product data records.
Post-Condition(s):	• Any changes made to product data (if applicable) are successfully saved in the database. • The product data is updated, retrieved, reflecting the user's input.
Basic Flow	1. The Sales Staff logs into the system. 2. The user navigates to the Warehouse Management → Product 3. The user selects the desired action (Create, Read, Update, or Delete). • For Read, the user views the product list or details of a specific product. • For Update, the user edits the information of an existing product and saves changes. 4. The system processes the request and updates the database accordingly.

	5. The system provides feedback on the success or failure of the operation.
Alternative Flow	2a. User selects specific search filters (e.g. category, price range) to find desired products. 2a1. The system processes filters and displays refined product list matching criteria. *Use case continues to step 3*
Exception Flow	3c. If there is a system error or database failure during any operation: • 3c.1. The system displays an error message and logs the incident. • 3c.2. The user selects the option to retry the operation. Use Case continues at the previous step. 3d. If the user does not have sufficient permissions: • 3d.1. The system denies access and displays an "Unauthorized Access" message. • 3d.2. The user contacts the system administrator to request appropriate permissions. Use Case stops until permissions are updated.
Business Rules	BR4.1-1: The system must implement record locking to prevent conflicts during simultaneous updates to the same product. (button “Edit” is unable)
Non-Functional Requirement	NFR4.1-1: The system must ensure that product data operations complete within 2 seconds.

Table 2.10 Use Case Specification Manage Product data, Purchasing Department

Use Case Name	Manage Vendor Data
Description	The Purchasing Department wants to manage vendor data to ensure the information is accurate and up to date.
Actor(s)	Purchasing Department
Priority	Must Have
Trigger	The purchasing department needs to create, read, update, or delete vendor data in the system.
Pre-Condition(s)	• The user has logged in and has permission to access vendor data management functions. • The database system is operational.
Post-Condition(s)	Vendor information is updated accurately in the system.
Basic Flow	1. The purchasing staff logs in the system 2. The purchasing staff accesses the Vendor Page in PO Management Page. 3. The employee selects the action to create, edit, or delete vendor information. 4. The employee inputs the required information or confirms the action. 5. The system validates the information and updates the database. 6. The system notifies the user of the successful operation.
Alternative Flow	2a. The employee enters Vendor Name in the Search bar in the Purchasing Management Page. 2a1. The system returns a list of relevant results.
Exception Flow	4a. The system fails to save the information:

	• The system displays an error message. • The employee reviews the information and retries the operation.
Business Rules	• BR3.2-1: When updating vendor information, the 'update' button will only be enabled if all fields are filled out.
Non-Functional Requirement	• NFR3.2-1: The interface must support search by name, ID, and filter by country.

Table 2.11 Use Case Specification Manage Vendor data, Purchasing Department

Use Case Name	Approve PR
Description	The purchasing department wants to approve purchase requisitions (PRs) to ensure only valid requests are approved.
Actor(s)	Purchasing Department
Priority	Must Have
Trigger	EOD, A list of purchase requisition (PR) is submitted to the system.
Pre-Condition(s)	• The list PR has been created breakdown by vendor and submitted to the system. • The Purchasing Department employee has logged in and has permission to approve PRs.
Post-Condition(s)	• The PR is successfully approved or rejected, with the reason documented. • The system updates the PR status.

Basic Flow	1. The purchasing employee accesses the list of PRs awaiting approval. 2. The employee selects a specific PR and reviews its details. 3. The employee selects the “Approve” action. 4. The system updates the PR status to “Approved.”
Alternative Flow	3a. The employee selects the "Reject" action 3a1. The employee provides a rejection reason. 3a2. The system updates the PR status to "Rejected."
Exception Flow	4a. The system fails to update the PR status: • The system displays an error message. • The employee retries the action or contacts’ support.
Business Rules	BR3.3-1: Only PRs with complete information can be approved. BR3.3-2: Invalid PRs must be rejected with a specific reason.
Non-Functional Requirement	NFR3.3-1: The rejection reason must contain at least 20 characters.

Table 2.12 Use Case Specification Approve PR, Purchasing Department

Use Case Name	Create PO
Description	Purchasing Management wants to create a purchase order (PO) manually to provide complete information to the vendor.
Actor(s)	Purchasing Department
Priority	Must Have
Trigger	A PR has been created and requires a PO to be created manually.

Pre-Condition(s)	• PR has been created. • The purchasing department employee has logged in and has permission to create POs.
Post-Condition(s)	• The PO is successfully created and stored in the system. • The vendor receives the purchase order information.
Basic Flow	1. The purchasing department employee selects the approved PR. 2. The employee inputs the product details, quantities and vendor information. 3. The employee confirms and submits to the PO. 4 The system saves the PO and sends a notification to the vendor.
Exception Flow	4a. The system fails to send the PO due to a connectivity error: • The system displays an error message. • The employee reviews the data and retries later.
Business Rules	BR3.4-1: Button "Create" in Create PO Page is enabled when all text areas are filled.
Non-Functional Requirement	NFR3.4-1: The PO must be formatted correctly before sending.

Table 2.13 Use Case Specification Create PO, Purchasing Department

Use Case Name	Create Return Request
Description	When the QM department detects defects in special goods, they notify the Purchasing Department, and the Purchasing Department employee creates a return request to return goods to the vendor.
Actor(s)	Purchasing Department

Priority	Must Have
Trigger	Receive Notification about special goods that are identified as non-qualified during inspection.
Pre-Condition(s)	• Defective goods have been identified and flagged by Quality Management Department • The Purchasing Department employee has logged in and has permission to create return requests.
Post-Condition(s)	• The return request is successfully created. • The system sends a notification to the vendor.
Basic Flow	1. The QM department notifies the Purchasing Department. 2. The Purchasing Department employee receives the notification and accesses the create return request function. 3. The employee selects the related PO and inputs the non-qualified goods information. 4. The employee confirms the return request. 5. The system saves the return request and sends a notification to the vendor.
Alternative Flow	3a. The purchasing employee manually inputs non-qualified goods information if the PO is not available.
Exception Flow	4a. The system fails to send the return request: • The system displays an error message. • The employee reviews the data and retries the action.
Business Rules	BR3.5-1: Button "Send to Vendor" in Create a Return Request Page is enabled when related task of Warehouse robot and QM (check and

	goods receipt tasks) are marked as “Completed” and “PO ID, Vendor, Items, Evidence” Area are filled.
Non-Functional Requirement	NFR3.5-1: The interface must support viewing return history by vendor.

Table 2.14 Use Case Specification Create Return Request, Purchasing Department

2.3.6 Arranging Robot

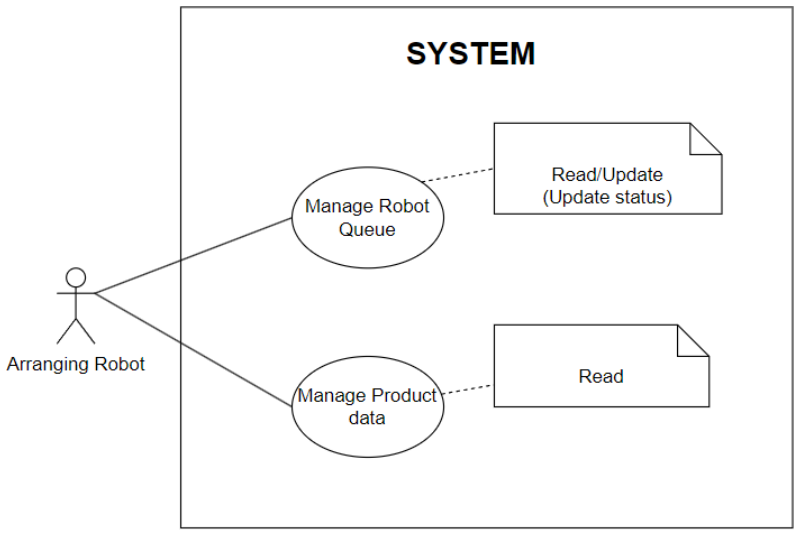

Figure 2.9 Use Case of Arranging Robot

USE CASE SPECIFICATION

Use Case Name	Manage Robot Queue
Description	Manage the queue of tasks and update the status of processing tasks.
Actor(s)	Arranging Robot
Priority	Must Have

Trigger	A new task needs to be added, or an existing task's status is updated.
Pre-Condition(s)	• The arranging robot system is operational. • The system has an active queue for managing tasks.
Post-Condition(s)	• The task queue is updated with new tasks. • The status of completed or in-progress tasks is updated in the system log.
Basic Flow	1. The automation system adds a new task to the queue. 2. The system appends the new task to the existing queue. 3. The arranging robot processes tasks in the queue sequentially. 4. When a task is completed, the arranging robot updates its status to "Completed" and logs the operation. 5. The arranging robot moves to the next task in the queue.
Non-Functional Requirement	NFR4.1-1: The system must support a queue of up to 3 concurrent tasks without performance issues.

Table 2.15 Use Case Specification Manage Robot Queue, Arranging Robot

Use Case Name	Manage Product Data
Description	Read product information to complete tasks.
Actor(s)	Arranging Robot
Priority	Must Have
Trigger	A task requires the robot to access product information to proceed.

Pre-Condition(s)	• Product information is available in the system database. • The arranging robot is operational and connected to the database.
Post-Condition(s)	• The robot successfully retrieves the required product information. • Tasks related to filling or correcting product placement are completed accurately.
Basic Flow	1. The robot receives a task requiring product information. 2. The system retrieves the relevant product data (e.g., product ID, location, quantity, specifications). 3. The robot uses the retrieved data to locate or manipulate the product.
Exception Flow	2b. The robot fails to retrieve product data due to a system error: • The system retries accessing the database after 10 seconds. • If the issue persists, an alert is sent to the IT team, and the task is flagged as "Pending".
Non-Functional Requirement	NFR4.2-1: The system must maintain 99.9% uptime for database accessibility. NFR4.2-2: All data read by the robot must be logged for monitoring purposes.

Table 2.16 Use Case Specification Manage Product data, Arranging Robot

2.4 Main Feature

Diagram: **LINK**

Mockup: **LINK**

2.4.1 Main Feature 1: Handle Out-of-Stock Shelf

2.4.1.1 Feature description, output and actor

The Smart Shelf is equipped with sensors and AI cameras to automatically monitor the weight and quantity of goods on the shelf every 5 minutes. When the quantity of goods falls below **60%** of the specified threshold, the Smart Shelf will send a notification to the system, which will then trigger the process of **"Fill product on shelf"**: restocking goods from the warehouse and addressing the empty shelf following the FIFO principle.

Output + Actor

Actor	Activity	Output
Smart Shelf	Send problem	Problem is shown in Notification Page.
System	Create and Assign task	Task is shown in the Task Management Page, Robot Queue Detail Page.
Warehouse robot	Provide the result	Task status, Goods Issue and New Quantity in warehouse are shown in the Task Management Page, Robot Queue Detail Page, Warehouse Management (Product, Goods Issue Page).
Arranging Robot	Send status	Task status is shown in the Task Management Page, Robot Queue Detail Page.
Smart Shelf	Update product	New quantity on the shelf is shown in the Warehouse Management Page.

Table 2.17 Output and actor of Hande out-of-stock shelf

2.4.1.2 *Sequence Diagram*

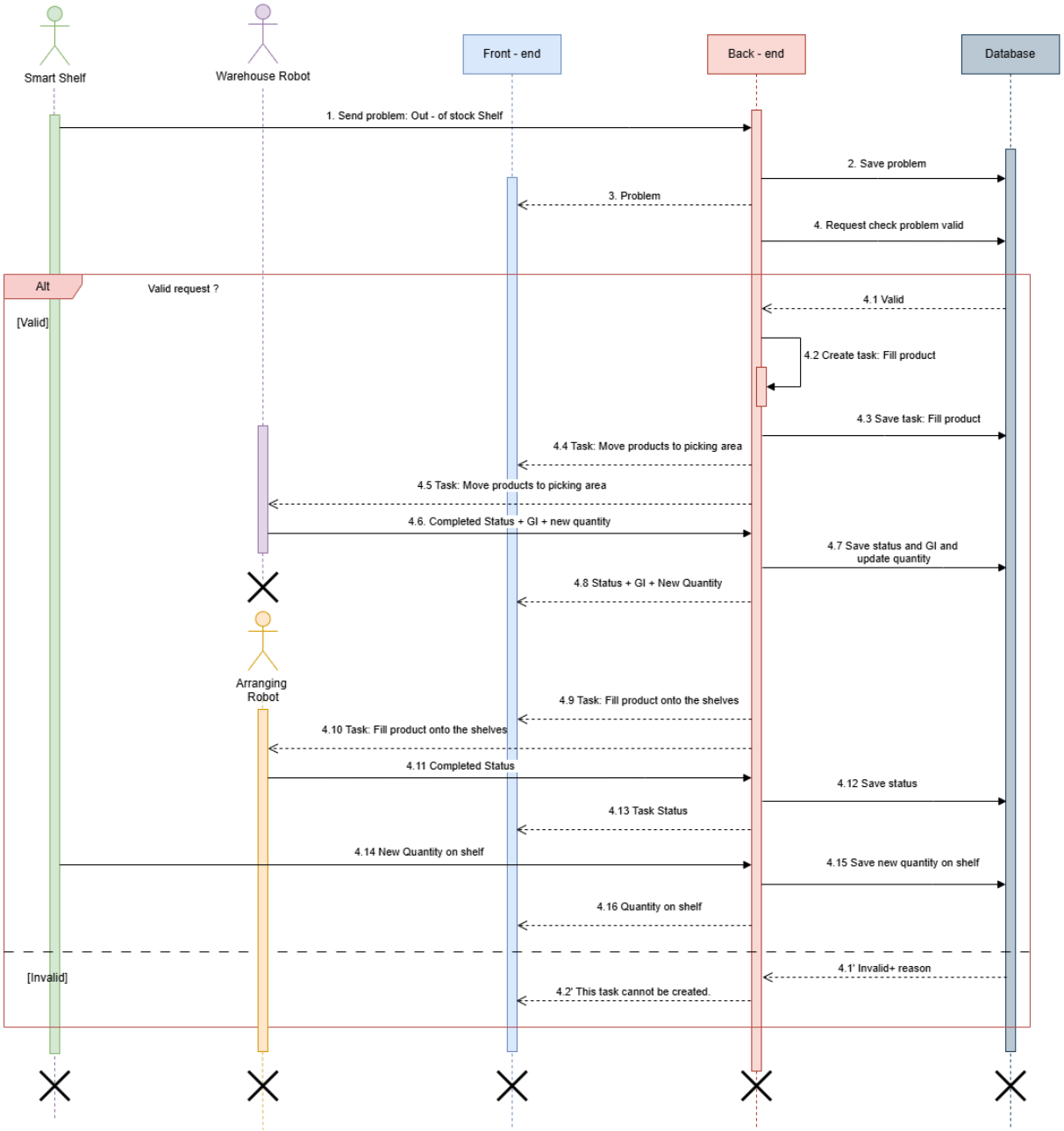

Figure 2.10 Sequence Diagram of Handle out-of-stock shelf

2.4.1.3 *Mockup*

Shelf Management: Here, the supermarket's shelf map with assigned shelf IDs is displayed. Staff can quickly see the shelf status through the displayed color and check information about a specific product by

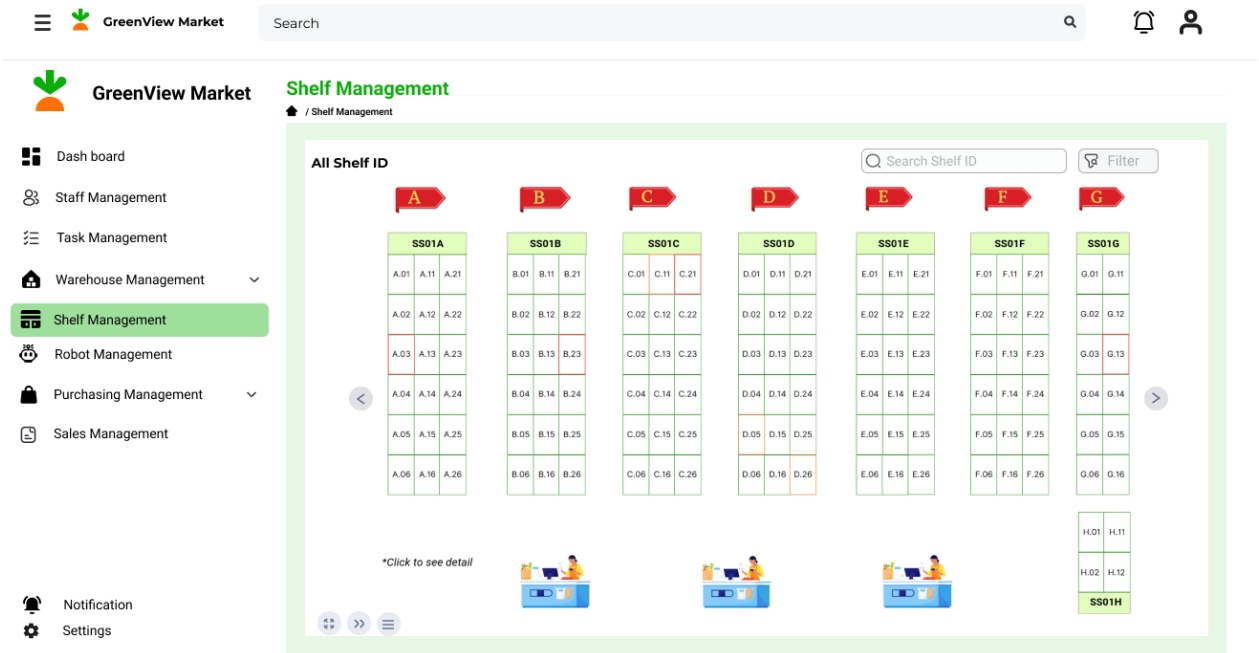

Figure 2.11 Shelf Management

Shelf Detail: Here, employees can view detailed information about products on a selected shelf, including product name, ID, quantity, expiry date, update history and shelf data.

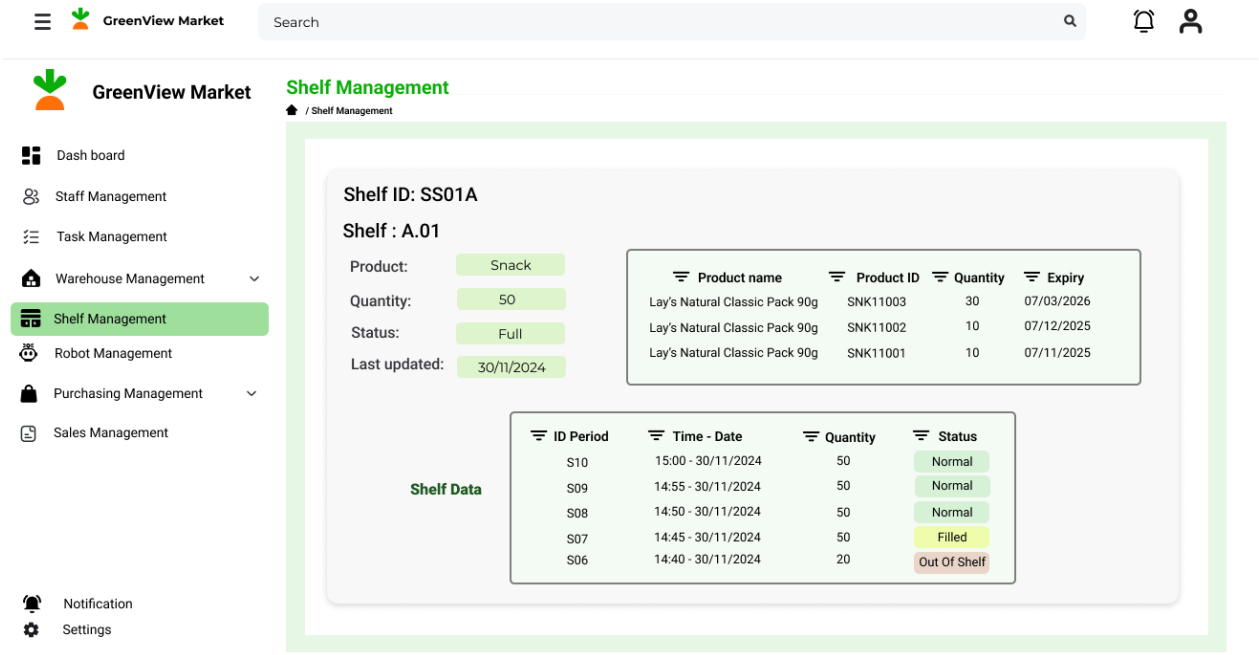

Figure 2.12 Shelf Detail

Robot Managemet: This tab contains two components. The left part is an overview of all the robots running in the system. The other part is detailed information about each robot. Each robot is listed with details such as robot ID, work location, job queue, and current operating status.

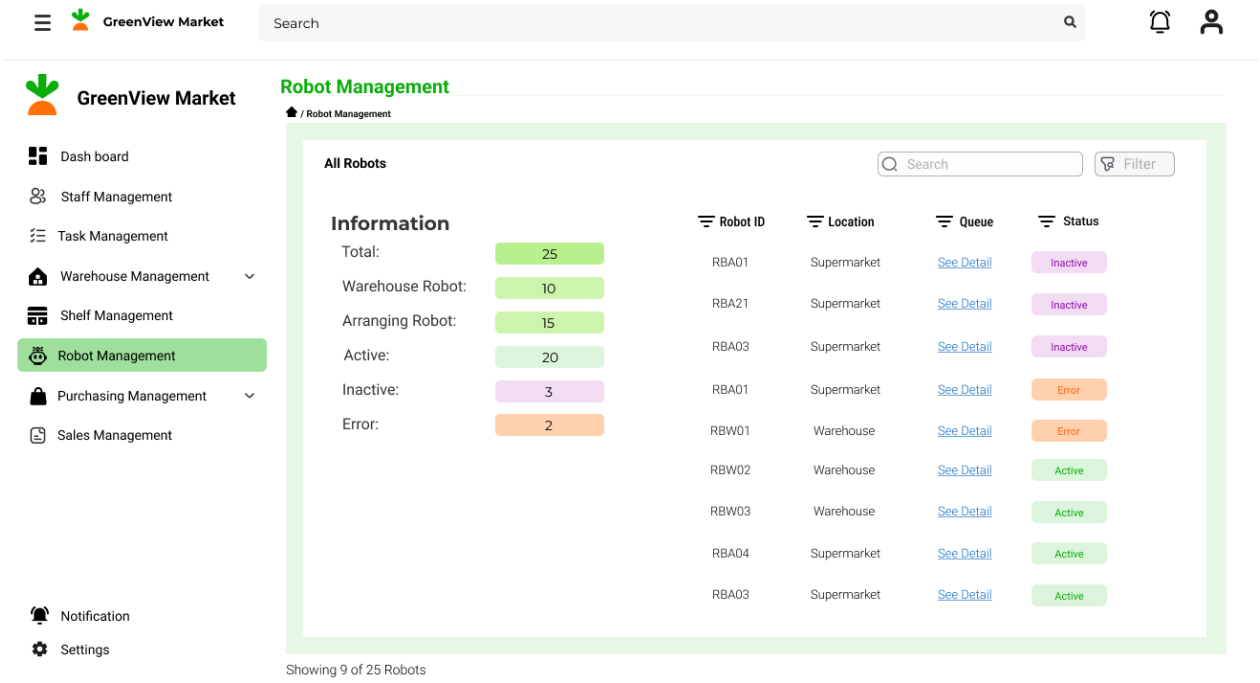

Figure 2.13 Robot Management

Robot Queue: Task of "Handle out-of- stock shelf" of robot will be shown on this page.

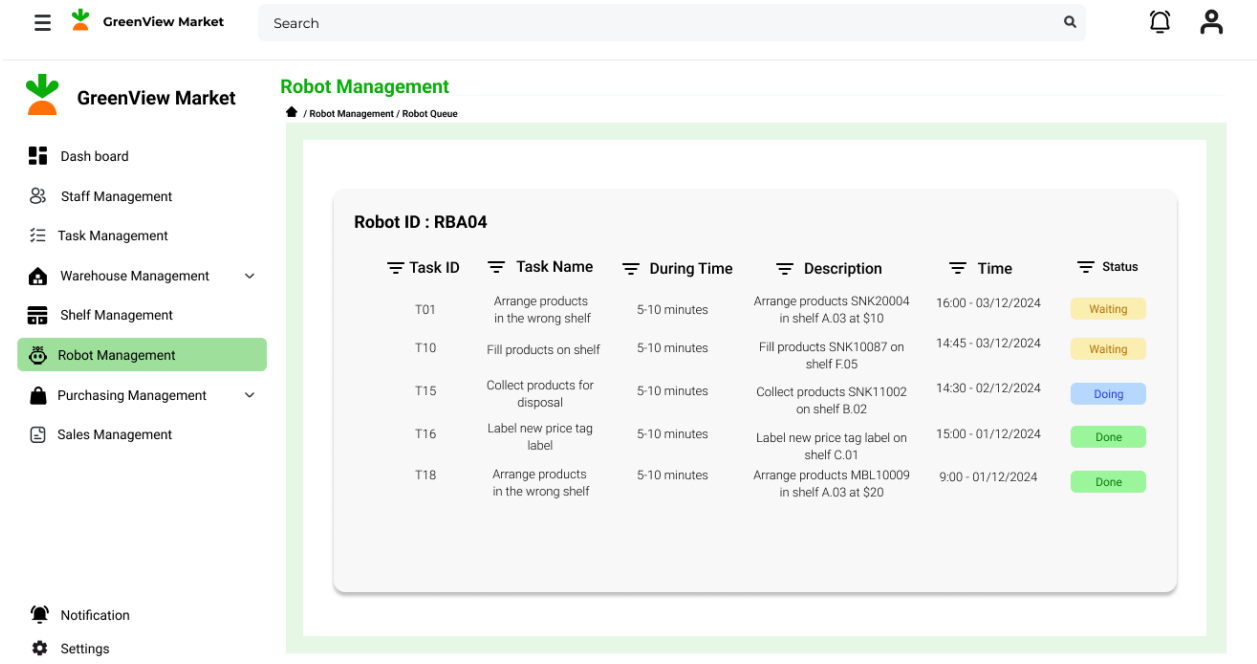

Figure 2.14 Robot Queue

2.4.1.4 Business rule

ID	Rule Type	Business Rule
BR-SS-1	Smart Shelf *(Rule for Robot)*	Trigger: every 5 minutes → perform action.
BR-SS-2	BE	Trigger: if smart_shelf.problem == "Out of stock shelf"
BR-SS-3	BE	Check if problem exists in database within the same time frame → if duplicate (invalid), skip task creation; else, create task and assign task.
BR-SS-4	Arranging Robot and Warehouse Robot *(Rule for Robot)*	Sort inventory by received date, place oldest items first (FIFO)

Table 2.18 Business rule Handle Out – of – stock shelf

2.4.2 Main Feature 2: Handle Expired product

2.4.2.1 Feature description, ouput and actor

The system automatically checks the expiration dates (EXP) of goods in the database on a scheduled basis (once per day at the end of the day). When it detects goods nearing their expiration, the system triggers the process **"Remove expired products"**, which includes removing the old product from the shelf, restocking with new items from the warehouse, and ensuring proper arrangement following the FIFO principle.

Output + Actors

Actor	Activity	Output
System	Daily auto check expiration status	Product status in Warehouse Management Page if expired products exist.
System	Create and Assign task	Task is shown in the Task Management Page, Robot Queue Detail Page
Warehouse robot	Provide the result	Task status, Goods Issue and New Quantity in warehouse are shown in the Task Management Page, Robot Queue Detail Page, Warehouse Management (Product, Goods Issue Page)
Arranging Robot	Send status	Task status is shown in the Task Management Page, Robot Queue Detail Page
Smart Shelf	Update product	New quantity on the shelf is shown in Warehouse Management Page.

Table 2.19 Output and actor of Handle expired product

2.4.2.2 Sequence Diagram

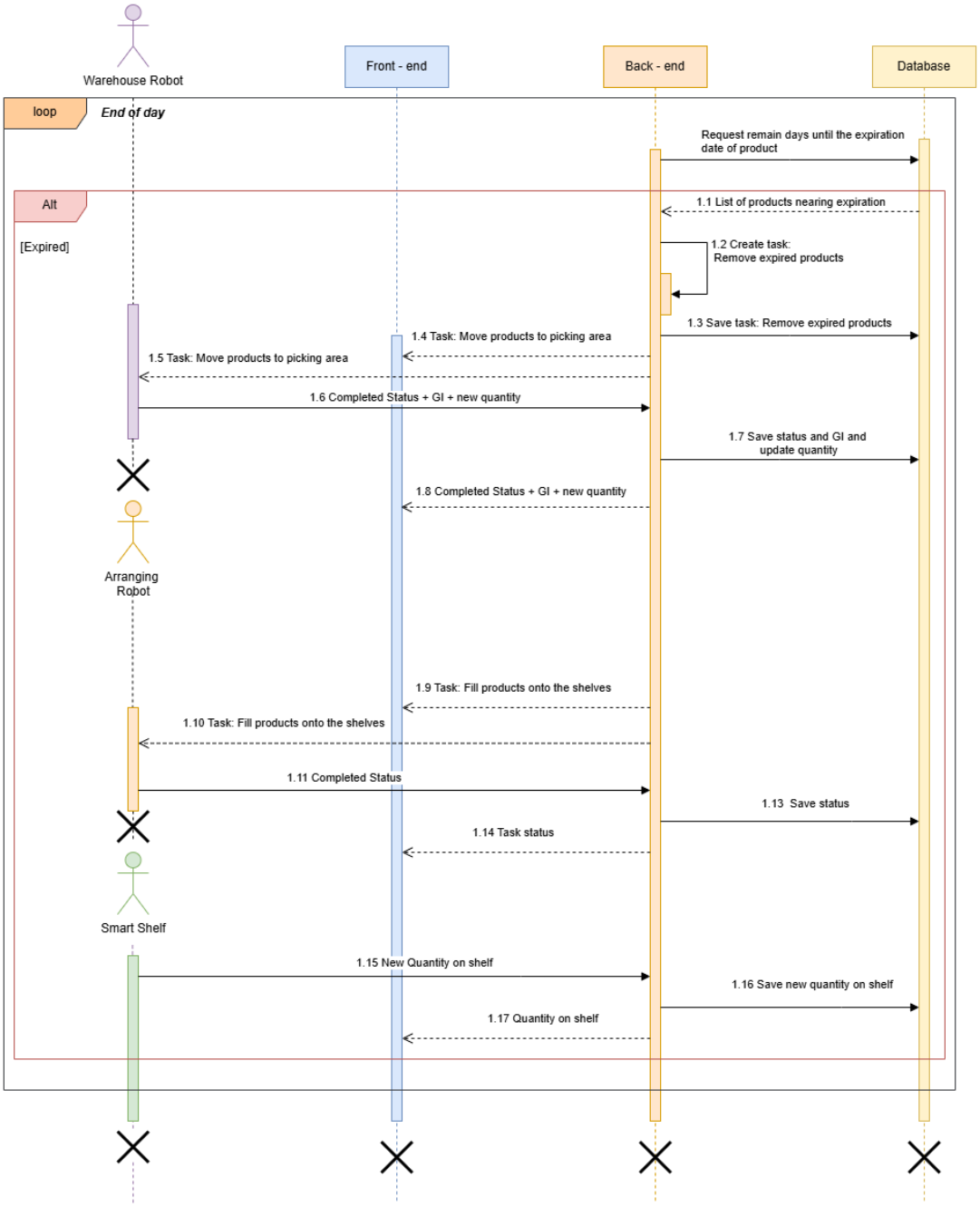

Figure 2.15 Sequence Diagram of Handle expried product

2.4.2.3 Mockup

Robot Queue: which clearly displays the operating status of each robot and the tasks being assigned. Staff can view details about each task, including description, execution time, and status.

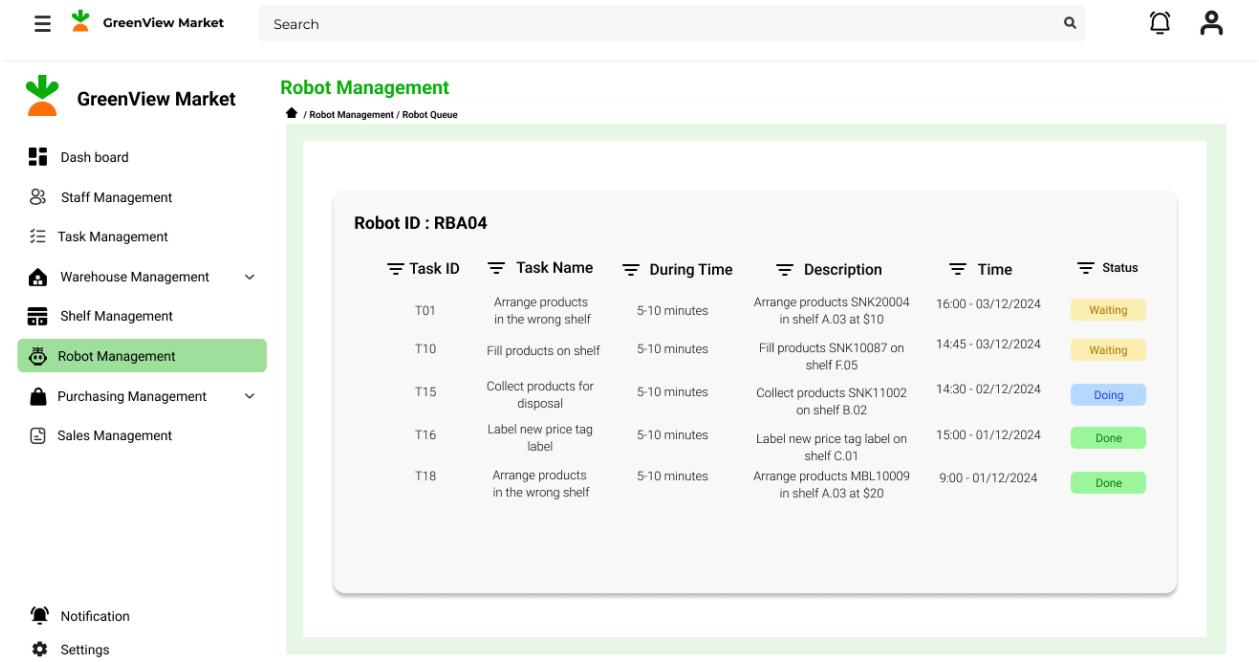

Figure 2.16 Robot Queue

Goods Issue: This screen describes the goods issue created after each time export products from the warehouse to fill on the shelves in the supermarket

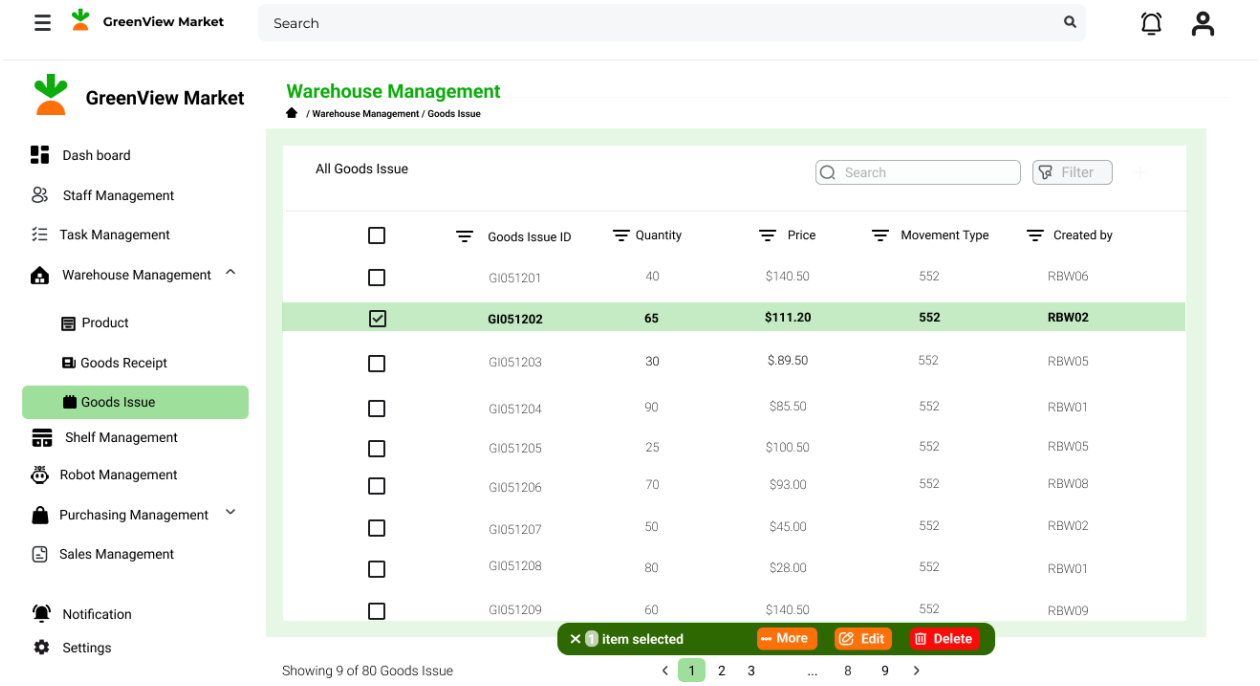

Figure 2.17 Goods Issue

2.4.2.4 Business rule

ID	Rule Type	Business Rule
BR-EXP-1	BE	Auto-check product expiration daily at end of day
BR-EXP-2	BE	Trigger: if expired products are found
BR-EXP-3	BE	Check if problem exists in database within the same time frame → if duplicate (invalid), skip task creation; else, create task and assign task.
BR-EXP-4	Arranging Robot and Warehouse Robot	Sort inventory by received date, place oldest items first (FIFO)

	(Rule for Robot)	

Table 2.20 Business rule Handle expired product

2.4.3 Main Feature 3: Handle Misplaced Product

2.4.3.1 Feature description, output and actor

The Smart Shelf is equipped with sensors and AI cameras to automatically monitor the weight and quantity of goods on the shelf every 5 minutes. When detecting a product in the wrong position, Smart Shelf sends the "Wrong Shelf" to the system. The system will activate the process **"Arrange product in the wrong shelf"**.

Output + Actors

Actor	Activity	Output
Smart Shelf	Send problem	Problem shown in Notification Page
System	Create and Assign task	Task shown in the Task Management Page, Robot Queue Detail Page
Arranging Robot	Send status	Task status shown in the Task Management Page, Robot Queue Detail Page
Smart Shelf	Update product	New quantity on the shelf is shown in the Warehouse Management Page.

Table 2.21 Output and actor of Handle Misplaced product

2.4.3.2 *Sequence Diagram*

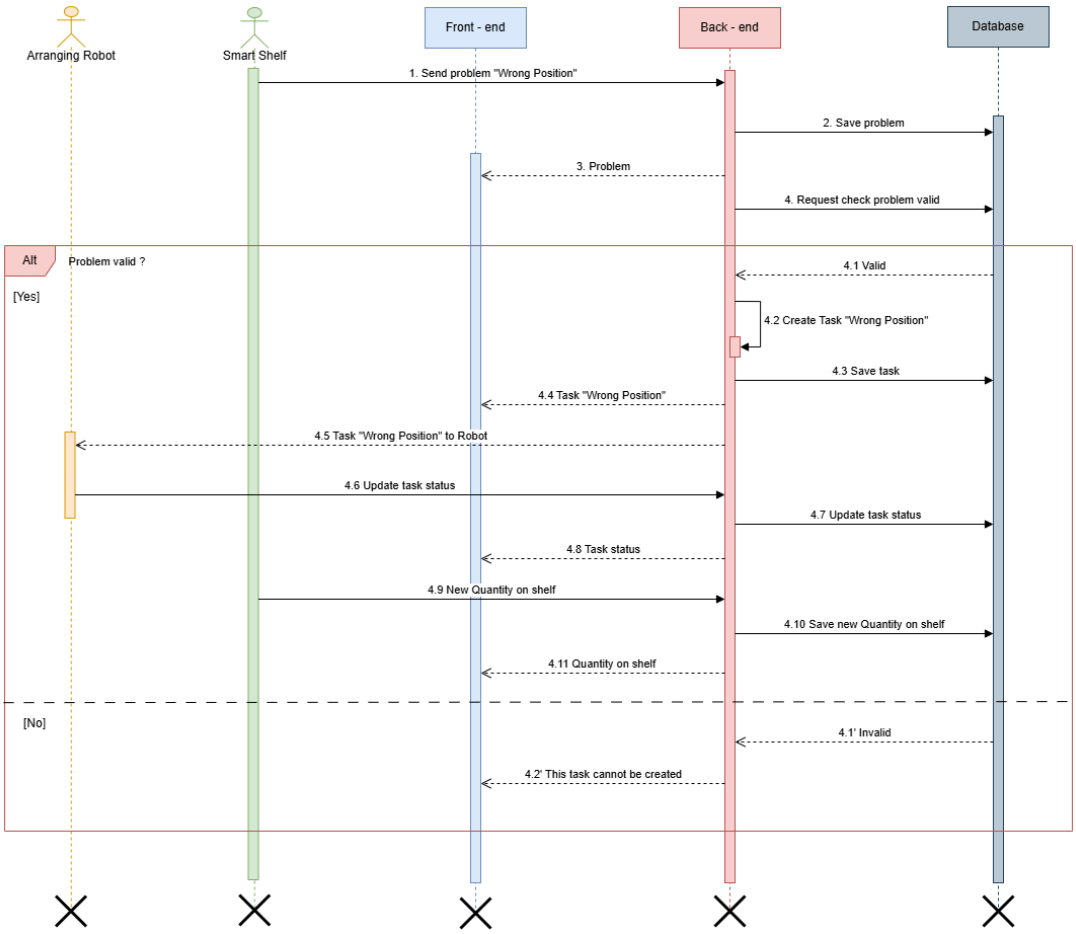

Figure 2.18 Sequence Diagram of Handle misplaced product

2.4.3.3 *Mockup*

Robot Queue: Task "Handle misplaced product" will be shown on this page for each robot.

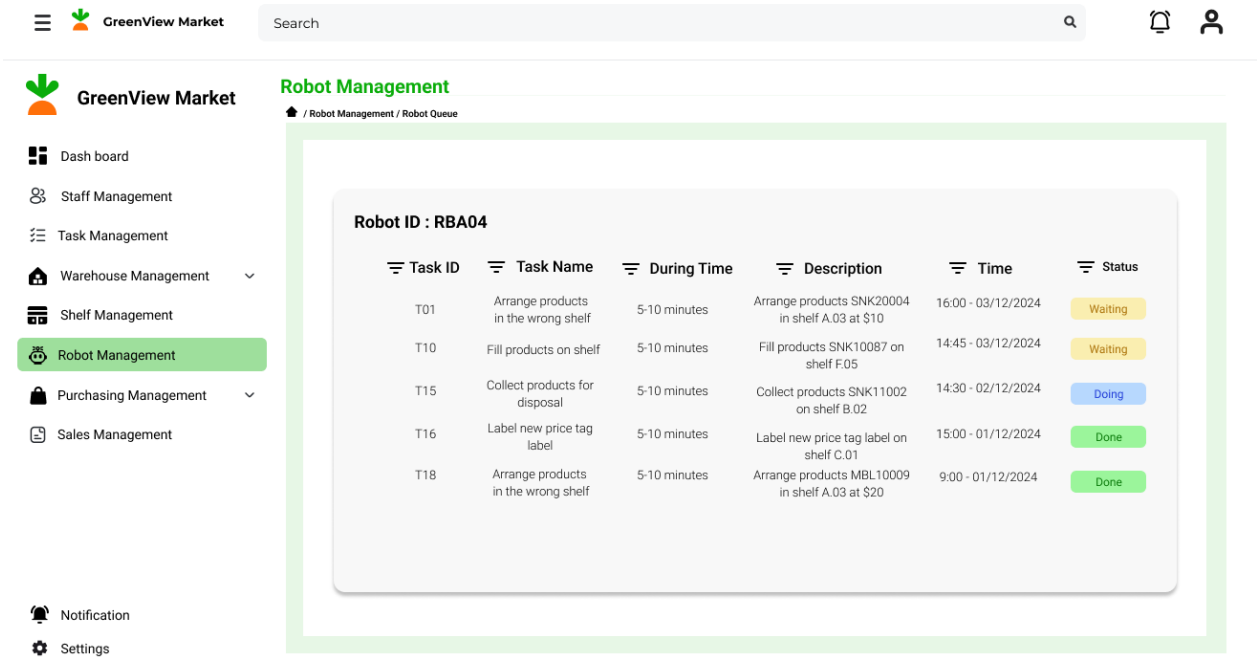

Figure 2.19 Robot Queue

2.4.3.4 Business rule

ID	Rule Type	Business Rule
BR-WS-1	Smart Shelf *(Rule for Robot)*	Trigger every 5 minutes → perform action
BR-WS-2	BE	Trigger: if smart_shelf.problem == "Wrong Shelf"
BR-WS-3	BE	Check if problem exists in database within the same time frame → if duplicate (invalid), skip task creation; else, create task and assign task.

Table 2.212 Business rule Handle misplaced product

2.4.4 Main Feature 4: Handle Discontinued Product

2.4.4.1 Feature Description, output and actor

The Sales Department selects replacement products for discontinued items and sends them to the system. The system will trigger the "Handle Discontinued Product" process, automatically checking the inventory of the discontinued product and repeating this until the stock reaches zero (both on the shelf and in the warehouse). After that, the system will initiate the process of restocking the replacement product.

Output + Actors

Actor	Activity	Output
Sales Department	Select discontinued products and replacement products	Information of discontinued products and replacement products are shown in the Sales Management Page and Status “Discontinued” shown on Product Detail Page.
System	Create and Assign task	If stock_quantity == 0: Task is shown in the Task Management Page, Robot Queue Detail Page.
Warehouse robot	Provide the result	Task status, Goods Issue and New Quantity in warehouse are shown in the Task Management Page, Robot Queue Detail Page, Warehouse Management (Product, Goods Issue Page)
Arranging Robot	Send status	Task status is shown in the Task Management Page, Robot Queue Detail Page.
Smart Shelf	Update product	New quantity on the shelf is shown in the Warehouse Management Page.

Table 2.23 Output and actor of Handle Discontinued product

2.4.4.2 Sequence Diagram

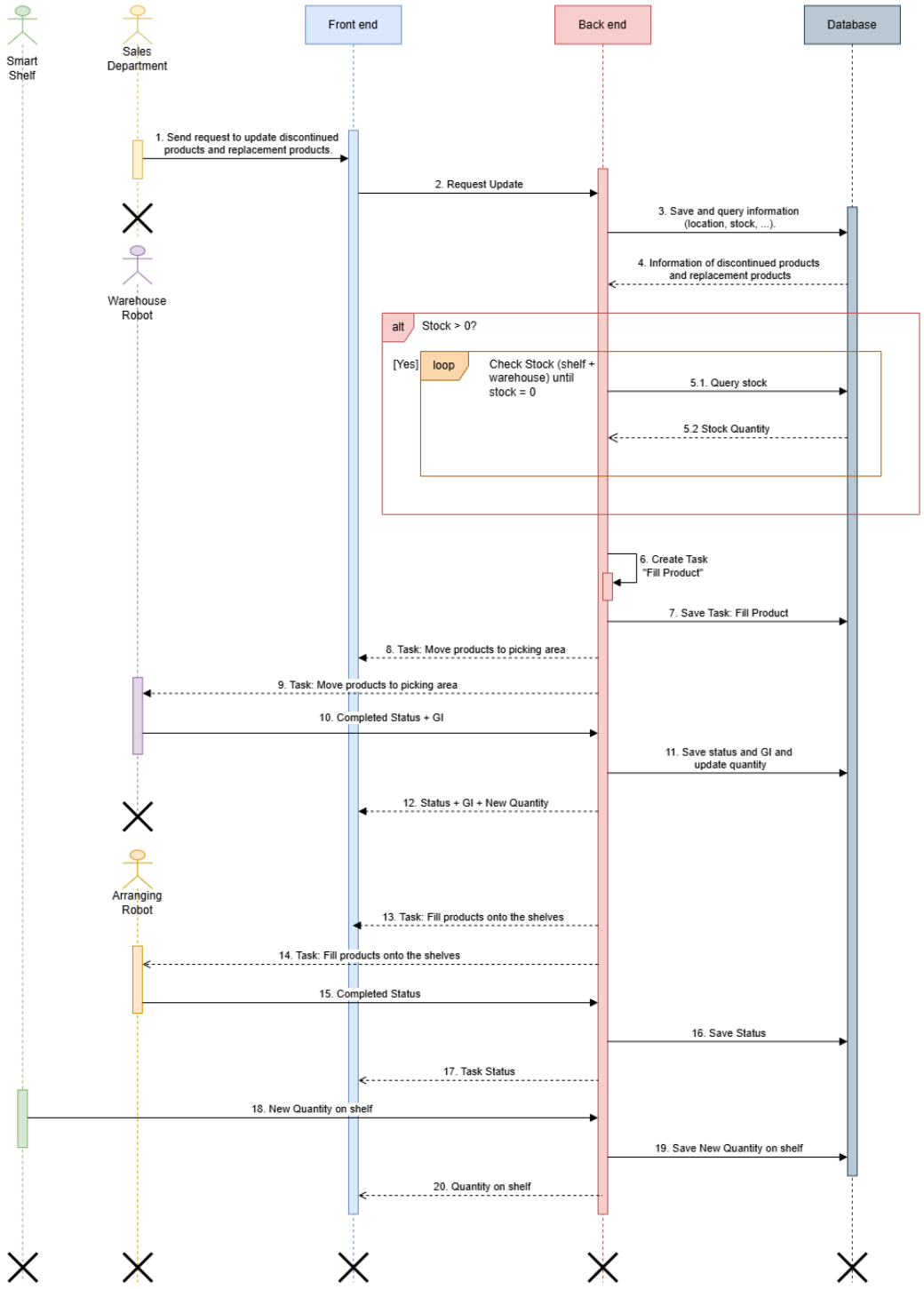

Figure 2.20 Sequence Diagram of Handle discontinued product

2.4.4.3 Mockup

Login: Staff use the provided account and password to access the system and perform operations such as inventory management, operation status tracking and robot management, etc.

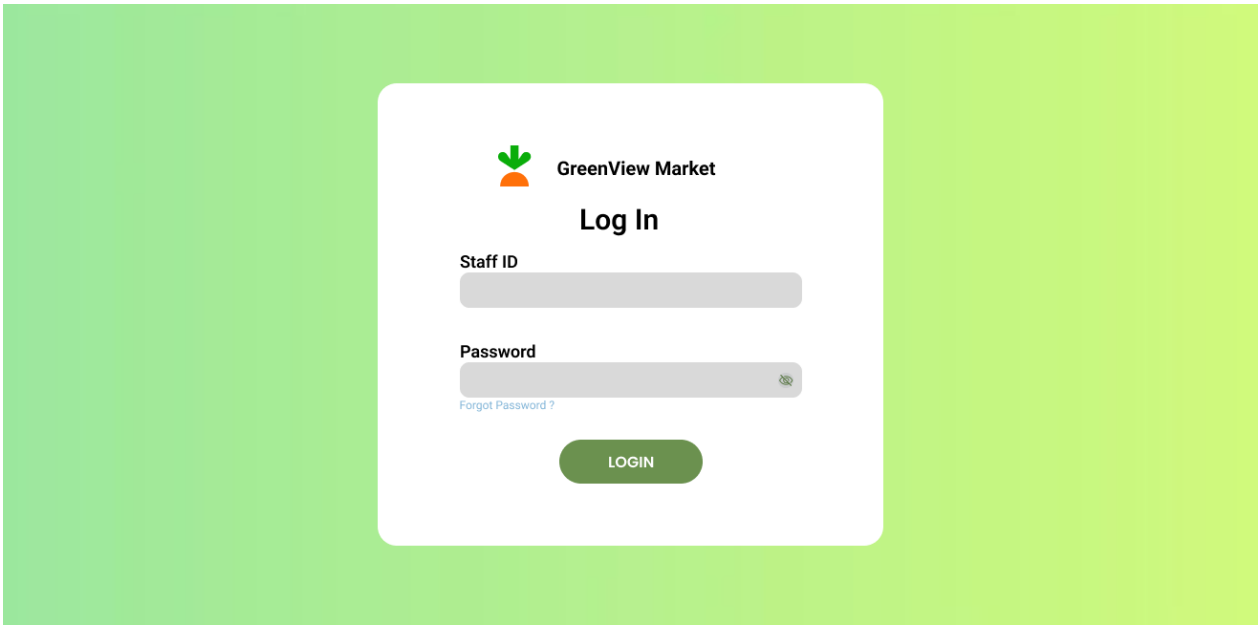

Figure 2.21 Login

Sales Management: This interface provides an overview of daily sales, revenue and top-selling products. View and manage notifications related to discontinued products to help employees quickly grasp the business situation.

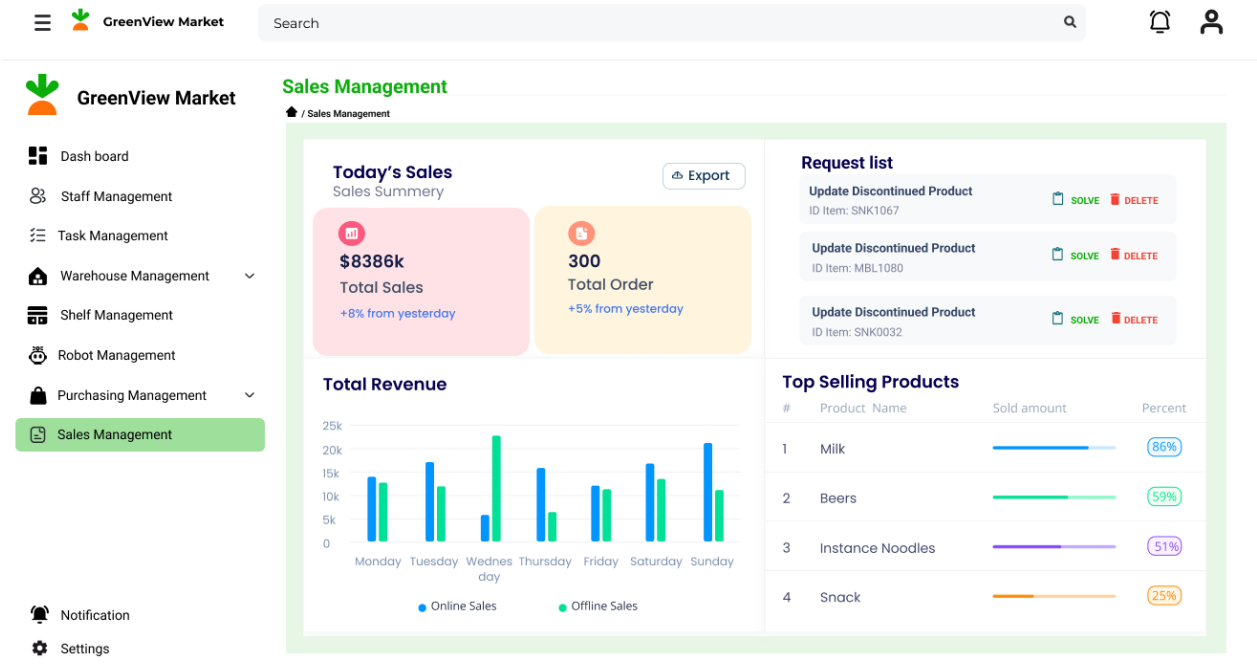

Figure 2.22 Sales Management

Product: This is the Product tab for Warehouse. It displays detailed product information such as name, description, category, quantity in warehouse, quantity on shelves, and price. Users can view detailed information about the product by ticking the checkbox.

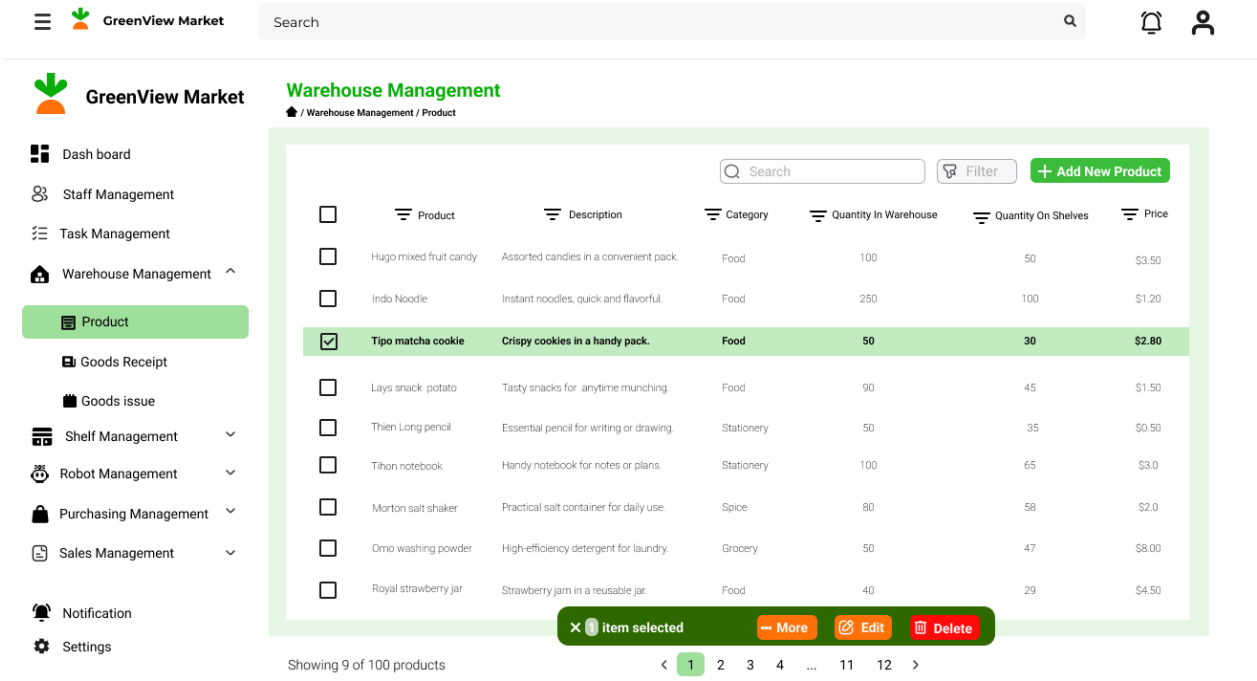

Figure 2.23 Product

Product detail: This tab displays detailed information about each product. Users can view detailed information including the product ID, imported date, expiration date, current quantity in stock, and on shelves. Additionally, the interface provides functional buttons to edit product information, view history, and add new products.

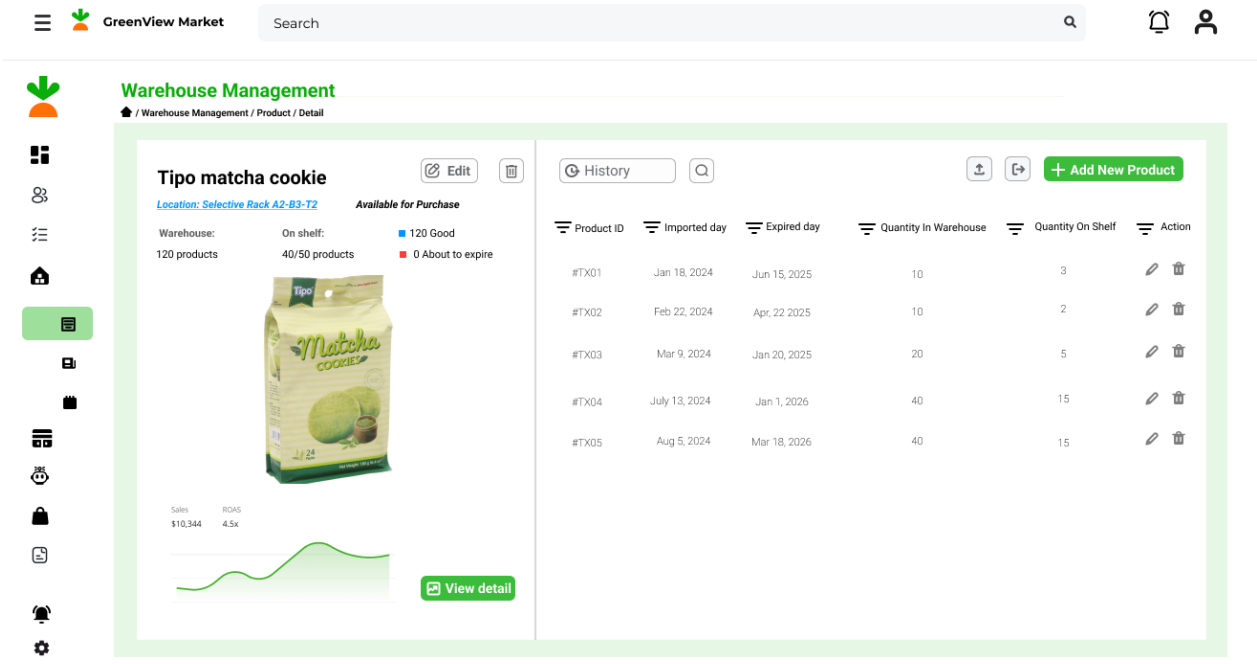

Figure 2.24 Product detail

Edit product status pop up: This tab displays a pop-up window being used to edit the status of products. Specifically, this pop-up allows users to change the product's status, select a replacement product, and update the new price.

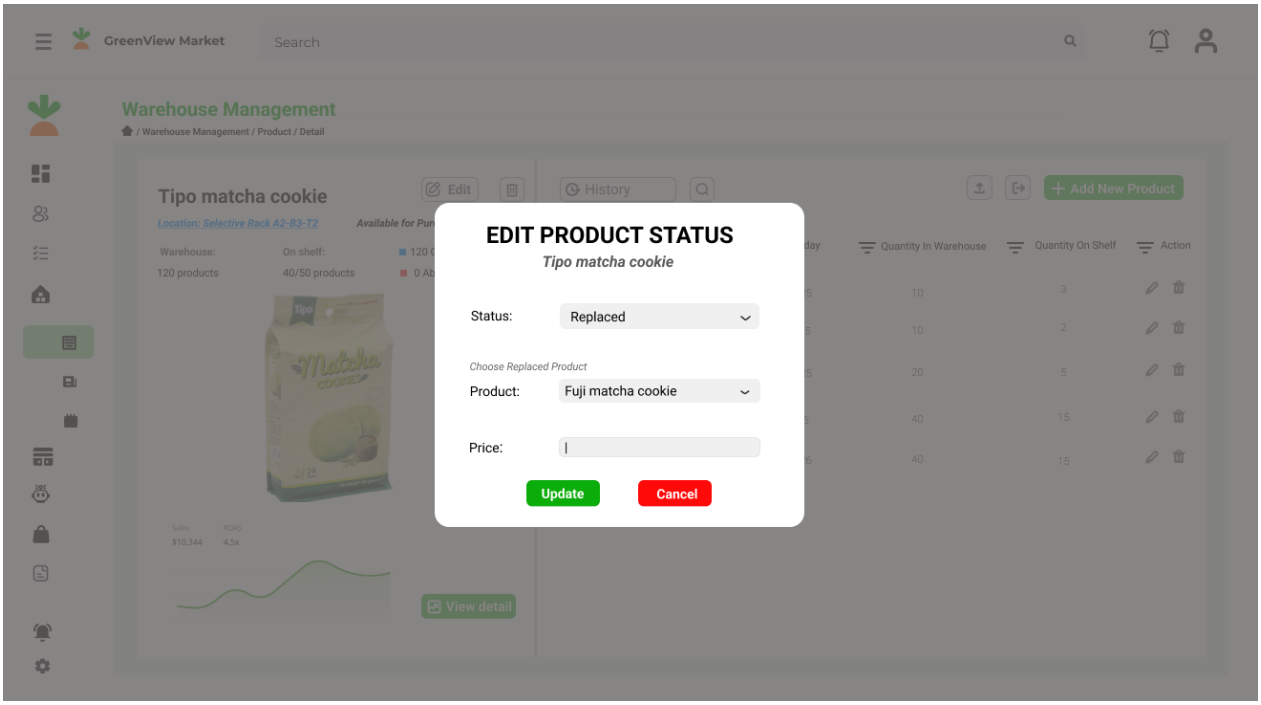

Figure 2.25 Edit product status pop up

2.4.4.4 Business rule

ID	Rule Type	Business Rule
BR-DP-1	FE	Button “Update” in Edit Product Status pop up is enabled when the Replacement Product is picked.
BR-DP-2	BE	Trigger: If product.status == "Discontinued", initiate "Handle Discontinued Product" process.
BR-DP-3	BE	Loop: Check stock of the discontinued product until stock_quantity == 0 (shelf + warehouse). If stock_quantity == 0, create restocking tasks for replacement products.
BR-DP-4	Warehouse Robot and Arranging Robot *(Rule for Robot)*	Follow FIFO (First In, First Out) rule when restocking replacement products from warehouse to shelf.

Table 2.24 Business rule Handle discontinued product

2.4.5 Main Feature 5: Manage stockout in warehouse

2.4.5.1 Feature Description, output and actor

When the inventory reaches the Safety Stock level, the system automatically generates a Purchase Requisition (PR). At the end of the day, this list is sent to the Purchasing Department for approval. The Purchasing Department approves each PR; if rejected, the reason is recorded, and if approved, a Purchase Order (PO) is created and sent to the vendor.

Output + Actors

Actor	Activity	Output
System	Generate PR	PR is shown in the Purchasing Management (PR Page)
Purchasing Department	Approve PR	PR status (approved/rejected) shown in the Purchasing Management Page. If rejected, the rejection reason is saved and displayed in the PR Detail Page.
System/ Purchasing Department	Create PO	PO is created and shown in the Purchasing Management Page (PO page)

Table 2.25 Output and actor of Manage stockout in warehouse

2.4.5.2 *Sequence Diagram*

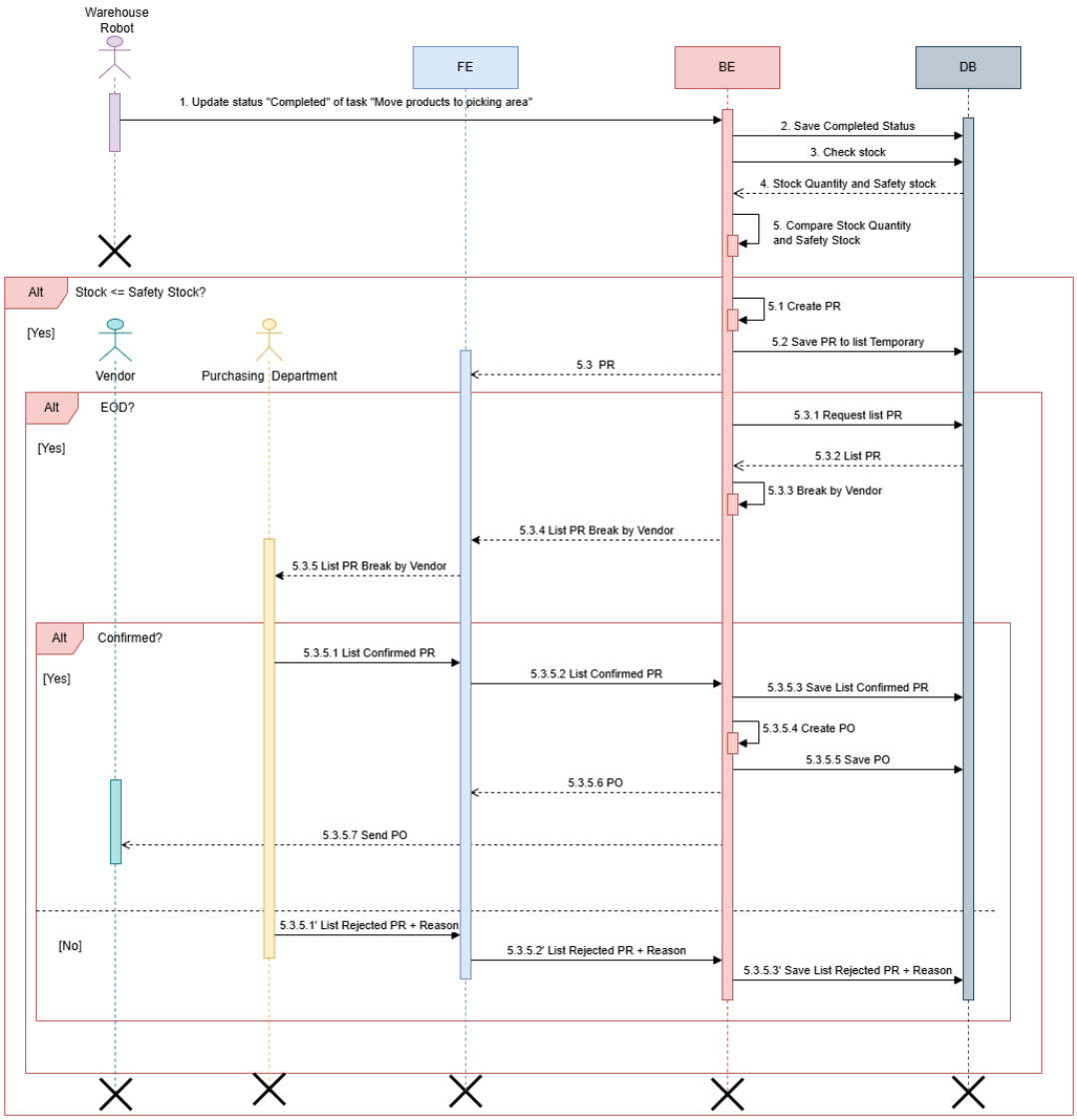

Figure 2.26 Sequence Diagram of Manage stockout in warehouse

2.4.5.3 *Mockup*

***Purchase Order*:** which provides detailed information about orders, such as order codes, suppliers, order dates, delivery dates, product categories, prices, and order statuses. Users can select PO items to send or print.

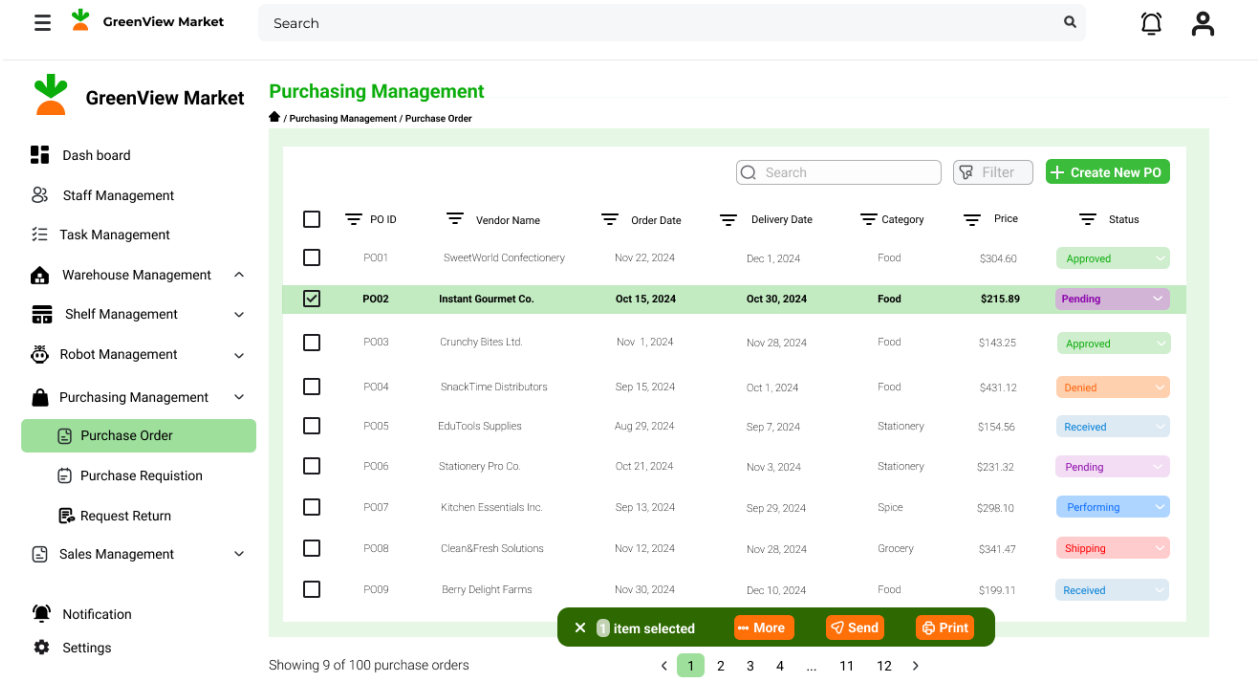

Figure 2.27 PO

Create PO: The tab for creating a new purchase order manually (not through PR), which provides fields to input information about the supplier, shipping address, date, list of products to purchase, quantity, unit price, and other additional costs such as taxes. After completing all the required information, users can proceed to create the purchase order.

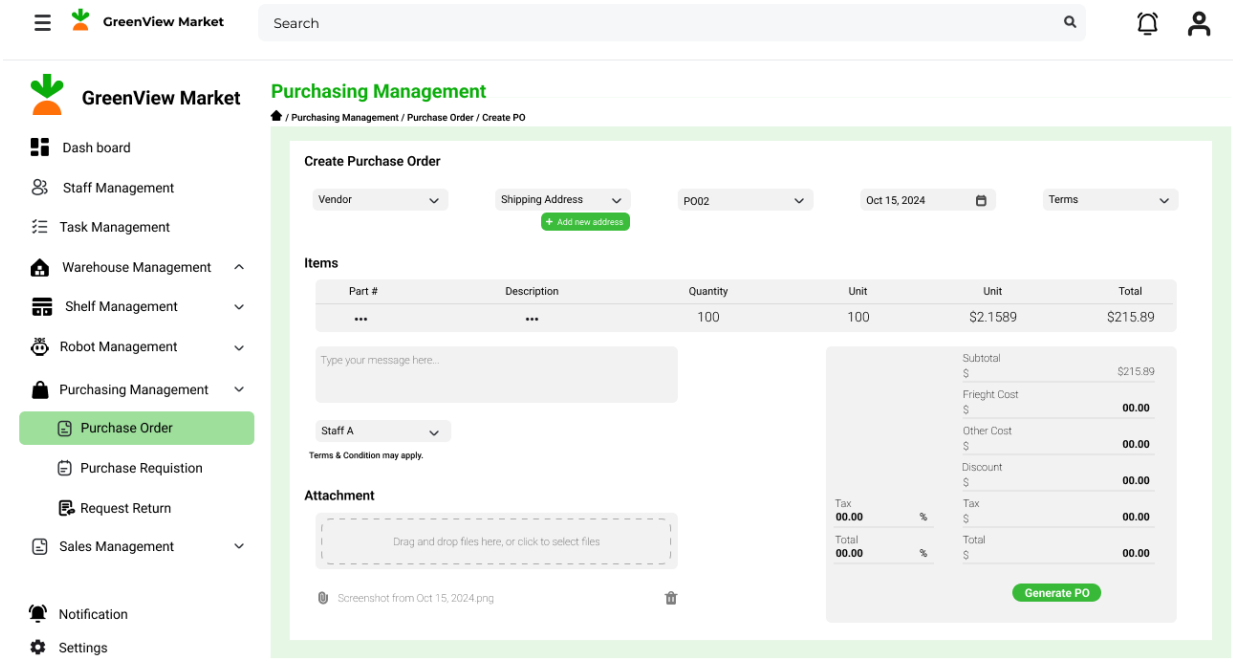

Figure 2.28 Create PO manually

Purchase Requisition: This is a list of purchase requisitions automatically created by the system. Each requisition is displayed with complete information, including the requisition code, vendor name, creation date, category, price, and the current status of the requisition.

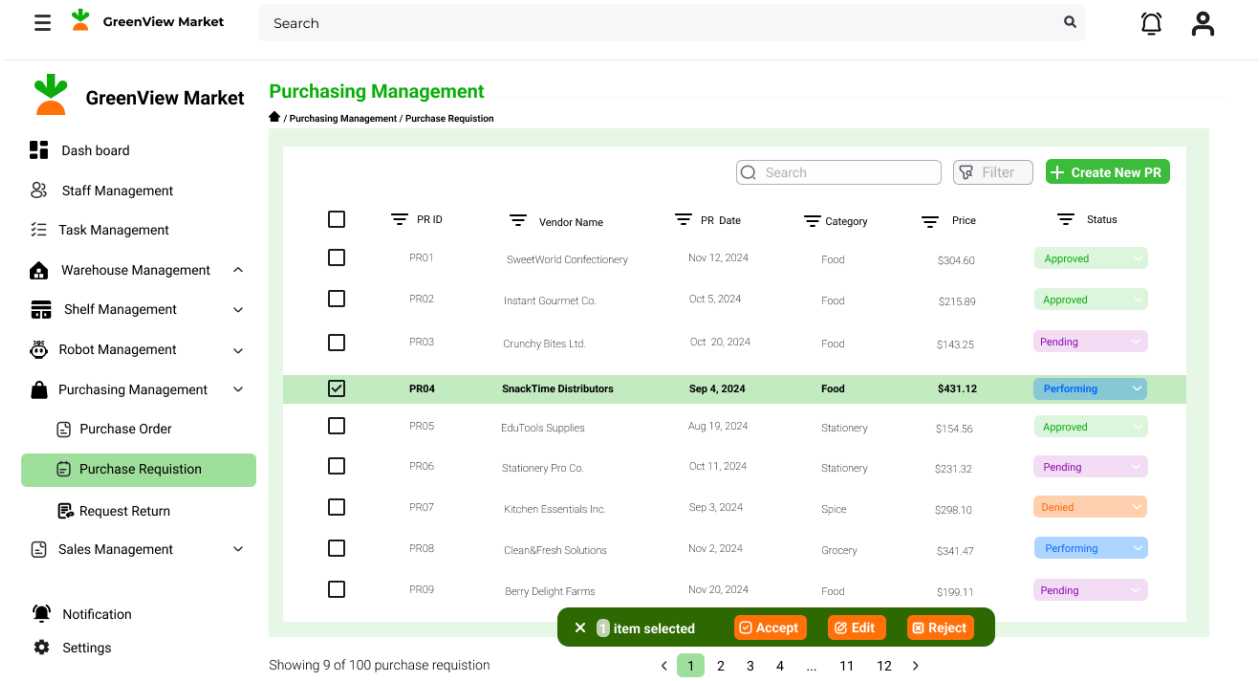

Figure 2.29 Purchase Requisition

Reject PR pop up: This is a pop-up window for rejecting PR. The Puchasing Staff can enter the rejection reason in the text box and confirm to complete the rejection process.

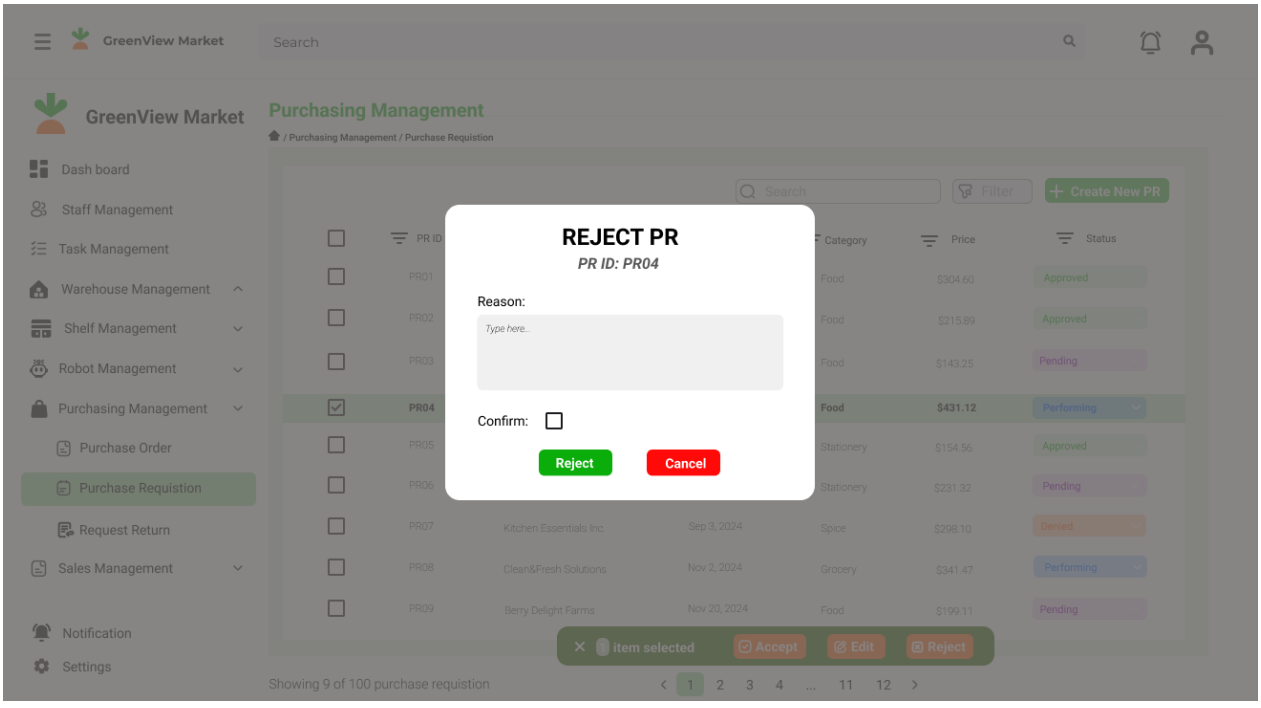

Figure 2.30 Reject PR pop up

2.4.5.4 Business rule

ID	Rule Type	Business Rule
BR-SO-1	BE	Trigger: If stock_quantity ≤ Safety Stock, automatically generate a Purchase Requisition (PR).
BR-SO-2	DB	Breakdown the list of PRs in Temporary PR by vendor.
BR-SO-3	FE	If PR status == "Rejected", Button "Reject" in Reject PR popup is enabled when the "Reason" area is filled.
BR-SO-4	FE	Button "Create" in Create PO Page is enabled when all text areas are filled.

Table 2.26 Business rule Manage stockout in warehouse

2.4.6 Main Feature 6: Receive goods into the warehouse

2.4.6.1 Feature description, output and actor

When a vendor delivers goods to the warehouse, the system triggers the process **"Receive goods into the warehouse"**, which involves assigning robots and the inventory team to handle and inspect the quantity and quality of the goods. The system ensures that all receiving information is recorded fully and accurately, generates a Goods Receipt report, and notifies relevant departments if any issues arise.

Output + Actors

Actor	Activity	Output

Purchasing Department	Confirm goods arrival	PO status shown in Purchasing Management Page
System	Create and Assign task	Task shown in the Task Management Page, Robot Queue Detail Page
Warehouse robot	Provide the result (for packaged products)	If the products pass quality inspection: Task status, Goods Receipt and New Product information in warehouse shown in the Task Management Page, Robot Queue Detail Page, Warehouse Management (Product, Goods Receipt Page). If the products fail quality inspection: Task status + Unqualified Product Information in warehouse shown in the Task Management Page, Robot Queue Detail Page, Product Page and Notification
Purchasing Department	Provide the result (for Fresh products)	If the products pass quality inspection: Task status, Goods Receipt and New Product information in warehouse shown in the Task Management Page, Warehouse Management (Product, Goods Receipt Page). If the products fail quality inspection: Task status + Unqualified Product Information in warehouse shown in the Task Management Page, Product Page and Notification

Purchasing Department	Send notification to vendor	If the products fail quality inspection: A request return shown on Return Request Page

Table 2.27 Output and actor of Receive goods into the warehouse

2.4.6.2 Sequence Diagram

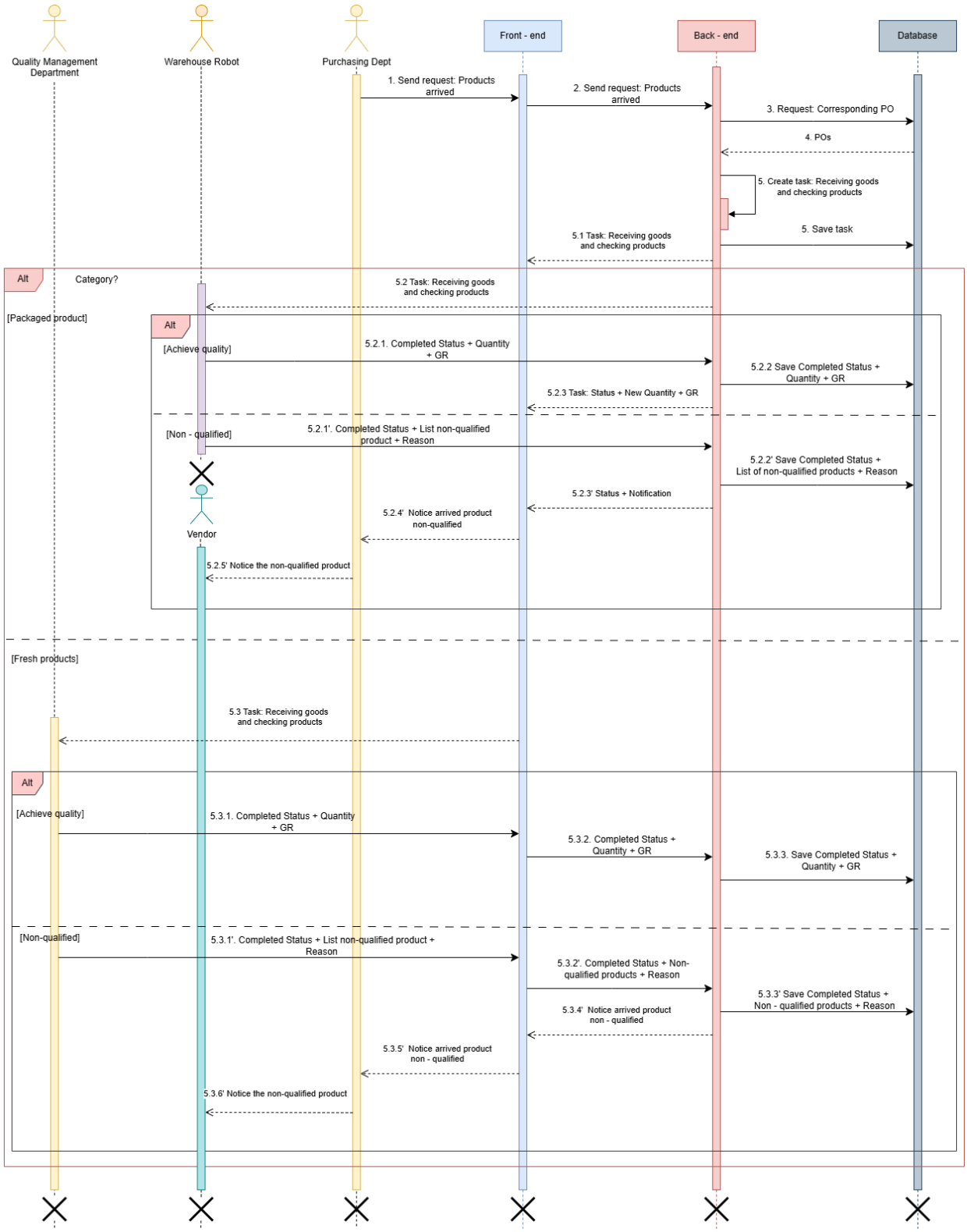

Figure 2.31 Sequence Diagram of Receive goods into the warehouse

2.4.6.3 Mockup

Goods Receipt: This tab shows a good receipt created when the vendor delivers products to the warehouse, created by the warehouse robot or employee. The interface shows a list of all goods receipts, including GR ID, created date, quantity, goods value and other relevant information.

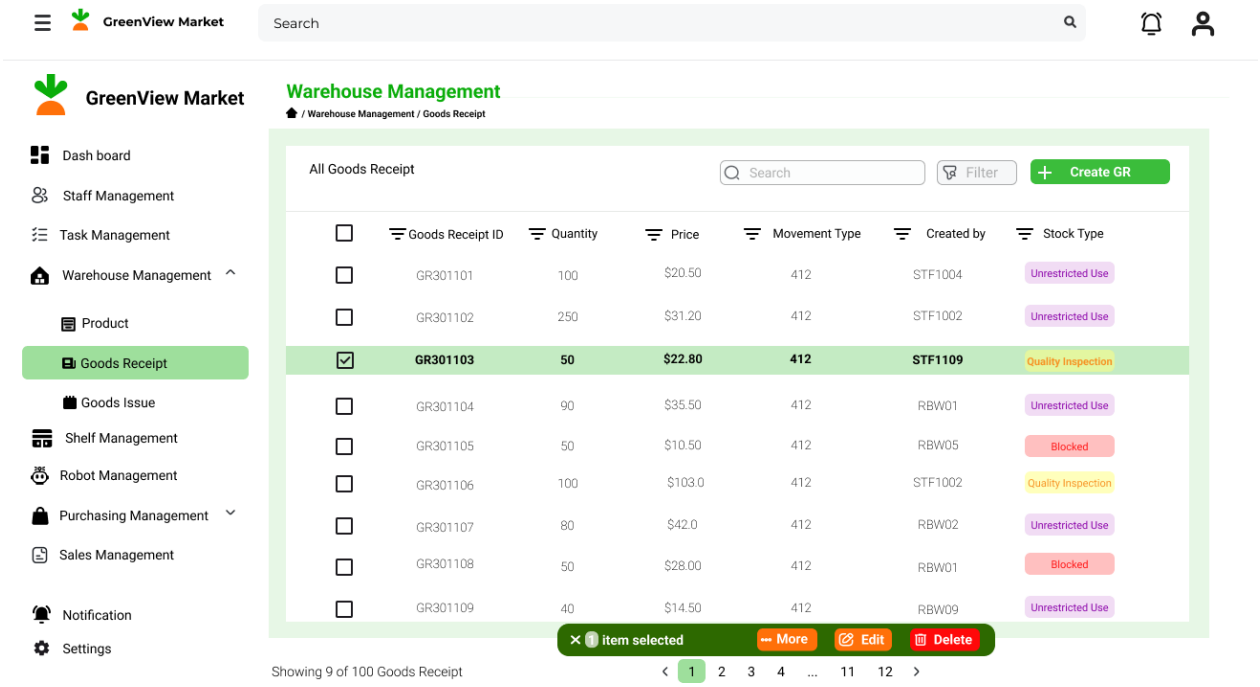

Figure 2.32 Goods Receipt

Create GR: The tab for creating a new Goods Receipt, which provides fields for QM staff to create GR manually. After completing all the required information, users can proceed to create the Goods Receipt.

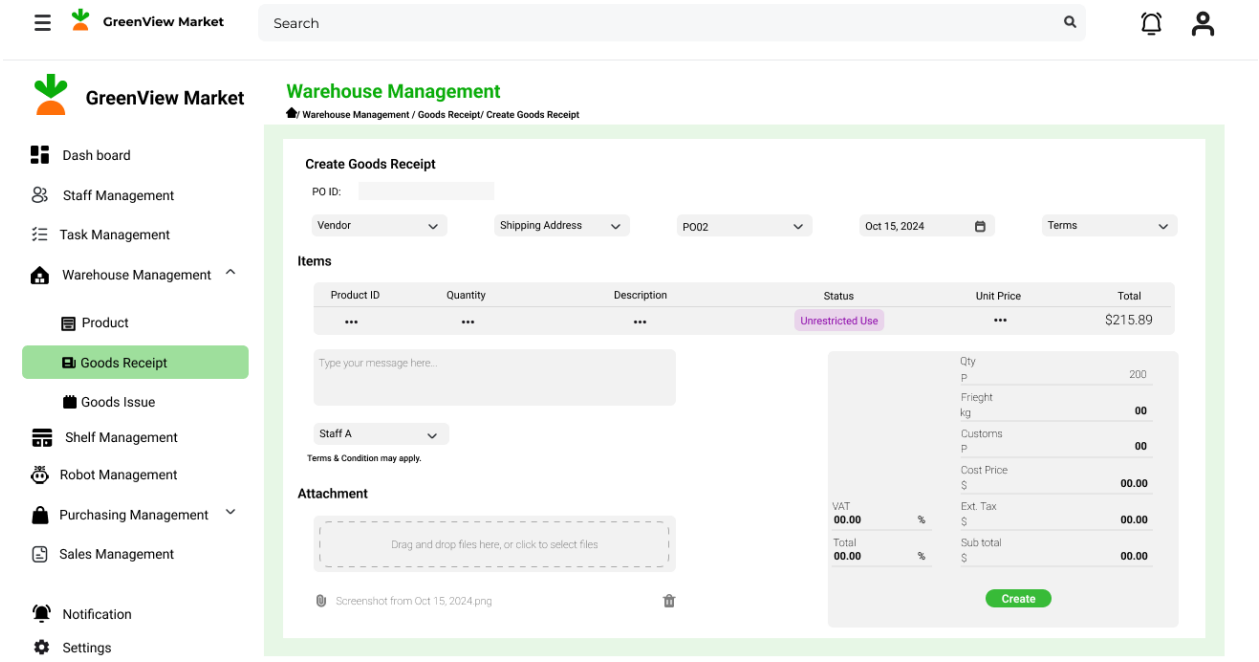

Figure 2.33 Create GR

Request return: This Request return tab provides detailed information about each request return when has non-qualified product, such as Request ID, PO ID, vendor name, request date, creator.

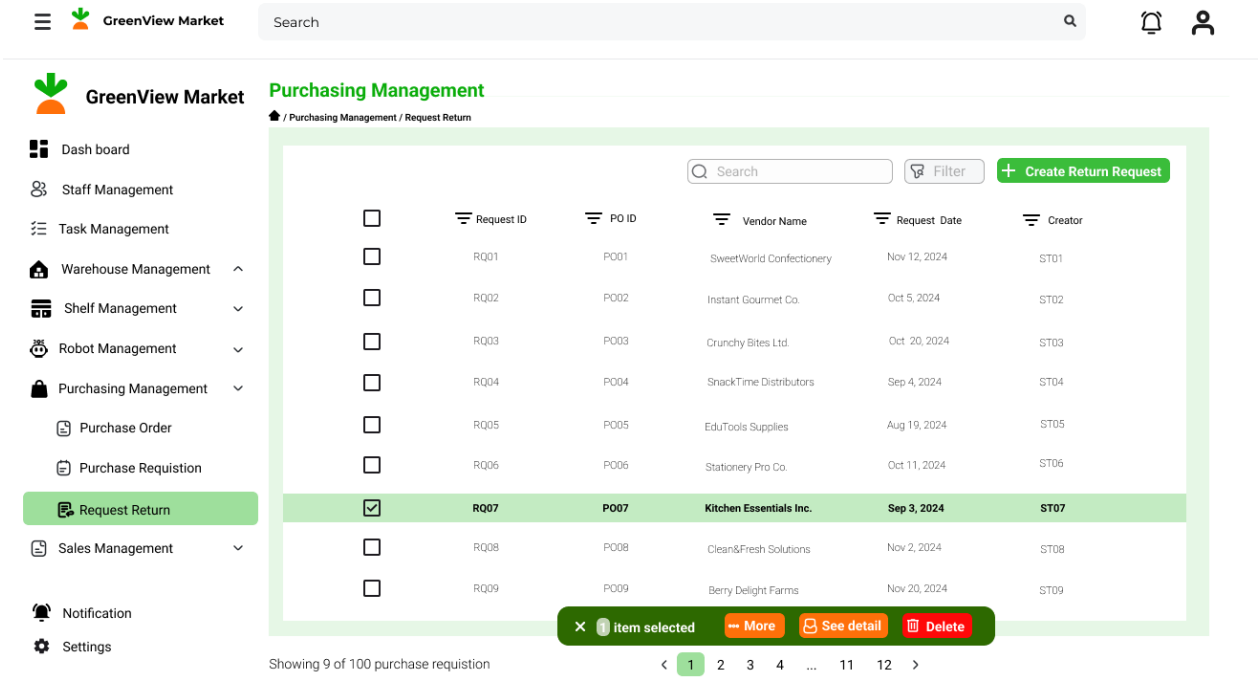

Figure 2.34 Request Return

Create request return: Create request return tab for Purchasing Staff includes fields for entering PO ID, supplier information, delivery address, expected return date, a list of products to be returned, quantities, reasons for the return, and allows users to attach files such as images and invoices as evidence.

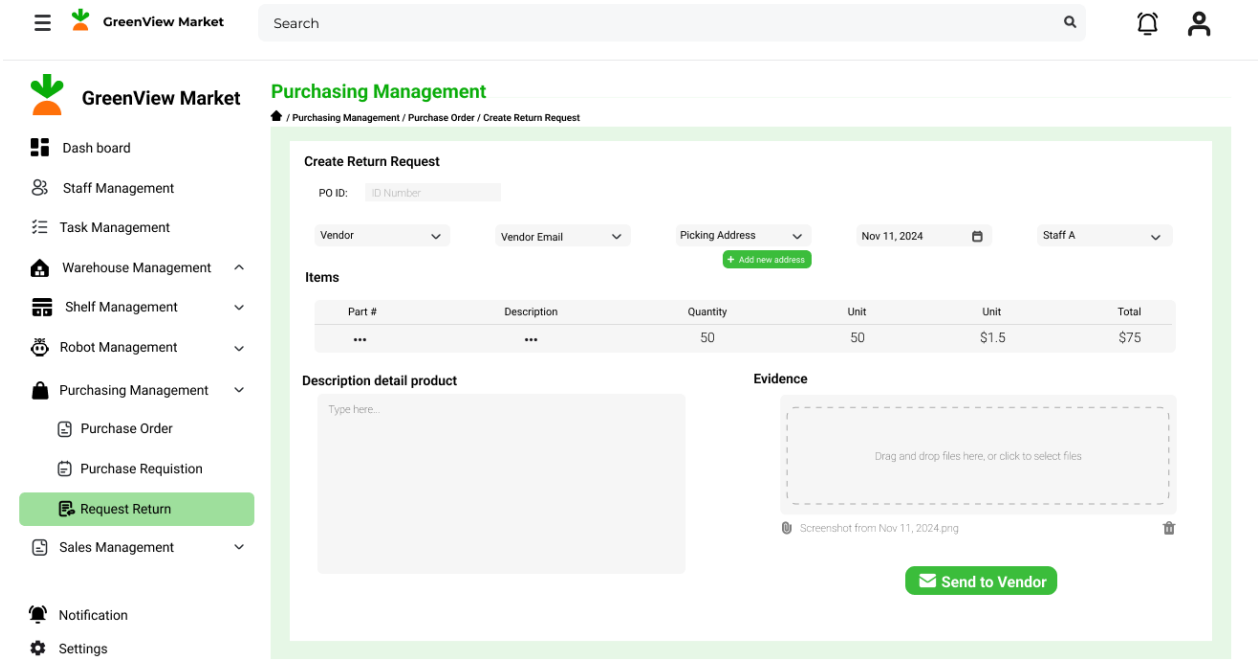

Figure 2.35 Create Request Return

2.4.6.4 Business rule

ID	Rule Type	Business Rule
BR-RG-1	BE	Trigger: if PO status changes to "Received"

BR-RG-2	BE	Check if problem exists in database within the same time frame → if duplicate (invalid), skip task creation; else, create task and assign task.
BR-RG-3	FE	Button "Create" in Create GR Page is enabled when “PO ID, Vendor, Items” Area are filled
BR-RG-4	FE	Button "Send to Vendor" in Create a Return request Page is enabled when related task of Warehouse robot and QM (check and goods receipt tasks) are marked as “Completed” and “PO ID, Vendor, Items, Evidence” Area are filled.

Table 2.28 Business rule Receive goods into the warehouse

2.4.7 Main Feature 7: Assign task

2.4.7.1 Feature description, output and actor

The system automatically performs the **"Assign Task"** process every 10 minutes from 8:00 AM to 10:30 PM daily, which includes ranking tasks by priority and allocating tasks to robots and relevant departments.

Output + Actors

Actor	Activity	Output
System	Rank tasks *(if multiple tasks are created simultaneously)*	Ranked tasks shown in the Task Management Page
System	Allocate and Assign task	Task shown in the Task Management Page, Robot Queue Detail Page

Table 2.2922 Output and actor of Assign task

2.4.7.2 *Sequence Diagram*

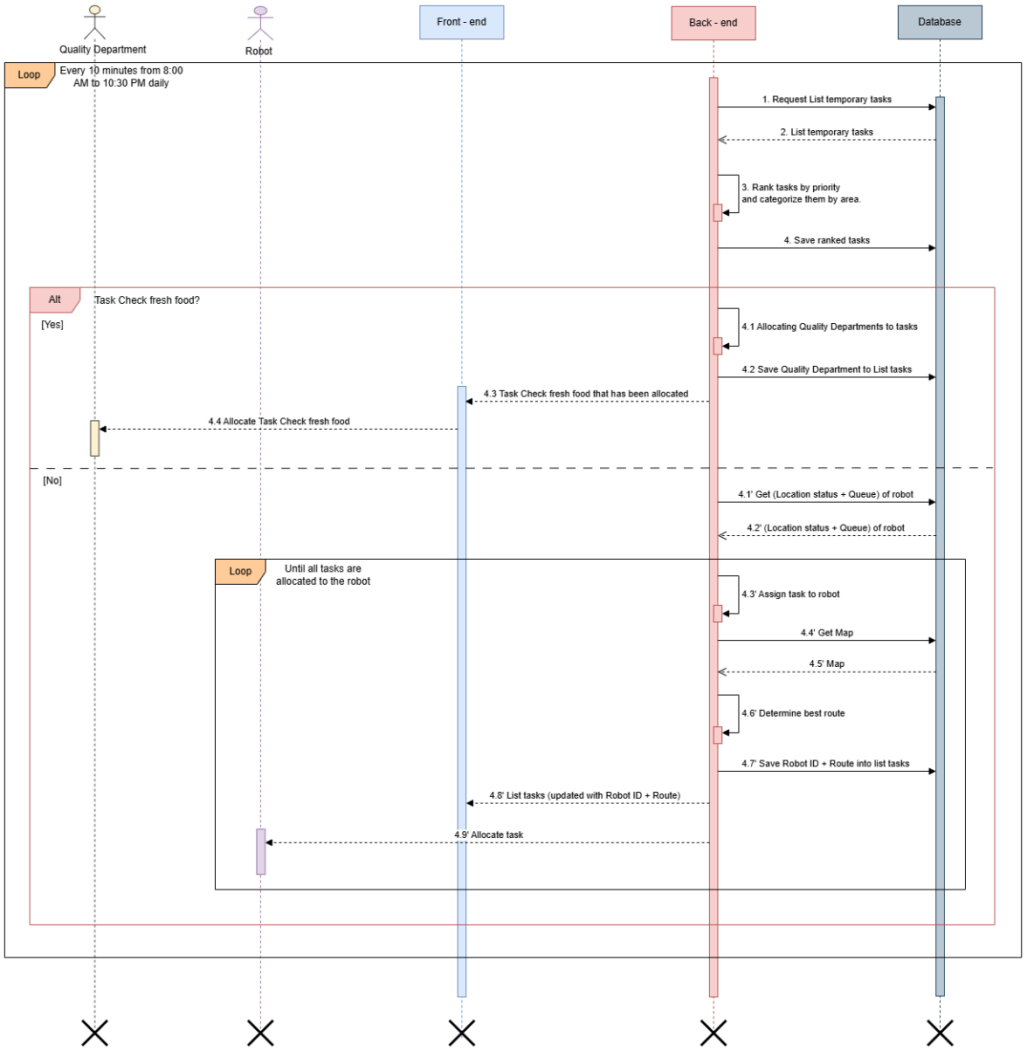

Figure 2.36 Sequence Diagram of Assign task

2.4.7.3 *Mockup*

Task management: It clearly displays the tasks to be performed including task ID, task name, duration, location, the status of each task, and information related to the robot executing the task.

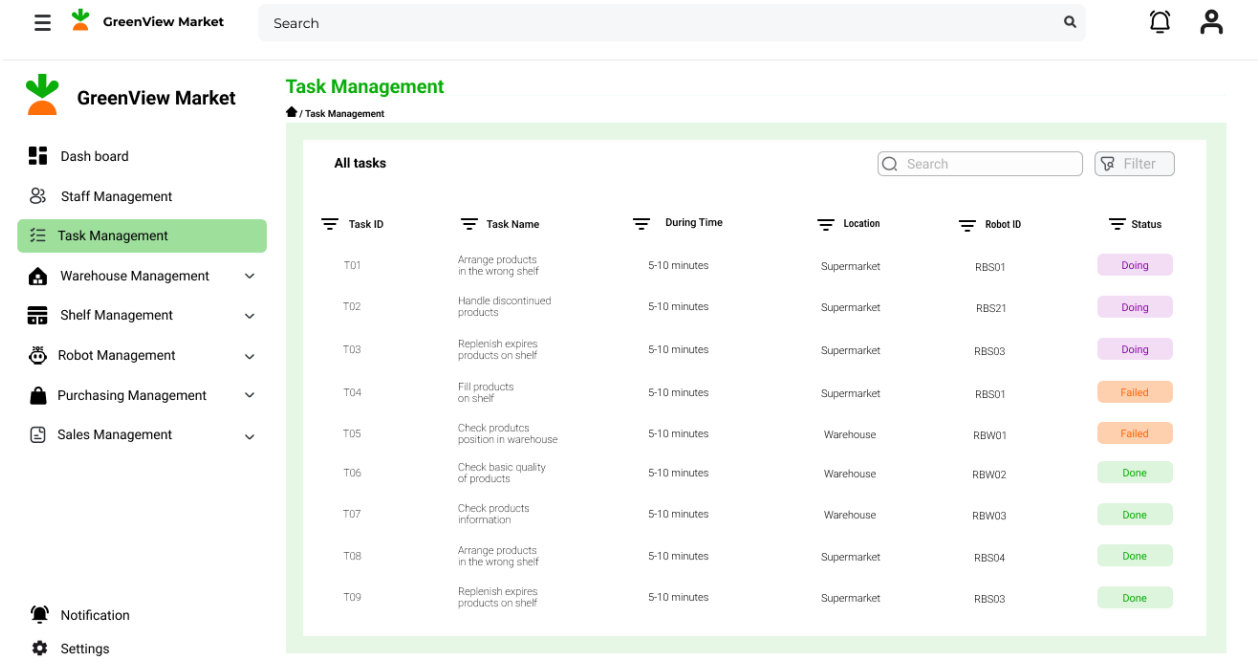

Figure 2.37 Task Management

Robot Queue: Which clearly displays the operating status of each robot and the tasks being assigned. Staff can view details about each task, including description, execution time, and status.

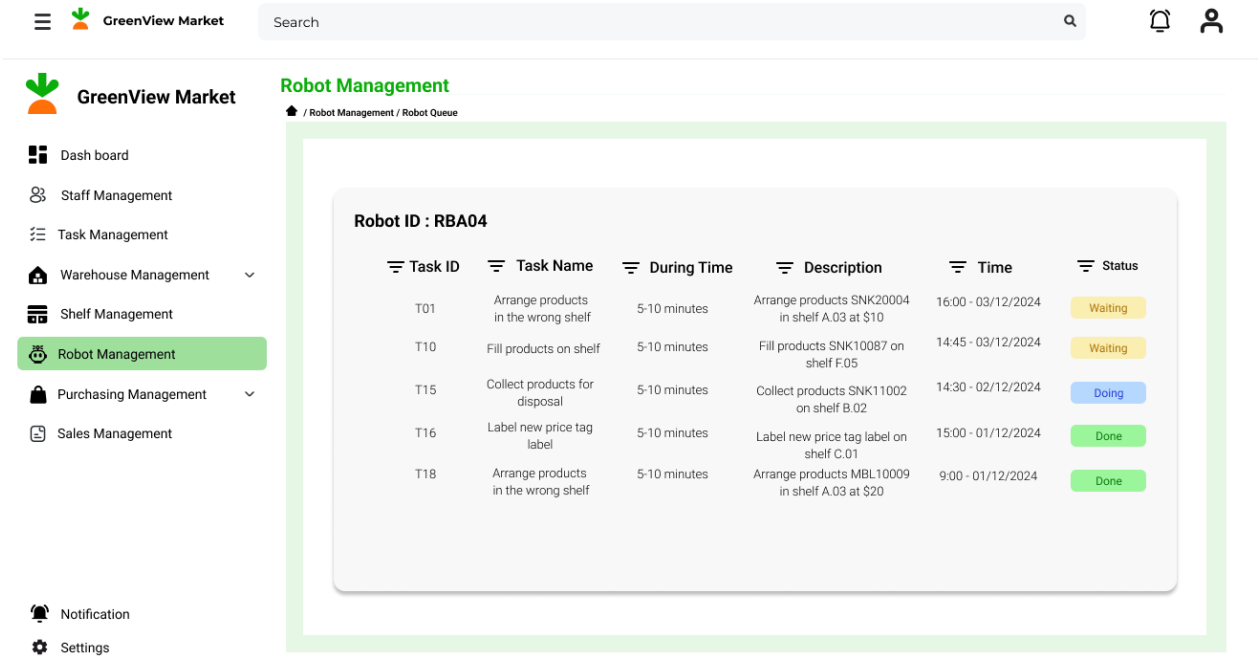

Figure 2.39 Robot Queue

Notification: Managers and staff can view notifications such as the robot is having problems, products with code SNK10008 are sold out, or warnings when the shelves have reached the minimum quantity. Managers can also view updates on the completion of created tasks or import processes.

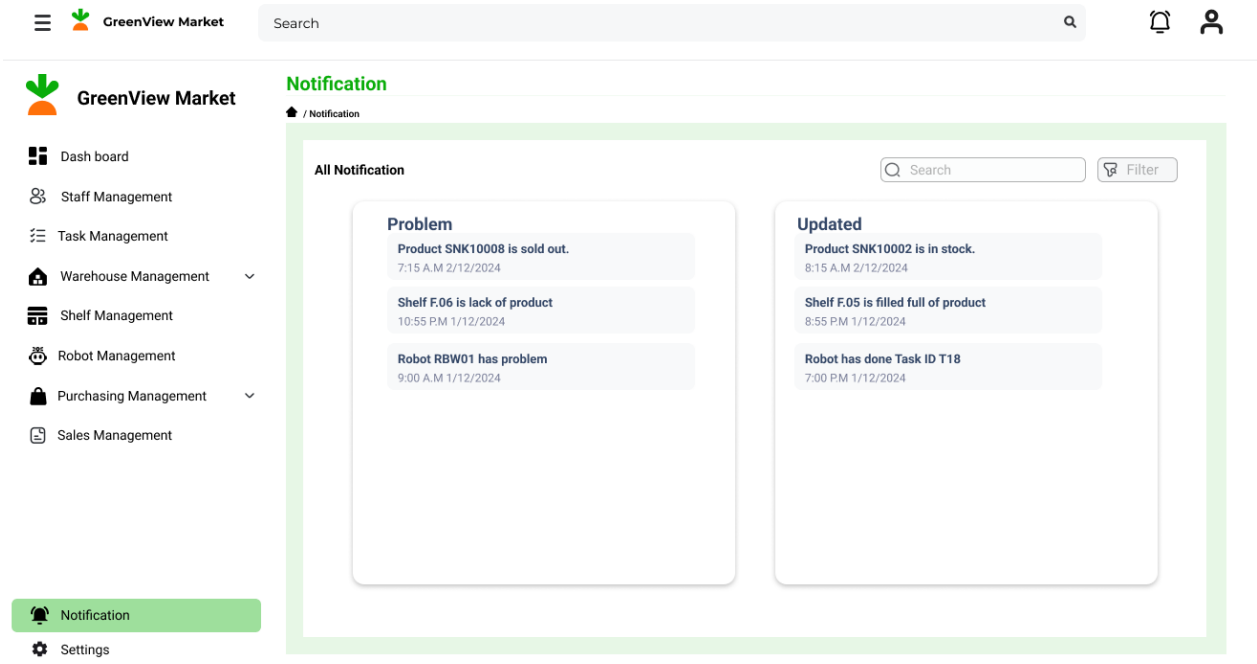

Figure 2.40 Notification

2.4.7.4 Business rule

ID	Rule Type	Business Rule
BR-AT-1	BE	Trigger every 10 minutes from 8:00 AM to 10:30 PM daily → start process
BR-AT-2	BE	Prioritize and rank tasks by area into the List of Tasks based on the following rules:

		• if area == "Market" → Task Priority: Fill Product > Correct Wrong Position > Remove Product • if area == "Warehouse" → Task Priority: Transfer to Picking Area > Replenish Stock • if area == "Cross-Area" → Execution Priority: Warehouse Robot > Arranging Robot
BR-AT-3	BE	Allocation for Tasks: • if task.type == "Check Fresh Food" → allocate task == "Quality Department" • if task.type != "Check Fresh Food" → allocate task == "Robot"
BR-AT-4	BE	Robot Allocation for Tasks if allocate task == "Robot" • if robot.status == "Inactive" → assign task to robot • if all robots.status == "Active" and robot.queue.size <= 3 → check robot.location after completing all tasks in robot.queue and calculate shortest route to task.location → assign task to robot with the shortest route to task location

Table 2.30 Business rule of Assign task

GROUP 3

THANK YOU FOR YOUR SUPPORT